

BIONETS

WP 3.3 – BUSINESS MODELS

NOKIA-TI-LSE

D3.3.2

Economics for BIONETS Business Models

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Summary

This document aims to present a selective view of the case for user-level business models that can be defined in the BIONETS environment. The complementary sources of this work are D3.3.1 and ID3.3.2 (Internal Deliverable 3.3.2) as well as common deliverables on BIONETS Application Scenarios (NOKIA) and the current project discussions that will determine the nature and evolution of the services at both the application or service and network layers. Business models for BIONETS are then further discussed in D3.3.3.

This document consists of eight sections and concludes with some reflections on the evolution of the applications models using the BIONETS infrastructure, and the description of computer model used to illustrate some of the business and economic models described in this document.

Document History

Version History

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0.6	<i>All sections</i>	<i>Revision</i>

<i>0.7</i>	<i>All sections</i>	<i>Major suggestions to enhance deliverable scope</i>
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<i>[1.1]^{note}</i>	<i>Post-review version</i>	<i>Including reviewers' comments and simulation model in Chapter 8</i>

Note

Reviews after final document delivery (Version 1.0) to the project may or may not result in modifications to the document. If post-review modifications are necessary, then the first version of the resultant document will be 1.1.

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1. EXECUTIVE SUMMARY

This document consists of a deliverable report on the work undertaken by NOKIA and the LSE within the context of the scope and objectives for BIONETS D3.3.2 due at Month 24. It cross-references the preliminary research work completed for the internal deliverable ID3.3.2, Economics of BIONETS Business Models (report that includes TI contributions), which explored the new business opportunities arising from the evolutionary framework at the core of this biology-inspired computational model.

An important task when developing this research work was to introduce to the BIONETS consortium the theoretical framework able to sustain several business models (conventional and alternative) able to be implemented using the BIONETS network, thus aiming to complete the work package research by presenting business cases analysis. The partners involved in this report are focussing their research on the presentation of a business case analysis for discussion and development as an interactive cooperation with all the other workpackages in the BIONETS project.

To follow up this research, the work package members have, over a number of workshops and discussions, elaborated a more consistent strategy to approach and development. This is for three reasons: firstly for integration of the work being carried out in different work packages; secondly for the consolidation of the descriptions of service scenarios; and thirdly for contributions to the definition of an integrated application framework layer.

Based on this ongoing work, this deliverable has applied socio-economic analysis as a point of reference to be taken into account for the analysis of the business models, and elaborated the analysis from both the point of view of the user and the system optimization of services. The output of this work has been merged with other consortium initiatives. A summary of such efforts is currently contained in an open internal document called Application Scenario Task Force: BIONETS Application Scenarios, which is currently in Round II of development.

This document shares one of the basic assumptions of the project that data propagation occurs mainly through opportunistic epidemic routing. In the context of BIONETS business models we refer to this effect as 'bio-inspired social networking' since it has a lot in common with the character of social interactions. The document compares the main elements of business analysis by addressing three use cases: *undersound* (LSE), Digital City with the particular case of Interactive maps (TI), and Personal BIONETS Platform (NOKIA).

The combination of more conventional analytical methods with potential revenue models based on the emerging context of mobile advertising, as well as others based on community currencies and economics of sharing, are also presented, accompanied by reflections on the limitations of such an analysis.

In response to a request from the reviewers at the 2nd project review, the document concludes with a chapter detailing and discussing an economic simulation framework that can accommodate different combinations of technical and business-level parameters in support of new business models for the BIONETS platform. Moreover, the simulation offers the possibility to the technical partners, provided they invest some work in specifying and implementing a suitable interface, to run this simulation environment on top of their infrastructural solutions, thereby providing a range of possible economic quantifications of the different networking technologies developed by the project.

2. OBJECTIVES OF THIS DOCUMENT

The aim of this deliverable is to present a business analysis focussed on the use case scenarios that are now at the core of the discussion on evolution, which all project partners are currently engaged in. These use cases are presented in the WP ALL- “Application Scenario Task Force” (Round II), which includes contributions from Nokia, TI , Create-Net and other BIONETS partners. This document only focuses on the business aspects of such scenarios and not on the whole core analysis of the many aspects described for the functional and non-functional requirements of the BIONETS infrastructure.

The common narrative of the deliverable will be to discuss, under the scenario umbrella of “Personal BIONETS Platform” and “Digital City”, the possible economic and business models that might emerge, grow, evolve, or be discontinued according to the bio-inspired models. The bio-inspired approach aims to ‘self-solve’, in real time, problems in which the nature of the BIONETS architecture with its opportunistic exchange, non-connected operation, and scalability can support the distribution of data clouds following social networking interactions.

In particular, the deliverable aims to focus its analysis on the applications currently being elaborated, developed and tested by partners in the BIONETS consortium. Those applications are *undersound* (which relies on the Service Framework and U-Hopper to different extents at different prototyping stages), Interacting maps (Digital City) and Personal BIONETS Platform.

It must be stressed that such economic and business models are being tentatively proposed for the moment, and will need to be verified at a later date when the applications have acquired greater definition or further progress in the project has been made.

[After the review and taking into account the feedback relayed by the EU reviewers of the project, an extra chapter has been added to this document \(Chapter 8\), which discusses a simulation framework for business and economics models for BIONETS.](#)

3. DEFINITION OF A SOCIO-ECONOMIC ANALYTICAL LENS FOR THE BIONETS BUSINESS MODEL

3.1 Modelling Technology as a mediator for value transfer

This section will describe theoretical principles used for alternative business models applied to the BIONETS services. Until now, the process of innovation in technology has been one that has generally been approached in traditional ways that do not properly consider the changes in viewpoint of new theoretical perspectives emerging, for example, from the Open Source movement or proposed by autopoietic models for systems development as part of complex simulation models [NL90, NL95], first implemented in social systems and later integrated into evolutionary models for biology research, in which innovation theory is still being researched. Our research aims to apply technological models to the economics of sharing, which underpins the BIONETS services.

3.1.1 Principles of Economics of Sharing applied to BIONETS Services

The aim of this section is to present a high-level model of the economics of sharing principles applied to the BIONETS Service layer. In doing so the aim is to interface the technology model applied to the BIONETS network with socio-economic theory that could contribute to the creation, evolution and sustainability of new or alternative business models.

It becomes evident that money is not only a medium of exchange and a way of quantifying value and carrying out economic transactions. Money is part of social life and activity, developing a two-way interaction with the overall societal system. On the one hand, money is used for exchanging or transferring goods, services or even sentiments, whereas cultures and social structures have a very important role to play in the ways in which money is shaped, categorised, ruled, used and evaluated [AZ89].

However, regardless of the self-evident social character and basis of money, there is particularly little literature and research into the social nature of money. The economics-driven utilitarian understanding of money dominates, 'as if it were not sociological enough' [RC79], and on the basis of definitions of money as: 'the most abstract and "impersonal" element that exists in human life' [MW78]. The field called sociology of money is thus particularly under-developed, largely ignoring that money is a 'réalité sociale' [FS34] and largely developing the instrumental conceptualisation of money as 'an arithmetic problem' [GS50].

The lack of sociologically-driven analyses of money's meanings and usages has been criticised by Barber as an 'absolutization of the market' [AB77], as if the market itself were free from social norms and cultural limitations. From that perspective, the free market does not exist, as people's decision to do business and exchange goods through money is always culturally and sociologically subject to qualitative restrictions derived from social elements of reality.

There is some literature approaching, from a consumption perspective, consumerism in a cultural and historical way [DM87]. However, the cultural foundations of money itself and of the constitution of the market have not been substantially addressed in the literature. Money is still discussed as an issue of 'how much' and less as a matter of 'how' or 'what', whereas the objectification and reduction of money to something quantitative and measurable, 'expressing the economic relations between objects...in abstract quantitative terms, without itself entering into those relations' (Simmel, 1978), does not allow us to see the symbolic and social value of money. Critical thinkers talk about money fetishism as the most 'glaring' form

of commodity fetishism, warning that money will become a ‘radical leveller’ that will allow the ‘equation of the incompatible’, entailing lack of trust and maximisation of risk.

In that sense, the economy-driven conceptualisation of money out of context raises questions about the quality of money per se, indicating furthermore the importance of a cultural account of money:

...a qualityless, absolutely, homogeneous, infinitely divisible, liquid object...money is a matchless tool for market exchange...Money is qualitatively neutral; personal, social and sacred values are qualitatively distinct, unexchangeable and indivisible...But money is neither culturally neutral nor morally invulnerable. It may well “corrupt” values into numbers, but values and sentiment reciprocally corrupt money by investing it with moral, social, and religious meaning. We need to examine more carefully how cultural and social structural factors influence the users, meaning, and even quantity of money. What is the relationship of money as a medium of exchange and measure of utility to money as a symbol of social value?
[AZ89]

Hence, what is needed is a contextualisation of money, a ‘sociology of money’ [TP+56] that would allow us to view money as a socially founded symbolic medium of social interaction and interchange, on a par with other symbols and social media. Money needs to be qualitatively categorised on the basis of social structures, social contexts, social interests and social purposes, in a way that ethnographic studies of the past have shown the existence of different types of money, for different classes and for different reasons.

Nowadays, economic psychologists talk about ‘mental accounting’ [SL+87], whereas this needs to go hand in hand with a ‘sociology of accounting’ [AZ89] which remains applicable and valid. This ‘sociology of accounting’ is needed in order for different social qualities and restrictions on the uses of money, on the users of money, on the allocation system of money, on the applied control mechanisms and on the sources of money to be identified and sufficiently taken into account.

Understanding the technological model

Understanding the socio-economic model implies the juxtaposition of this model to the technological model developed by the BIONETS infrastructure and an in-depth analysis of the potential economic relationships that can be formed by the different actors that are part of this model.

Economics of Sharing

Most of the contemporary economic models adopt a very simple model for human motivation: the basic assumption is that all human motivations can be more or less reduced to positive or negative utilities – things people want, and things people want to avoid. These utilities are all represented by the money or currency exchanged by members of society. There is plenty of room to discuss these assumptions, which are obviously not correct in representing the diverse social frameworks in which humans live. Community currencies’ continuous presence in social history has shown that humans do have other motivations besides the accumulation of money for their consumption of utilities, especially if there is a long-term view of how to use and manage human and natural resources. Like any other economic theory dominant in the XX century the utility assumption is currently subject to a revisionist process, where economic models can widen their assumptions for human motivation by creating a distinction between intrinsic and extrinsic motivations.

Extrinsic motivations are imposed on humans by external factors and social pressure that reduce the room for intrinsic motivations. There are two rewards associated with human beings in a social structure: economic and social standing [MG00]. As technological developments make society better networked, new ways of social production emerge [MC96]. Even so, ‘post-modern sharing is emerging from certain physical, rivalrous goods

and will increase due to advances in technology' [YK06]. Until now this sharing has not been extended to the spheres of 'social sharing, in which a third mode of organizing economic production, alongside markets and the state' [YK04], is being built up.

Intrinsic motivations such as the need for belonging to a community and being valued not only by the products or goods consumed, but also through the exchange of money, are better expressed in this post-modern sharing of resources. The economics of sharing is departing from these models of human motivation, searching for a motivation for human economic activity that goes beyond the value of human actions based on money exchanges; instead it builds upon human capital to create a more optimal distribution of wealth and resources that give not only a material but also a spiritual reward.

Although Benkler discusses the sharing of unused capital as the main manifestation of the economics of sharing [YK04], from a broader perspective what is understood as sharing is the ability to motivate human interaction or sociality besides the need to be awarded money for exchanging goods and services. The source of this type of sharing is a way of providing an interpretive and subjective space in which humans can allocate a subjective value to the sharing. This more explicitly social constructivist interpretation of the economics of sharing motivates our integrating it with the concepts, theories, and practical realisations of community currencies.

Current economics of sharing models contextually attached to the use of mobile technology are evolving over service platforms that are social networks in digital forms; the driver to share is expressed in several modes, for example:

- Sharing and distribution of electronic tokens between social networks of friends using I-mode enable phones in Japan [HR02]
- Sharing tokens, or paying for services through mobile services that are centralized, such as car parks, vending machines, and others.
- Sharing Contribution to the fitness valuation of mobile services, sharing moods or opinions about service quality.
- Bluetooth sharing of information in digital format (MP3s)
- Video Sharing (www.mytube.com), available on mobile format

These are basic forms of sharing that have been adopted by many mobile users around the world; a valid query is how a sustainable economic model of sharing, developed through mobile services, can be defined? Until now, sharing has provided only limited exchange between small groups of friends (e.g. Java applets) but has not linked such exchange to any monetary value. It is possible however to forecast a near future in which the economics of sharing will develop to produce exchanges in which the interest shown by the community of users would account for a variable exchange value for the goods or services exchanged.

A brief description of Community Currencies

The gap in the social and moral use of money, as well as the inherent contradictions in today's economic system, bring the necessity for an alternative to the fore; in this alternative view money will become a broader and more flexible concept, whilst its usage will serve not only financial aims but also social purposes, moral ideals and community interests.

This alternative model is commonly referred to as Gift Economy or Economics of Sharing. Economics of Sharing signifies the gradual shift of the study and reality of economics from a utilitarian to more complex and multi-dimensional perception of the use of money. The Economics of Sharing model maintains that beyond the external forces driving the use of money, such as economic and social standing [MG00], intrinsic incentives such as community and network building are of critical importance. According to the Economics of

Sharing, money can be thought of as a spiritual asset creating human and social capital and beyond its understanding as a medium of exchange, a unit of store and a capital.

However, the 'gift economy' model depends on reputation, trust, and mutual knowledge of those participating and being involved in transactions. The individuals or bodies providing the 'gifts' need to trust and engage with the gift recipients, a precondition that unavoidably raises issues of sustainability, scale development, incentives and stability. On the other hand, this presupposition acknowledges the moral advantages of the gift economy, where risk is minimized if not eliminated and extensive social capital comes to be added to the purely economic resources exchanged and traded.

Community currencies, in general, come to the fore as this kind of alternative, relying on a non-hierarchical structure, local or regional scale of diffusion and community-based principles and ground rules. The absence of a compulsory price system and of a restricting management structure [YB06] allows the money to serve participants' needs and to strengthen social bonds under the pre-condition of trust and reciprocity. In that sense, what mainly distinguishes risk economy from the ideal of community currencies is that, whereas the risk economy locates risk on the side of individuals [JJ04], community currencies attempt to minimise risk by shifting responsibility to community and the power of the community spirit.

The Open Source/Free Software community, where source code is accessible for development by anyone who participates in the community, is an illustrative example of the information gift economy. In the Open Source community, individual contributors gain prestige and respect, and the community as a whole benefits from better and continually evolved software. Giesler [MG06] in his "Consumer Gift Systems" has developed music downloading as a system of social solidarity based on gift transactions.

BIONETS node infrastructure from an economics point of view

The node infrastructure can be explored as a potential place for the emergence of a community currency. This can be provided by the exchange and allocation of value to the diverse aspects of technology transfer, by sharing either services or infrastructure within the layout settings provided by BIONETS. We should point out that until now conventional economic models and parameters for valuation of the BIONETS node infrastructure have been used.

The bio-evolutionary nature of the network provision allows the development of new economic relationships between such nodes that are themselves also in evolution depending upon the roles and values assigned to such roles. This requires further research because it is required for a clear understanding of the parameters in use for the provision in the U-nodes and as well at the service layer.

3.1.2 Socio-technological actors and value transfer

From the social science point of view the technological components included in the BIONETS infrastructure can be assigned relative transfer values according to either a static framework in which such actors are allocated values that do not change over time, or a bio-composed self-evolutionary framework, which will determine variations of the transfer value according to the evolution in services and infrastructure.

Another issue to take into account is the relationship between the self-referential economic models and relative values for value transfers. At this stage it is difficult to determine who are the socio-technological actors or how the value transfer components are defined.

3.2 Mobile Business Models and BIONETS use-cases

This section describes theoretical principles and analytical lenses used for alternative business models applied to the BIONETS services as well as conventional perspectives for the analysis of business cases based on the BIONETS service architecture. In the preliminary work completed in ID3.3.2 the work of the partners addressed the models available, first by understanding the hyper-cycle curve for autonomic services, i.e. modelling technology as a mediator of value transfer, and then the mechanisms of value transfer that relate actors to the BIONETS systems. From these theoretical models it has become clear that the BIONETS architecture could be unique as the basis for novel business models in which the incentivization of transactions between nodes on a distributed network leads to new ways of providing services and uses of technology.

In the wider conceptualization of business model analysis applied to mobile business, many definitions of mobile business focussed on enabling business transactions through wireless devices confuse mobile commerce and mobile business [GC+03]. In the context of this document we take a broader view of mobile business, which includes “all activities related to a (potential) commercial transaction through communication networks that interface with mobile devices” [PT02].

In the words of Intel [BBC06], BIONETS infrastructure is able to provide services that can be defined at the nuclear and networked level "It's an internet that is proactive, predictive and context-aware." This envisages devices that are location-aware and access the internet over Wimax wireless connections. "Instead of going to the internet, the internet comes to us. We need a ubiquitous, wireless broadband infrastructure which eventually will blanket the globe in wireless broadband connectivity." The BIONETS vision is not dissimilar to Intel's, but aims to achieve ubiquitous connectivity through disconnected infrastructure-less networks.

A business model describes the logic of a “business system” for creating value that lies behind the actual processes [PP01]. A detailed conceptualization of a network strategy for development and planning, at the abstract level, serves as a basis for the implementation of business processes. At the higher level of analysis, a mobile business framework that relates such elements or actors can be proposed. In Figure 3.1 below such a model is proposed in an attempt to incorporate the elements relevant to the establishment of mobile business models frameworks.

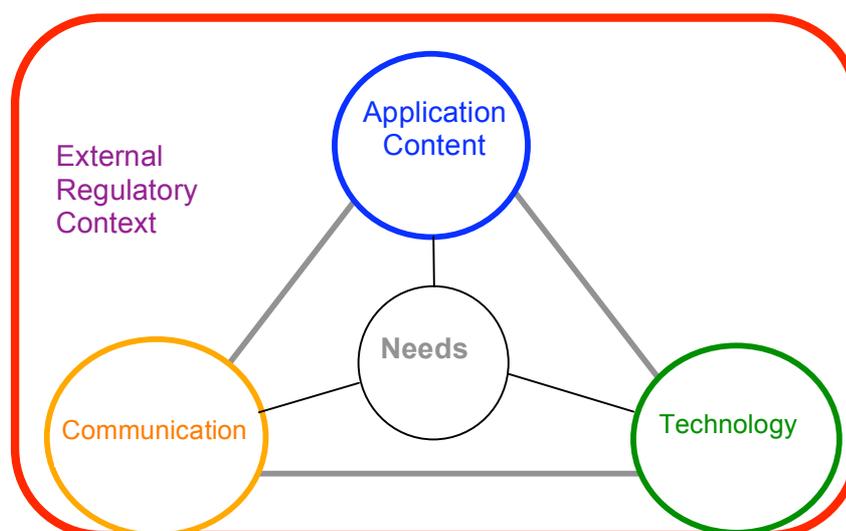


Figure 3.1: Mobile business framework (Camponovo and Pigneur, 2003)

BIONETS-inspired business models need to be described with reference to a socio-economic analytical lens which takes into account the restrictions that functional and non-functional requirements have defined as relevant for the development of service and network infrastructure in the project. By “functional requirements” we understand the variables linked to improving the experience of using services especially designed for the BIONETS architecture. Non-functional requirements are variables linked to improving the overall network architecture, either by expressing its variables through desirability, compatibility and best estimate or by best-guess survival, i.e. survival of the fittest in a technical performance optimisation sense.

Together with the mobile business characteristics that are specific to the economic phenomena associated with mobile operations such as mobility, network effects and proprietary assets, the use case scenarios selected fulfil the requirements of mobility understood as a combination of freedom of movement (services that are used while on the move); ubiquity (the possibility of using services anywhere, independent of the user's location); localisation (user's location information can be explored to offer location-based relevant services); reachability (users can be reached anywhere any time, and then the applications can be restricted and customised to the particular persons and contexts); convenience (as mobile devices are always at hand); and instant connectivity and personalizations (since mobile devices provide services that can store personal information, which can be used to provide personalized services) [FM+00].

Taking into account the economic network effects on services that can potentially be provided by the BIONETS infrastructure, an open question arises: formally speaking, networks are components held together by links. In BIONETS such components are dynamic and loosely associated, whereby the valuation of a network externality as proposed by Economides [NE94] cannot be simply quantified as the value of the units of a good (or link) increasing with the expected number of units sold. In loose networks, a space is created for communities of sharing in which the value of the network is reflected by the dynamic associations that can emerge from the services provided by the BIONETS network. Adding to the dynamic topology and new economic models, BIONETS business models are rendered even more challenging by the biological evolution that permeates the service and network frameworks. A possible integration could be obtained by treating market selection as a form of natural selection. This link will be examined more closely as the service and network frameworks are further developed.

Another element of conventional business analysis that changes radically is the exclusive control (by a mobile network provider) of important assets of a network. The possibility of producing economic exchanges excluding the main network is a real advantage of the BIONETS architecture that can be selectively coupled to wider telecommunications networks. The elements described in Figure 3.1 are expressed by primary and secondary actors that can be found at all layers of the BIONETS architecture. Taking into account the five main components:

- a. Technology expressed by the boundaries determined by device manufacturers and network equipment vendors.
- b. Services: the discussion in this document focuses on value-added services, content and applications that users or other network devices can access through the BIONETS mobile network: the symbiotic relationship between content providers (individual or networked), application providers, and payment agents/or exchange agents.
- c. Network, U-nodes, T-nodes that effectively work at the nuclear level as mobile network operator or ISP.
- d. Regulation, protecting the privacy of users, regulating the market and legislation and other requirements for service provision
- e. Users/needs determining the success or failure or evolution of BIONETS services or applications,

Figure 3.2 below illustrates the two possible models based on such a view of network control, which the BIONETS network can support with its current layout.

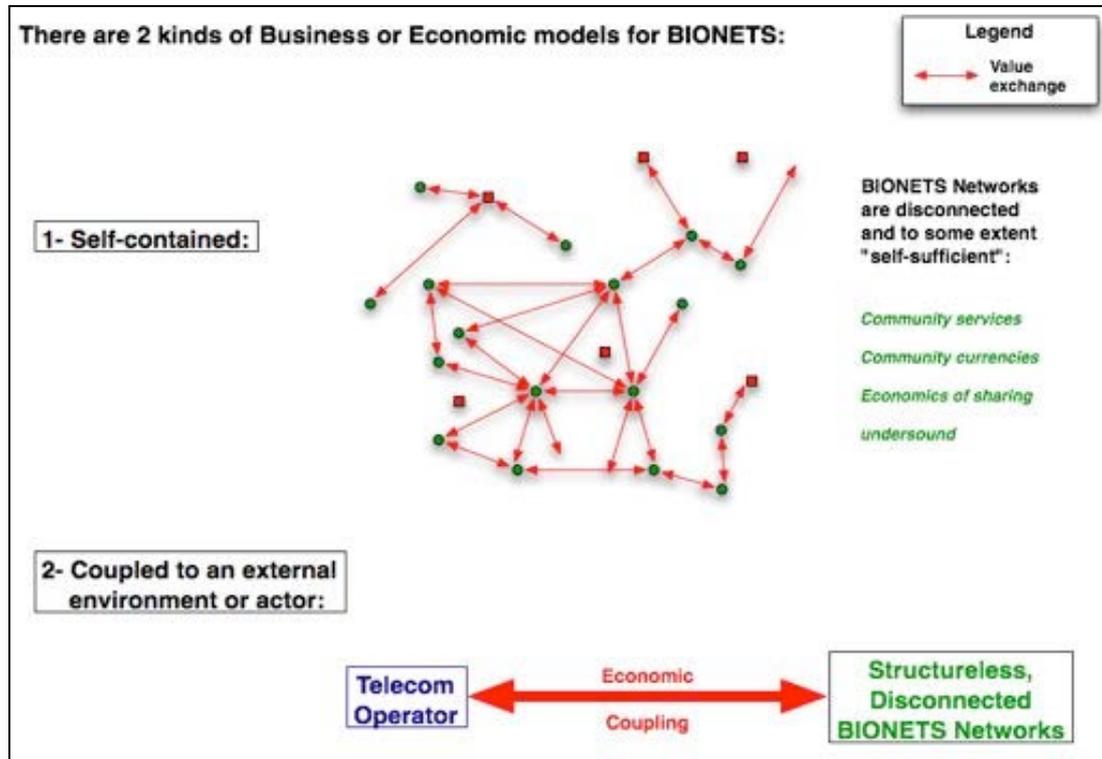


Figure 3.2: BIONETS Business Models

The implication of this model is that, at one level, the provision of complete mobile service solutions requires the collaboration of a large number of market players, including network operators and manufacturers. At the self-contained level, such partners are disaggregated to a more basic level of interaction, and a greater proportion of business value depends on social interactions and social networks of users.

At this stage in the project a number of possible case scenarios that have an overall integrated view of services within an evolutionary framework have given rise to a number of definitions that can be made for interpretative purposes. Queries still not determined or addressed are related to the actual working operations of these services for BIONETS features; for example the use of a disconnected "Disappearing Network" SerWork Concept, or Service-Driven Networking, or the use instead of data-driven networking. It is still to be determined whether the use-cases will find some kind of parallel in the autonomic behaviour proposed in BIONETS; at which levels of analysis, one or more; the type of service life-cycle; how user interaction is defined; and the possible performance issues related to data dissemination, energy consumption and speed for BIONETS mobile devices.

In this model the aim is to link the many elements of the BIONETS project in a consistent description that links the general features of the services with actual business cases linked to the use cases. In doing so, the operational concepts merge with the services currently developed. Figures 3.3 and 3.4 below present how the integration of some of the use case scenarios, to be discussed in further detail in the next sections, can be integrated into the two-layer model described in Figure 3.2.

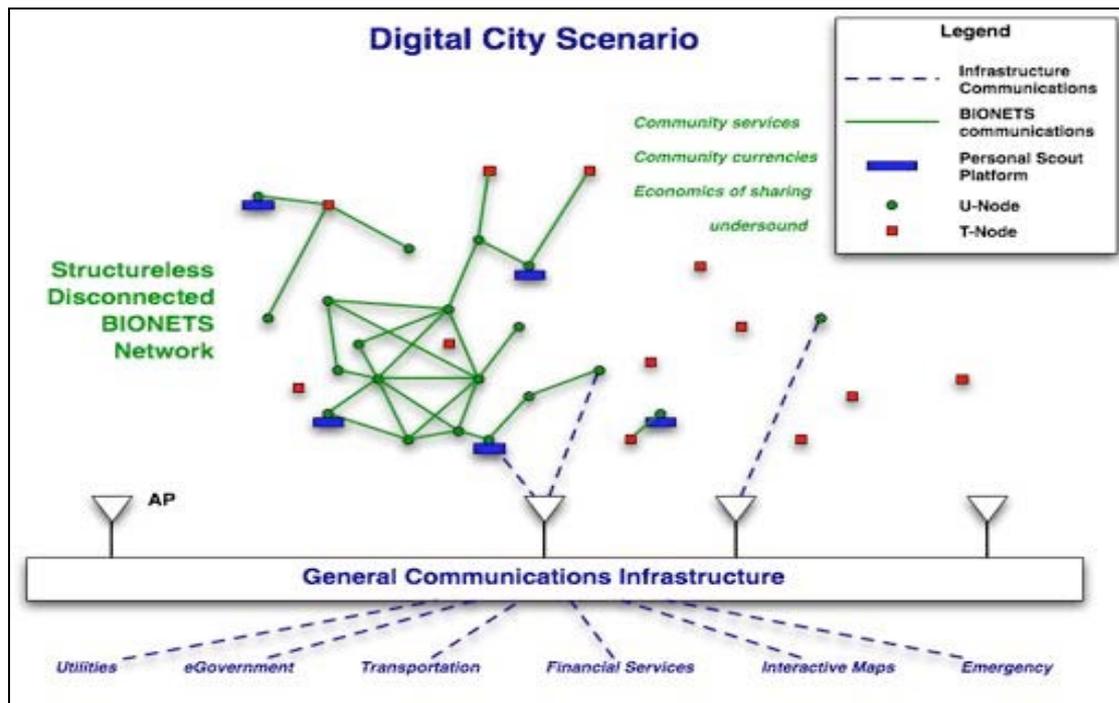


Figure 3.3: Digital City Scenario

Figure 3.3 stresses the structureless disconnected services and applications provided by the BIONETS network, providing opportunities for services that are time based, sharing-oriented, and perhaps token or exchange-based.

Figure 3.4 aims to express the symbiotic and evolutionary mix of services when aggregated to established backbone networks such as the general communications infrastructure provided by more conventional valuations of network assets and interoperability between actors or elements of the business models associated with the BIONETS network.

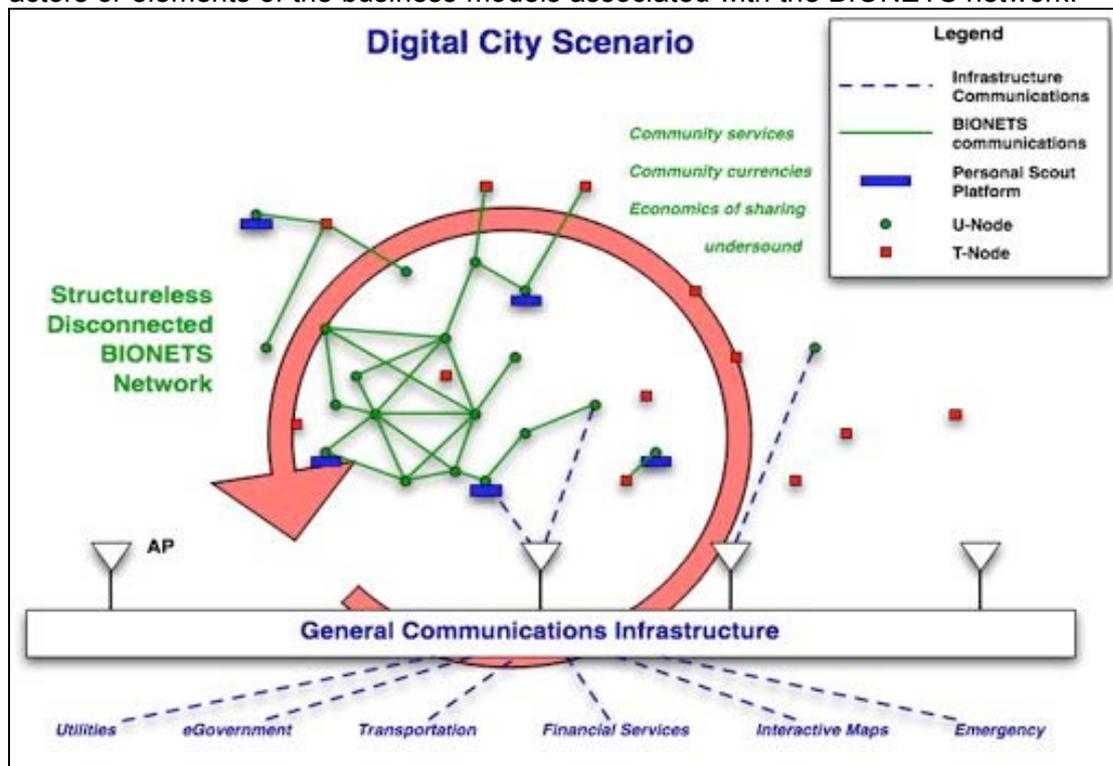


Figure 3.4: Making the need for economic coupling explicit

This approach to the analysis of business models for mobile technology is, to say the least, innovative and creative in understanding the integration of components that are, in economics terms, considered to be deterministic for establishing a mobile value for such networks [JL+00]. Services such as utilities, e-government, transportation (booking information, etc.), financial services, interactive maps, or emergency services are in the first instance designed and deployed to take into account a significant investment in infrastructure.

However in the case of the BIONETS network the loosely associated networks such as *undersound* and Personal BIONETS Platform (also known as Personal Scout) have a sense of formation that is dynamic and ephemeral, contextual and situated in time and space. Networks such as *undersound* and PBP will, given certain conditions, exist for long enough to provide meaningful exchanges of data which have a relative economic value. This economic value is relative as it cannot generally be directly quantified using conventional methods of business analysis.

In some cases – take the example of the Personal BIONETS Platform – access to linked networks is layered by secure and insecure communications. For some, a kind of registration to a service provider is required, which allows authentication with permissions for financial transactions that are perhaps stored and communicated to a third party. In the more dynamic and ephemeral networked links, the level of security seems to be lower, in terms of establishing personal peer-to-peer and social services which do not require security and are unlikely to be persisted in a centralised database to keep records of exchanged information.

The economic model introduced by the BIONETS architecture is a fragmented platform for collecting and disseminating sensor data and other information. It works on personal devices (mobile phones, PDAs etc...) which act as U-nodes possibly containing some T-node functions (sensors). This modelling also works on the Personal BIONETS Platform. The mobile device introduced to the BIONETS Habitat "will collect sensor information which will be stored in a distributed semantic database together with time and location stamps. All collected data will be stored for some relatively short period of time after which BIONETS Habitat(s)¹ will process it to long-term storage based on service/user/community preferences".

These disconnected networks have a common purpose of establishing an exchange community in the BIONETS Habitat, rather than simply replicating existing services that are in many cases already provided by the web and TELCOs. Hence the Personal BIONETS Platform is one of the possible U-nodes that can characterize the Digital City (a wider concept of BIONETS Habitat) but also other U-nodes that play different roles and can co-exist.

From that point of view community services are an example of such U-nodes but not the only possibility that might evolve. Further discussion is required to determine whether the Service Mediator is a lower-level agent or a higher-level agent, which is an architectural choice currently been researched in the relevant WPs in the project. In the first instance this model might allow an initial and very tentative guess at a possible economic framework, in which the (functional) application scenarios currently being developed at the core of the BIONETS project are integrated. It is important to highlight that at this moment in time it is unknown how many of the requirements established by the partners at the network and computing layers will continue to be present when a beta release of some of the applications based on the use cases takes place, which will be tested close to the end of the project life.

¹ BIONETS Habitat is used here in a wider contextual meaning as singular or plural. In BIONETS WP3.1 and WP3.2 the BIONETS Habitat is the Node (U or T). Thus, each Node represent a BIONETS Habitat. Two Nodes are two habitats.

There is a risk, not yet quantified, of perhaps establishing a disconnected "5G" network that could hardly be of interest to a general communication infrastructure if applications can be found that are able to sustain a workable business model that produces some return of investment. Looking to the case of the Digital City it seems to rely on a certain level of infrastructure. The functional architecture relates to use cases, whereas the structural architecture pertains to the mediators between system and users. The use cases are the same regardless of whether the mediator is a high or low-level agent.

In any case, the main idea Figures 3.2, 3.3 and 3.4 is trying to convey is that the challenge to develop business models that are meaningful for a general communication infrastructure through a disconnected network such as BIONETS might be through building an economic coupling between these very different ways of mediating communications and services. The coupling could be rationalised through the following observations:

- A certain set of services is likely to be delivered most effectively through a structured network, such as a general communication infrastructure already implemented. These services can generally be accessed through standard mobile phones.
- One way to make the BIONETS scenarios relevant to a general communication infrastructure could be to increase the volume of users and the data flowing through the infrastructure.
- This could happen if, in turn, the users are encouraged to adopt the BIONETS U-Nodes because they derive a greater utility from their usage. Users could be stimulated through the list of services on the right of Figure 3.3. However these are "local" to the BIONETS instance and are not much help to the general communication infrastructure.
- The Personal BIONETS framework could provide a bridge between the U-Nodes and the Digital City services, thereby mediating the economic coupling for sustaining evolving business models.

Now, a greater number of U-Node users is likely to lead to an increase in Digital City service usage, simply through the customisation and optimisation function the Personal Platform can provide to facilitate service discovery.

3.3 Summary

This section has introduced first the concepts associated with the existence of the services and applications that might be provided by the BIONETS architecture. A discussion of the concepts of business model analysis and business models for mobile business has been followed and applied to the particular characteristics of BIONETS. A high-level model integrating the use-case scenarios currently under development in the project has been discussed. These descriptions have been selected as representative descriptions for certain key features of BIONETS. The discussion on using social networking models for spreading self-evolving services will be part of the core discussion in Section 4.

4. BIO-INSPIRED SOCIAL NETWORKING

This section aims to focus the discussion on understanding each of the use cases selected for analysis, which are those related to the components or elements of models that do have a strong bio-inspired component from the social networking point of view. The perspective is that as the project progresses there are a number of collective issues emerging from the need for real-time responses for the services proposed in the BIONETS architecture, leading to a more holistic approach to the propagation of ideas for alternative business models. As seen in ID3.3.2, a theoretical discussion of the possibility of applying concepts such as Economics of Sharing and Community Currencies co-exists with more conventional models of revenue and advertising.

This section is named bio-inspired social networking to reflect the fact that applications and services provided by the BIONETS infrastructure will require, besides bio-inspired computational algorithms for creation, evolution and propagation of services, a counterpart in the human-to human social interaction.

Social networking has long relied on bio-inspired models for understanding social phenomena. It is one of the best defined areas in social sciences aimed at understanding the structure and dynamics of social phenomena such as organizational efficiency in the spread of knowledge and disease. It must be noted that the “epidemy” metaphor used for computational modelling of propagation originates in studies on social networking.

Research into social networking has tried to address five main areas, which are in many ways linked to computer science. In this document the direct association to the BIONETS framework will be listed below:

- How do social networks change over time, over short periods and long periods on diverse time scales? It has been seen that BIONETS has such attributes in the generation of dynamic and structureless disconnected networks.
- Can association behaviour be predicted by shortening paths in a network, and/or predicted when the network is likely to break into disconnected components? In the case of BIONETS, the initial status is of disconnected components, which can be seen as an inverse process of integration.
- What is the spatio-temporal distribution of interactions across locations and classes of locations? In BIONETS the spatial and temporal dynamics of associations provided by the service and network layer application can be understood by using social networks.
- How do locations serve as hubs or bridges, channelling the evolution of interpersonal networks? Some services such as *undersound* and Digital City in the context of BIONETS are aimed at creating dynamic changes between providing and distributing content to other users (U-Nodes).
- Is it possible to predict the rise and fall in the popularity of particular locations or hubs for social networks (T-nodes and U-nodes)?

Overall, social networking allows us to provide a bio-inspired, socially constructed representation of the behaviour associated with the use of services that BIONETS seems to aim to provide over time. The role of social networks as generators of value is precisely one of the concepts the economics of sharing and community currencies are based upon. The role of this research is to investigate a more general conception of “value”, which transcends revenue and grows out of the value we place in social interactions. The following subsections will take this view and explain how social networking can be used to enhance the current understanding of the use cases developed in the project.

4.1 *undersound*

This is a case of a social experience creating a business opportunity. *undersound* is a new type of experience, an interface that is on your mobile phone and in the underground stations you pass through every day. It is part personal, part public and all about an underground system (the London Underground). *undersound* is a way of listening to, distributing and affecting the flow of music in the underground that goes beyond just the music itself. It allows a user to see his/her journeys, their fellow passengers, and to explore their contextual surroundings with a mediated technology which sheds a new light on the space.

undersound aims for spatial distribution at individual stations and throughout the wider tube network. Users can add music to the system at upload points in the ticket halls, and can download tracks on the platforms. Architectural configuration of the stations affects their contextual experience of contributing and downloading music as the proximal nature of the interaction with these situated points requires them and other *undersound* users to congregate at certain locations within the station for the purpose of interacting with the system.

Each track in the *undersound* system will be tagged with its place of origin (the station where it was uploaded) and this information is visible as the track is being played. This may trigger memories and musings around users' personal relationship to that place. Is there also a correlation between the flow of people around the tube network and the flow of music tracks around the *undersound* network? What might a sense of place for these digital artefacts be? Do they care about geographical location too or might their sense of place revolve around the quality and type of network and the technological devices they pass through?

From this wider aim of this BIONETS application, some use cases have been generated to explain the interactivity at the core of the choices made by these users. For example, let us suppose that a user is on a station platform and wishes to communicate with other (authenticated) users in their community. The community is interested in a particular type of music. They are able to firstly browse other people on the platform with the same taste in music, secondly look at the songs they have downloaded to their mobile device, and thirdly upload and play the songs. They can also look for users broadcasting podcasts on their own personal stations, see the profile and statistics regarding these stations.

Figure 4.1 is a diagram illustrating a user and the potential capabilities the *undersound* application has for executing the functions described above.

This diagram was selected to illustrate the potential of *undersound* to create bio-inspired propagation of the services provided by BIONETS applications as well as illustrating the potential business cases that can be sourced from the model. Those business models will be discussed in further detail in Section 6 of this document. Each of the components listed in the use case have a strong link to social behaviour in the user to be known – not necessarily identified - for using the dynamic networks that BIONETS supports.

4.2 Digital City: Interactive maps/ Communication services in critical situations

Interactive maps are a simple example that involves a distributed collection and elaboration of data and info (from real and virtual worlds). In this scenario, users in a city may want to run services on their mobile handsets that require digital maps (e.g. of the area where the users are located). In particular maps can be downloaded either from distributed access points or from neighbours' devices (avoiding the need to access a centralized server).

Standards maps are downloadable from access points; richer maps, containing other content and information personally created (audio files, images, commercial text), can be shared by users in peer-to-peer mode in each area. Real-time information (e.g. traffic jam) can be further added and correlated to maps.

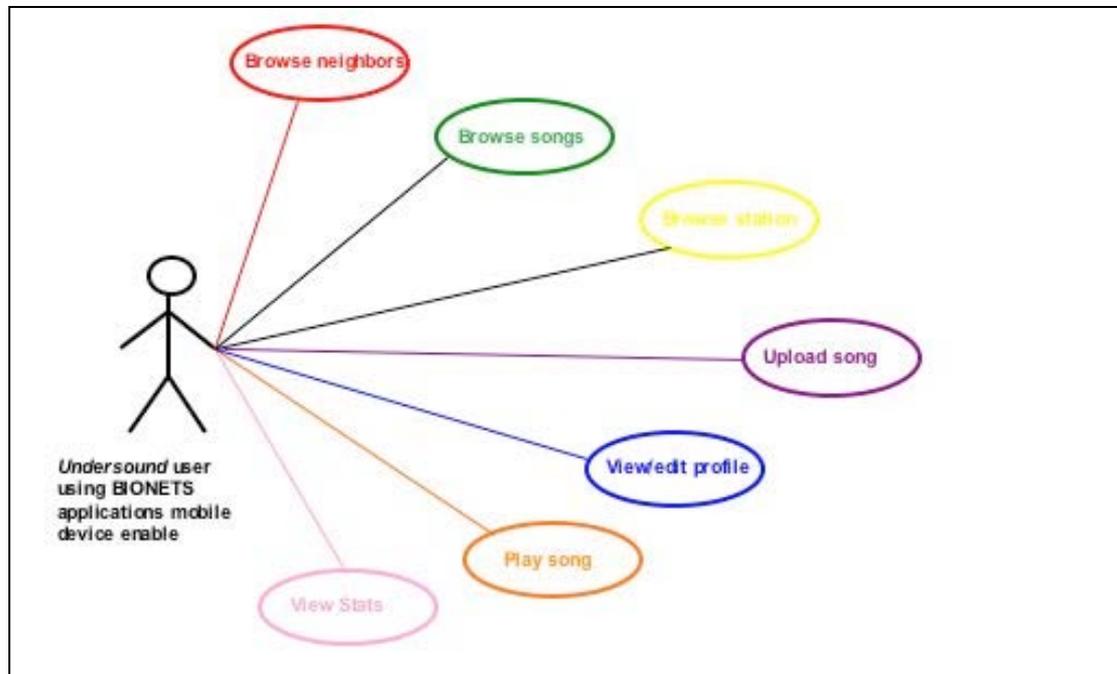


Figure 4.1: undersound high-order use case scenario

Let's assume a user would like to find the nearest restaurant and the best route to it. The map of the area (also containing commercial information about restaurants) is downloaded from the device of a neighbouring user. Best route and traffic information is also correlated to its location. Let's assume that the restaurant has a virtual representation in a Virtual World (e.g. Second Life). The user may want to pre-access such a virtual representation of the restaurant to get some preliminary commercial information on menu and costs.

Figure 4.2 illustrates the context of a situation of extreme unpredictability – an emergency – in which the Digital City explored the ephemeral and dynamic nature of its network. It is proposed to analyse use-case requirements in order to derive solutions showing that a population of distributed lightweight components interacting with self-organization algorithms can perform as a highly adaptable communication architecture meeting the challenges of providing communication services even in critical unpredictable situations (e.g. catastrophic event in a city).

As it is being under development in a scenario project activity this is a critical system that relies in many ways on bio-inspired propagation to achieve effective usage.

Regarding solutions based on distributed lightweight components, we suggest to study and apply an autonomic technology approach.

Specifically, concerning self-organization algorithms, biology has been a key source of inspiration, so we suggest to study and apply bio-inspired algorithms. Group-living animals have provided inspiration for the field of the collective, or swarm intelligence, which models problems through the interactions of a collection of individuals cooperating to achieve a common goal.

Environment simulating the city

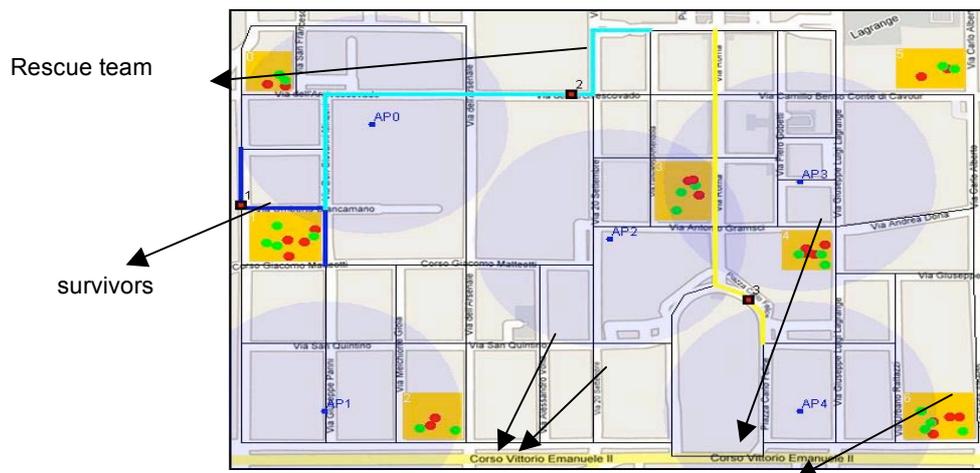


Figure 4.2: Digital City: Communications in critical situations

In the use cases the self-organisation, epidemic, or gossip algorithms should be applied in order to spread information, set-up the communication between survivors and discovering survivors. A different kind of algorithm can be applied to the Rescue Team, in order to optimize the paths, to remember the path to the group of Survivor, to come back to the same group of Survivors that it started to help.

Stigmergic² collaboration is the key point in those systems that present a high degree of social organisation, where problems are “self-solved” in real time through the emergence of the appropriate collective behaviour, which arises from the sum of all interactions occurring between the components and with their environment. Modification of the local environment as a means of communication simply means leaving a mark (“stigma”) or a trace that can be sensed by someone else. For example, this is how ant colonies organise themselves, through pheromone trails.

Concerning evolution aspect we deal with BIONETS distributed environment strongly characterized by data variation in space and time. The physical variation in location for the establishment of dynamic networks creates a complex habitat for evolution. Even when such dynamic networks are topologically stable variations in usage and creation of data might occur over time. There is the possibility of more than one evolutionary model in place over time depending on usage and requirements.

4.3 Personal BIONETS Platform

Personal BIONETS Platform or the “Personal Scout” system is a mobile and distributed platform for the collection and dissemination of sensor and other information. It works on a personal device (Mobile phone, PDA etc....) which acts as a U-node containing possibly some T-node functions (sensors). This platform can implement many previously proposed use cases like wellness and virtual guides etc. The platform is also suitable for financing by

² **Stigmergy** is a method of indirect communication in a self-organizing emergent system where its individual parts communicate with one another by modifying their local environment
<http://en.wikipedia.org/wiki/Stigmergy>

targeted advertisement as it can implement a social network over the BIONETS peer-to-peer proximity infrastructure and will include detailed preferences of the user.

Another area for applications based on this system is the exchange of service as a special type of data. Since there is already work completed by the computing partners for providing distributed services over the network to make then available to all users. The service will be active as long as the user is using its user interface, e.g. is interested in the data collected. If the service is unused for a long period of time it will first suspend its data collection function and later on remove itself from the system.

The purpose of BIONETS habitat - which is currently still being defined - aims to enable services running on different U-nodes to compare each others' features and offerings and learn both relevant data and new/better service functionality from each other.

A BIONETS habitat can be removed from the device if needed. It is also possible that a BIONETS habitat comes to the user as part of the device and is the user interface for the device, and thus cannot be removed.

In Figure 4.3 the coloured dots represent different services running within the BIONETS habitat of personal devices. Users of the same service will form a community that exchanges information related to that service. One such service could be the one described within the Wellness scenario, or it could be a community-based environmental monitoring service envisaged to be implemented based on BIONETS. Naturally a single user can run one or several services within her BIONETS-enabled device.

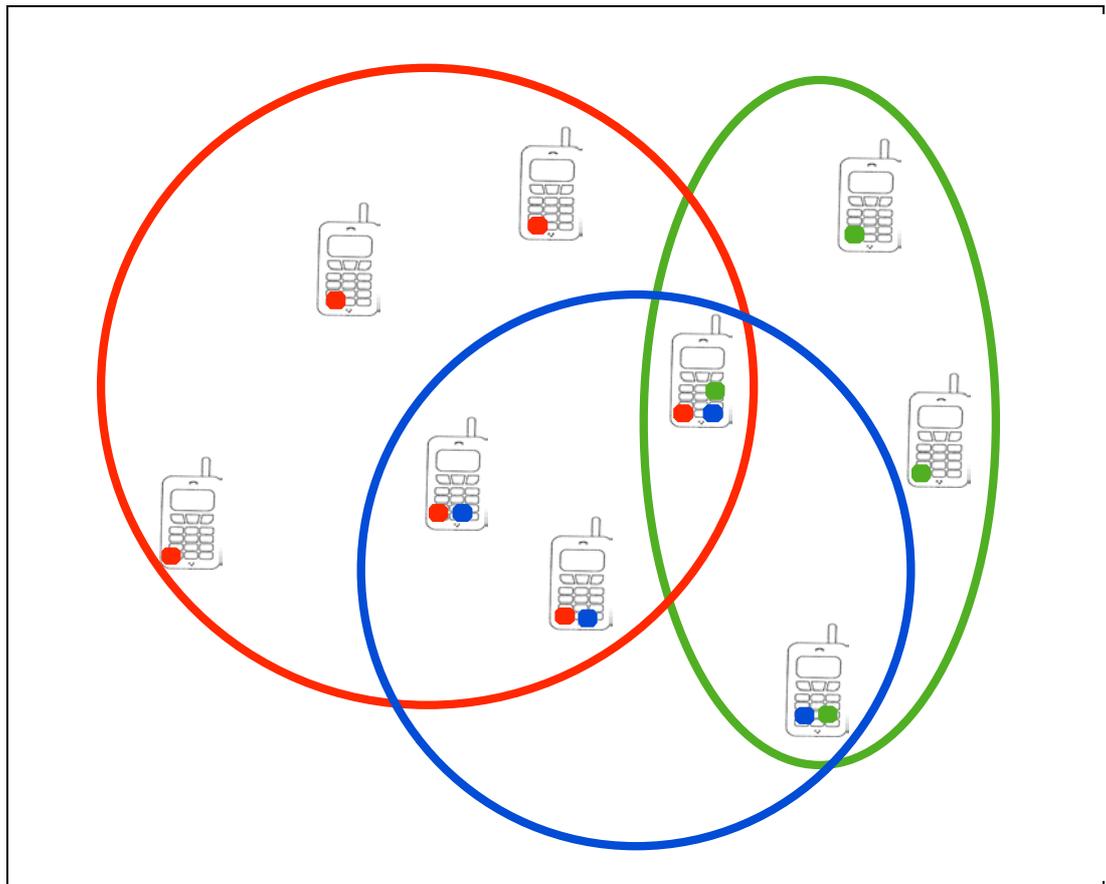


Figure 4.3: Service Communities within Personal BIONETS platform

4.4 Summary

In this section a summary of the main characteristics for the three use cases selected in light of social networking and bio-inspired propagation models have been presented. The discussion has been focussed on the potential business models that those bio-inspired models could provide, specifically aimed at the functionality of such services and applications. Section 5 of this document will summarize the main operational links to the business analysis that such models have. In section 6 the elements of the use-cases will be integrated into an alternative business model analysis.

5. OVERALL USE-CASE SCENARIO DESCRIPTION FOR BIONETS

This section discusses the status of Scenario Description work within the project and especially business modelling related issues that are relevant to them.

5.1 Scenario Descriptions in BIONETS

During the first half of the BIONETS project it was found that describing the BIONETS system, despite its fairly simple basic architecture, is a complex task. Given that we want to study it from the business model point of view there is a need to describe the whole technical, economic and social system related to BIONETS to some extent.

Thus during the second half of 2007 a renewed effort for describing the BIONETS system as a whole was initiated. This description should include overall and service architecture at a high level, use cases, and business model issues. This work has now been formally planned as a new task within WP3.3 of the project's detailed implementation plan from months M25 to M42. This section describes briefly the approach selected to implement such a description. The following figure shows the proposed structure of the description document.

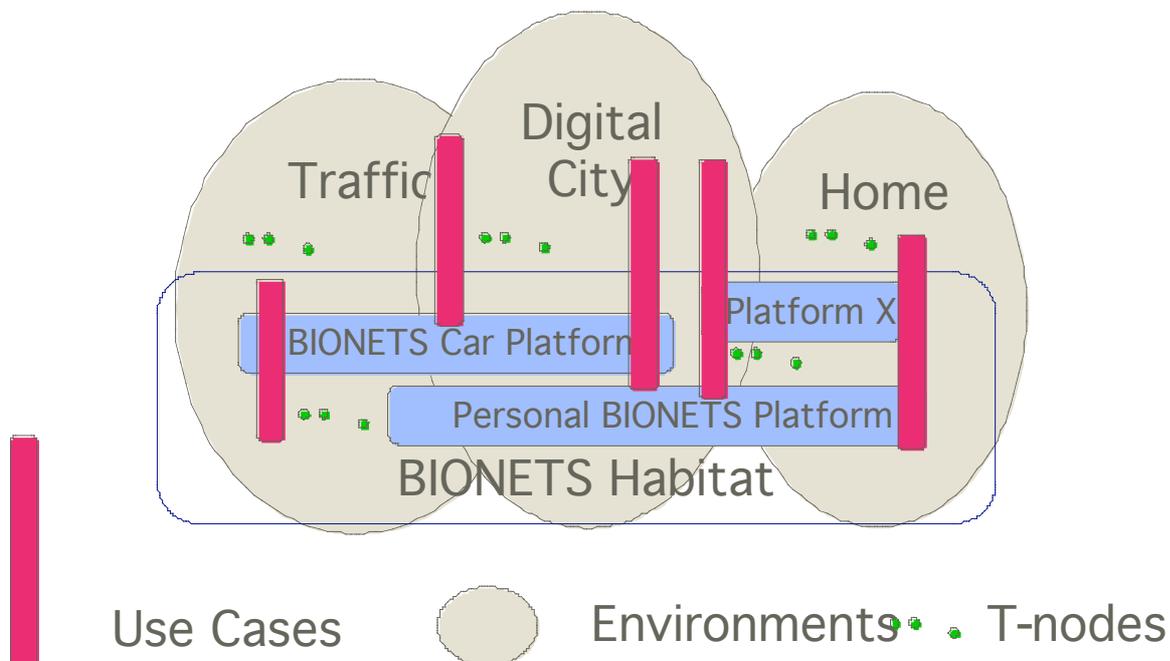


Figure 5.1: Proposed Structure for BIONETS overall description

The description starts with an introduction to the main features of the BIONETS system. After that some representative environments, where the BIONETS system can operate, will be described. We then describe some relatively concrete implementations of BIONETS Service/U-node platforms, after which use cases can be put forward.

So far the use-case document describes one environment (Digital City) in greater detail as well as one service platform (Personal BIONETS platform). The Digital City environment envisages a future city within which a vast number of sensors (T-nodes) are embedded, from which U-nodes can read useful information and base services. The personal BIONETS platform has been defined as a subset of U-nodes running within personal devices. The

reason for this subdivision is to be able to capture the impact of social networks of user communities as there is a high correlation between personal devices and their users.

Based on Service Scenarios collected so far we expect to define additionally at least the BIONETS Car Platform, which is functionally similar to the Personal Platform, but may be more powerful as it is attached to a car. On the other hand this car-based platform is less personal than the platform based on personal devices, and thus services running in cars cannot rely as much on user communities.

It is important for the project and for WP3 if business models are better described in the document (BIONETS 2007b). During 2008 these models need to be better defined, mostly within use case descriptions, as business issues are primarily relevant for specific services and their usage. To some extent the platform descriptions also need to deal with business issues. Some viable mechanisms for the emergence of such platforms need to be defined.

5.2 Business model-related issues within BIONETS

The scenario descriptions so far within the BIONETS project have mainly focussed on the physical environment of the system and the functionality of the services. From the point of view of the business model analysis it is important to understand the possible cash flows within the system and in and out of it.

Traditionally the profitability of ICT systems has been analysed by calculating the total cost of the system over time and dividing the discounted costs by the expected number of users and services over the same period of time. This gives the minimum level of revenue per service and user required to break even. Within the BIONETS project there has so far been no discussion about the potential costs of BIONETS based systems. In this section we highlight some problems that the BIONETS system has from a costing point of view. Calculating total cost is not a trivial task, as nodes are owned by different entities and there is not necessarily any direct economic coupling between them.

It can be assumed that the BIONETS habitat could be installed onto U-node devices as open source software and thus not cause any direct cost for the node user/owner. In practice, the real cost to the user of BIONETS services is the time spent using the service together with the resources – mainly memory, processing power and energy – used by the BIONETS habitat and its services within the node. There are approaches that could deal with this issue, for example by calculating personal time budgets or by assuming a certain share of node resources to be used by BIONETS services. It may even be possible to have a user-defined parameter which specifies how many resources a BIONETS habitat is allowed to use within the node.

The number of users/services to be used as the divisor for the total cost, if such can be calculated, is also unclear.

It appears that most probably the profitability of a single service within BIONETS can be evaluated only from a single node point of view. In the evaluation it is still important to consider the impact of other nodes on the quality of service, as services are expected to be implemented as co-operative processes.

5.3 Summary

The current scenario descriptions within BIONETS were a good source of requirements for networking and service architecture definition work. However they were initially collected in

an early phase of the project when partners did not yet have a full view on what the BIONETS-specific features will be in the end.

From a business modelling point of view there are still several open issues that we need to deal with during the latter part of the project. We need to define an approach for evaluating the cost and value for the user for adopting the BIONETS habitat. We also need to find a way to evaluate the possible revenues generated by the system to various actors within the system either as real money or as some type of community currency.

6. USE CASE ANALYSIS

In ID3.3.2 the case for alternative business models was widely discussed and explored from a theoretical point of view. Firstly an attempt was made to understand the role technology has in mediating the value transfer or services and applications at a general level, either by understanding the technological model, the socio-technological actors, or the value transfer associated with the BIONETS research framework. Secondly value transfers were related to the BIONETS system, depending upon service specification, and the actors' actions were seen as economic elements.

In this deliverable an understanding of what a business model is from a mobile service point of view and elements of social networking have been added to the analysis, focusing on the use case scenarios selected. As the economic case for business models grows in BIONETS, the elements of analysis of the business models reflect upon the opportunities arisen for novel business models from the user and provider perspectives.

Based on this research, the challenge encountered in BIONETS in its current status is the lack of developed applications. This section will focus on providing for each use case selected the potential business models that can be created from their current operational form. First identifying the economic requirements and potential benefits created from this network layout at application layer.

6.1 undersound

6.1.1 Requirements

undersound as described in section 4 can be understood as an interactive system that allows users multiple functionalities, which are disseminated over a connectionless and propagatory network. Based on the use cases described in deliverable D2.2.1, the seven variables or properties of a user of *undersound* are each an opportunity to explore novel models for creating new relationships of exchange and trust that add value to the current business models taking a broader perspective to such transactions.

When a user engages in *undersound* by browsing for neighbours, this is in fact the act of linking and creating a temporal ephemeral network. As seen in the case of Smart mobs (Rheingold, 2002), the ability to summon people to meet at some point for sharing or expressing for example a political idea or maybe an art form is an important and valuable social trading system. Also users might want to give a token or relative value to this ability to create a reunion or mass grouping. An analogy would be music promoters in old discos that used to drive people into the disco by word of mouth.

When browsing songs, users are relinquishing a passive position in the network just formed. The options are open for exchanging layers of information about data available in the network. To browse is a way to increase contextual awareness of events (such as a new song) that are available all around. Also some kind of rating was included in this browsing, and some form of exchange can be established for users that rate the most songs for perhaps a free download of a song of their choice. It could be also possible to view other neighbours' rankings and create a community of affinity based on the sharing of likeness to a certain type of musical genre.

When browsing on a station platform, users shift from a U-node to a T-node mode, and depending on how much functionality is enabled in the devices running *undersound* and the memory capacity those devices have, the shift can be seamless and passive, depending on

the requirements of the network. For example if a network is overloaded in the T-node, a u-node or user could search on the neighbourhood for other T-node performing the similar data exchanges.

When uploading songs to the network, this might be a free feature, but users could be encouraged to provide information about their profiles that can then be used as an advertising opportunity to tailor ads to their consumer needs. Uploading songs to the network can also provide a unique opportunity to provide rankings to songs previously uploaded or available in the network surrounding the user.

When creating a view or editing a profile, some issues of security and identity might arise. However many users will have a flexible rule for the levels of sharing they can consider tolerable or acceptable for profiles. As in virtual worlds, users might want to be able to create or perhaps purchase profiles that make them more attractive for exchanges within the network. Or the user just might want to adopt a 'temporal' identity in a physical location.

When playing songs, there can of course be a revenue to artists in the copyright, assuming that there is an exchange of a value transfer for such action. Most of the songs envisaged by D2.2.1 are assumed to be made freely available, for example under Creative Commons, which adds a level of complexity to the challenge of developing sustainable business models based on this kind of application. For example, playing part of the ring tone of a song on a T-node a number of times could allow users to collect tokens that can then be exchanged for a full song at another station.

When viewing/monitoring statistics, the collection of this type of data is very valuable for marketing and the customization of locations. There is a possible model for trading either the data collection or the users' own data, either at the aggregate or individual level, with other users, collectors or network exchanges.

The possibilities are many. The question many backbone operators have asked is the viability for supporting such trading exchanges with such networks, and how to make some kind of profit from them. As will be shown in Section 6.2, besides direct advertisement more subtle ways of collecting and distributing data can provide such viability.

6.1.2 Benefits

The benefits of using such a model are highly advantageous for the development of alternative approaches to business. *undersound*, is characterised by its real-time interaction and by the capacity to take up communications again over a certain period of time, and perhaps to record similar events (location and time), which could enrich social contact between its users. In terms of business models, this sociability has a value in offering alternative ways of advertising and distributing content or knowledge about people, products or others in the network.

The success of *undersound* – when trials finally happen – will be limited to the capacity to provide fast and reliable exchanges. From the social networking point of view, exchanges such as the ones *undersound* aims to make are already being made with similar mobile technologies; what is new and perhaps more elaborated in this BIONETS service is that *undersound* can provide a strong lead for socially bio-inspired networks of people sharing interests such as music likeness of social activities.

6.2 Digital City

6.2.1 Requirements

Digital City has primarily been aimed at building an ephemeral but stable background for BIONETS services in case of disaster or emergency such as an earthquake. As such, it is

able to provide in its current format both alternative models: a community of sharing (exchanging information about survivors, people searching for relatives, friends, family) and a community currency (information about where to find resources, help or aid).

Whilst in a conventional advertising model the infrastructure provider or network operators pushes advertisements through the communications network, in the case of Digital City there is room for the creation of content by users wishing to propagate their own advertisements over the temporary established network. Determining the flexibility and space of such content delivery in real-time networks is a critical factor for the successful adoption of this network.

Openness and willingness to share information about persons, profiles, events, locations, resources while conventional communication networks are down is critical. The provision of exchanged real data such as maps provides a business case for content providers to distribute sponsors' advertisements or information.

6.2.2 Benefits

The other application of Digital City could be the provision of extended experiences for real life locations that otherwise will take too long or will be too time-consuming to obtain. Digital city is a framework that can potentially provide a wide range of services that can be integrated into profile-based services (see personal BIONETS Platform) or into less tailored or customized services.

Digital City is a good starting point for providing such services with a low cost of entry, enabling fast propagation with the advantage of reinforcement or supply by the backbone network once this is re-established. It could also support the presence of one or more community currencies that could be exchangeable depending on the parameters the applications will be able to support. The community currencies can support exchanges of information, resources, either by allocating local exchange values, or allowing negotiations similar to a bidding service for transactions out the local exchange with other dynamic nodes set up with this service model. This could increase the value generated by the network and the utility of each user.

6.3 Personal BIONETS Platform

6.3.1 Requirements

The collection of private data, and the ability to keep the data private or shared within the contextual mobile surroundings, is a powerful generator of novel business models for the Personal BIONETS Platforms. The applications running on such platforms have the capacity to include or remove functionality from the collection sensors available in BIONETS mobile devices. In doing so, the network topology emerges as probabilistic and distributed. A direct consequence of this dynamic is the changes on the volumes and formats for data collection and transmitted in each temporal node.

Potential exchanges of generic data at T-node level can have an important value for community sharing for elaborating profiles of for example location preferences, such as collecting information of visited sites and rating them. Perhaps a key to allowing these transfers is to determine the cycles of keep-alives. Longer keep-alives will allow deals or brokerages between users and applications that can develop into a normative transaction value in the form of tokens. Such exchangeable tokens can then be used over widely spread networks with multiple topologies to obtain information about environmental variables in remote nodes.

6.3.2 Benefits

Personal BIONETS Platforms can provide the collective and supportive environment required for the BIONETS habitat or ecosystems. Exchangeable tokens assigned to each of the different environmental variables permit the existence of not only but many community currencies, that will be defined by exchange and use on its transaction value. Some of the transactions provided by the platforms will add value to services and applications existing on BIONETS networks, whilst others will support or work as 'daemon' tokens for other applications or networks.

At this stage in the project it is necessary to narrow down the paths of how, when and which environmental variables can be collected as well as defining the exchanges parameters. Since there are two alternative ways to measure the use of novel business models in this case: either by aiming to maximise the utility of the network, or by supporting a distributed network with some kind of evolutionary framework for sharing benefits to the overall applications deployed in this habitat.

6.4 Summary

This section has summarized the main analysis of the three use case scenarios and the shortcomings in the possible business models that can be developed under the BIONETS infrastructure. It must be noted that the evolutionary model for those use-case scenarios is primarily a social networking propagation or distribution with some limited or user invisible bio-inspired components at the computational level.

undersound has the potential to become a social networking tool able to collect data, with the co-operation of the user, which can both enrich the user experience and provide valuable analysis of anonymized use patterns over time. Whilst there are some questions about security, the user remains in charge of access control. The main potential shortcoming is that whilst the network adopts a peer-to-peer business model, and content can be tailored to use patterns, licensing a song or data released in the network is very difficult, and the risks associated with an overflow of content providing a security flaw in the network which could generate a network shutdown.

Digital City adopts a more subtle approach in that content is generated by the individual user and although there is room for sponsorship and advertising, the user is responsible for the creation of their own profile and the content they wish to add to it. In essence it is a model centred on user actions and preferences for particular types of content, whereas in *undersound* the model of content acquisition is more automated.

To summarise, the purpose of this section has been to identify ways in which each use case studied can draw on alternative or novel business models that can co-exist with conventional business models integrating as shown in Figure 3.2 both business model layers.

7. APPRAISAL OF THIS RESEARCH APPROACH

After 24 months of the BIONETS project, there is still a long way for consensus to be achieved in terms of computational, biological and social drivers contributing to the BIONETS evolutionary framework. It is true that the use case scenarios described in this document and others of similar content do not require an evolutionary environment such as BIONETS for their execution. However, BIONETS services need to do something valuable for the user or users, and evolution may happen in some or all of its non-functional properties, not changing the actual function. This evolution shall add value to the services, and users can describe a desired service by using tools or wizards. Services can be performed until there is a desired function to be created. Evolution shall occur by building from existing services (e.g Send SMS, GPS maps). The economic distribution of profits by the users who describe the service and the user/stakeholder who run the evolution process might not be a direct economic reward.

The models discussed in this document have aimed to present an alternative to the traditional business approach exploring the non-direct economic rewards that might sustain some BIONETS services taking maximum advantage of the BIONETS infrastructure and applications. It is not easy to achieve this task due to the complexity involved in developing such an evolutionary model, together with the diversity of research agendas brought by partners to the project, level of expertise, and driving forces on integration of research agendas. The business unit has, along with its participation in the project, provided a strong contribution to the integration of use cases, understanding evolution parameters and providing feedback to the science and computational groups.

However, an evolutionary environment will in most cases improve their functionality and the user experience. Thus, the missing element for the cohesion of the BIONETS project is the question of developing an integrated evolutionary framework and philosophy. Normally business models should be developed along with user tests or at least some demonstration prototype. The tight schedule of the project and the parallel development of multiple strands of activity make this impossible, so in this report we have brainstormed about business models based to a significant extent on hypothetical functionality

But with all these concerted efforts there is still an unanswered question – and source of concern – as to the evolution models for services and network of BIONETS. In terms of the business units, the lack of relevant empirical data to test services and provide a cohesive view of the services and how they will evolve when exposed to real social and technological networks is a major limitation in providing a more detailed view of the resources BIONETS can offer. In the second half of the project we look forward to further work with the partners of the other WPs towards the development of a more integrated realisation of the BIONETS vision.

8. **ADDITIONAL CHAPTER: BIONETS ECONOMIC AND BUSINESS SIMULATION (BEBS)**

Deliverable D3.3.2 was presented at the 2nd Annual Review (end second year of the project) for BIONETS on March 2008 in Turin, Italy. The deliverable was focused on presenting alternative economic models linked to the usage scenarios developed by BIONETS such as Digital City. Due to the abstract conceptualization of the many aspects discussed in the first submission of D3.3.2 that could potentially contribute to the development of business models, the reviewers' feedback was to suggest extending the deliverable by developing a computer-based simulation to illustrate the models presented. This chapter presents the work completed to satisfy this requirement.

This type of simulation is relevant to the BIONETS project for two reasons: it provides a user interface to the economic theory through an intuitive and easily understandable quantification of the economic value of alternative business models, and it can also provide a way to measure some of the economic properties of different technical solutions developed by the rest of the project. It also provides a testing environment in which behaviour can be illustrated and the value or importance of some of the calibration parameters can be forecast. This provides a good starting point for the discussion on how BIONETS applications can be sold or used on a commercial basis. It must be noted that at this moment in time the "real" values of the parameters used in the simulation do not correspond to any particular BIONETS application in service (there is none). However the model emulates behaviour for usage scenarios such as Digital City. In doing so it illustrates how the economic performance of those applications could make the case for the sustainability of the alternative economic models.

A major advantage of agent modelling as used in BEBS is the independency from the physical surroundings to test models, which is advantageous since BIONETS can be implemented in different locations with particular requirements. The bio-inspired computational models being developed for BIONETS applications can be integrated in this model by developing an interface that feeds the applications' variables to BEBS.

8.1 Economic Models and Use Cases in BIONETS underpinning business models

At the core of the work on usage scenarios presented by several BIONETS partners there are two main networks of interaction in which business models might develop. The first network is a self-contained, 'disconnected' and distributed BIONETS network of nodes (actors) able to exchange data with each other using the token values of alternative trading systems -- where no actual money changes hands -- whilst the other network is that used by the telecom operators, in which economic revenues are based on more conventional business models. Both models are depicted in Figure 3.2.

Neither of these networks has an exchange rate to convert between the services or transmissions within the distributed BIONETS network and that of the conventional telecom network. The decision to build a computing model using a modelling tool to illustrate alternative business models is a way of evaluating how these exchange rates could be calculated. Further details on the choice of the modelling tool are explained in Section 8.4.

The economic principles of the model are based on the use cases developed by the BIONETS consortium, which can be grouped at an abstract modelling level as the ability of each node or actor to transmit (send or receive) up to five types of data (this can be changed

in the model), assigning to each of these transmissions a token value for the desirability of this transaction. The data transmitted can be for example either environmental variables such as the ones presented in the Digital City scenario, with services that for example allow real-time access to Digital Maps or music exchanges, or a combination of all of these.

A generic model in this case tries to express the added value of the exchanges that occur in the node-based networks that are trading values or exchangeable, for either other tokens or real monetary value, for the actors or users of the network.

To illustrate this idea, consider for example the situation in a metro station in which BIONETS applications can be run by any agents in a certain area within the station. Each agent can receive or send data based on their needs. Assume that at some point in time there is a number of people waiting on the platforms for trains to arrive; whilst waiting, some if not all of those people might use their mobile devices locally. Each of those devices is an agent in the business model being simulated. As agents discover other agents they might start exchanges of data that result in economic transactions based on agreed token values or evolving token values. A historical record of such transactions could be stored in an individual virtual account for each agent, thereby making possible a valuation of the desire or ability to exchange data successfully.

One type of exchange could be the case of an agent broadcasting to other agents within range a message or data file containing some kind of advertisement; all the other users within range might choose to accept or reject the sender's file; however, each time an agent accepts the sender's file, the sender is credited with a token value to its virtual account. This could be the case for a localized advertisement used to reach a small network of users: the eagerness of users or agents to accept the advert could ultimately be converted into real money units for the sender by, for example, the telecom operator providing the permanent network.

Over time the number of agents in the metro station changes; at some times there will be peaks of data exchange and/or number of agents, and at other times minimum or no exchange of data or no agents at all. There is a dynamic cycle, based on agents entering and leaving the metro station, wishing to exchange or trade information. Some of the evolving, bio-inspired applications from BIONETS will merge then with social networking behaviour to express over time the changing nature of these transactions.

As explained in Chapter 3, conventional business models cannot effectively allocate value to this type of agent network in which the exchange of data is or can be considered separate from the backbone telecom network, as is the case for example with Bluetooth. *One of the aims of the modelling is to illustrate how alternative economic models can actually build up enough subjective or token-based value to make it worthwhile to develop an exchange rate for its conversion into real money.*

This can be done by evaluating the total of the exchanges in the metro station in terms of both the number of tokens and the volume of data transferred against the telecom's valuation of volume data transfer per minute. This will allow for example potential marketing companies and telecom providers to estimate, based on the potential number of users or actors accepting a broadcast message in the metro station, the cost of advertising localized and perhaps focus-orientated advertisement.

In this way an exchange rate of sorts is established between the advertisers and telecom network providers, based on allowing access to these networks to marketing companies, and a pay-off for the telecom providers who always maintain an external connection to the metro stations.

There are many cases that could be illustrated with this type of modelling, and complexity will depend on many factors; since BEBS aims to illustrate the potential of alternative economic models running on top of the BIONETS infrastructure, some choices have been made in developing the model, as explained in the section below.

8.2 Choice of a modelling tool

Our search started with tools in which the dynamics for representing social networking and economic transactions could be modelled. Because of the limitations of resources and availability of referenced work in the area, we decided to use open source tools.

One tool that has been used for this purpose is Repast. Repast has been used to illustrate algorithms in which there are a number of transactions in social networks. Examples of these types of uses are: Genetic Office³, Friendship Network⁴, and Models associated with Social Networking⁵, whilst using computing analogies for the building of agent modelling⁶. Also due to the experience of this researcher on other EU research projects in social networking, contact was established with Mr Thomas Kurz, who worked on EveSim⁷ on behalf of the University Salzburg, Austria. One option considered was to use EveSim as an applied model for BIONETS. However an exchange of ideas about the best environment and modelling tool to use for developing an emulator for BIONETS led to the decision to use Repast, which like EveSim is an agent-based simulation modelling software. This section briefly discusses their potential as candidates for the initial modelling in the BIONETS project for business models. It considers them only within this domain and is not a reflection of their relative merits.

8.2.1 Environment

EveSim is a distributed application and runs in a multi-machine environment. Although a virtualisation technique can be used to emulate a multi-machine environment on a single machine, this is complex to set up and administer. Examples of VMs include Solaris zones, Linux VirtualBox, *nix Xen and Windows VMWare.

<http://www.sun.com/bigadmin/content/zones/>
<http://www.virtualbox.org/>
<http://www.xen.org/>
<http://www.vmware.com>

8.2.2 Dependencies

For Repast, the Java Development Kit (JDK) and Eclipse need to be installed:

JDK: <http://java.sun.com/j2se/1.5.0/>
 Eclipse: <http://www.eclipse.org/>

EveSim also requires the JDK, as well as the following dependencies:

JDK: <http://java.sun.com/j2se/1.5.0/>
 Tomcat: <http://tomcat.apache.org/>
 Spring: <http://www.springframework.org/>
 Swallow: <http://swallow.sourceforge.net/>
 Soapod: <http://www.soapod.org/>

³ http://repast.sourceforge.net/repast_3/examples/index.html

⁴ <http://www.santafe.edu/research/publications/workingpapers/01-06-032.pdf>

⁵ http://www.cscs.umich.edu/lab/documentation/RePastStuff/repast/repastj/docs/how_to/network.html

⁶ <http://www.cederman.ethz.ch/teaching/archive/comppmodels/ws2004/slides/comppmodels-20041026.pdf>

⁷ <http://cims.nyu.edu/~gn387/glp/lec4.pdf>, <http://www.econ.iastate.edu/tesfatsi/RepastTutorial/Collier.pdf>

⁷ <http://evesim.org/>

Fada: <http://fada.sourceforge.net/info.html>
Crossfire(nowCXF): <http://xfire.codehaus.org/>
Maven: <http://maven.apache.org/>

As can be seen from the above, EveSim has several dependencies. These require extensive knowledge of Java, SOA (web services) and project build tools (e.g. Maven), which all need to be configured separately before being assembled. Repast, on the other hand, is installed as an Eclipse plugin and automatically built within Eclipse. The Repast model can be created in a graphical user interface, or developed as a Java or Groovy program depending on preference. A combination of both approaches is also possible, since creating a model in the graphical interface automatically generates Java code.

Advanced software development skills are lacking in the LSE BIONETS group and, furthermore, the deadline (January 2009) is very tight. Another option is to ask the EveSim group for help, but this cannot be guaranteed and would necessarily be on a voluntary basis.

8.2.3 Applications

EveSim aims to investigate the behaviour within a model (in the DBE, the "biologically inspired P2P system"). It is aimed at *analysis*. The variable here is the behaviour itself. However, it has no means of calculating the total economic value of the system, i.e. *synthesis*. In Repast the behaviour is more or less pre-defined, but within each model numeric weights, representing (in our case) economic values of exchange, (e.g. the value of a link) can be changed, in order to calculate their effect on the overall model.

8.2.4 Suitability for intended application

EveSim was developed in part to demonstrate the technical feasibility of the DBE proposition, the economics of which had already been examined. Repast, as a tool, is intended to be used for evolutionary or economic modelling without looking in great detail (at this stage) at how it is to be implemented. BIONETS is now looking again at the economic model, and to this end Repast may be the more suitable tool. In fact, the EveSim team first built a model in Repast, before going on to develop EveSim. See:

<http://evesim.sourceforge.net/general/repast.html>

8.2.5 Types of Model

EveSim has service interfaces to other applications and users and is therefore suitable for a working model of a real application, which could easily scale into a real-world execution environment. Repast, on the other hand, is aimed at "pure" simulations. A limited analogy could be made with architecture. First, sketches and measured drawings are made, many of which will be rejected – the "pure" simulation. When an appropriate design is chosen, a physical scaled model is made – the "real world" simulation. Like all analogies, this is useful only within limits.

8.2.6 Extensibility

Repast offers a choice of complex, pre-designed templates for the most common situations encountered in simulation modelling. In EveSim, only simple, basic interfaces are offered which are then extended or implemented with the functionality required. Repast is therefore a more concrete but less flexible product, whereas EveSim is designed at a higher level of abstraction, but is also more flexible and less prescriptive.

8.2.7 Documentation and user groups

Repast evolved from Swarm, the first individual-based computer simulation that was developed in 1994. There is a great deal of (sometimes conflicting) documentation and a number of user groups which can provide help in developing Repast models. A couple of caveats: there appear to be few ready-made Repast models which can be easily adapted for

BIONETS, and Repast Symphony (the Eclipse plugin) is not backwards-compatible with earlier versions. That said, the documentation could be sifted to find what is most useful for our intended purpose.

EveSim is new software and whilst the documentation is very clear, it has had only one application (DBE). Also, the dependencies outlined above are all documented separately and have their own user groups, none of which would have any knowledge of the EveSim application itself.

In conclusion, the bottom line is that Repast is suitable for testing economic and mathematical models, which however have limited application in the real world. EveSim allows highly customised working prototypes to be implemented and extended into practical applications, but assumes that the economic investigation is either not needed, or has already been carried out. As a consequence, we decided to use Repast for this simulation.

8.3 Model Fundamentals

The model fundamentals are based on representing the type of exchanges illustrated in Figure 3.2. Based on the description in Section 1, a number of assumptions have been made in order to develop a computational model.

1. The simulation focuses on the assessment and evaluation of the self-contained economic model proposed in the figure, by assigning to each data exchange or storage a token value to be summed over a certain time period for both the overall network and individual nodes (e.g. 20 minutes).
2. Each node will have the same set of attributes. The number of attributes has been limited for the simulation to five. See list in point 5.
3. Each node will be both a supplier and a consumer of communication requests (this is based on the EveSim modelling).
4. A node can have a limited number of connections to other nodes based on its transmission capacity.
5. Attributes list:

Type	Token Value	Protocol
Node stores transmission ⁸ data	1(*)	
Node distributes transmission data	2	UDP
Node stores non-transmission ⁹ data	3(*)	
Node distributes non-transmission data	4	TCP
Node can send and receive streaming services ¹⁰	5	VoIP

⁸ Transmission data is data that can start to be consumed before the completion of the full transmission of the data between nodes. E.g: streaming music files (mp3)

⁹ Non-transmission data is data that can only be consumed after the full data is transmitted between nodes. E.g: library of files, phone directory (text), album cover (binary file)

(*) The Token Value of storage is for all the files hosted at any time in a node, it is a unique value representing the operational cost of storing data.

6. The attributes for each node define the local environmental conditions
7. A connection between two nodes is an active link for the transmission of data or music.
8. At any time the communication between two nodes will have a maximum of 2 channels in the same direction (one for music and one for data).
9. Over time traffic on links and channels will change randomly, keeping condition 4 as their only constraint.
10. Each link will have a cost/value (token value) and the simulation will add up those values over a period of time to estimate the global economic benefit generated by the economic model.¹¹

8.4 The Actual Model

The model was developed in Repast using a template, adapting the code to the requirements of the model.

8.4.1 Running the Model

The model is used by setting parameters and then running the simulation. The results are calculated and displayed at each time step of the simulation as a dynamic graph of the aggregate value of all the nodes' transactions plotted as a function of time. The model can be run continuously, paused, or stepped through and examined at discrete intervals. The output can be examined in graphical and numerical form and comparisons using different sets of parameters can be made.

8.4.2 Concepts of the Model

The model consists of three basic concepts: agent, link and space.

1. The agent represents a person with a mobile device who makes the decision to receive or send data using one of the means specified above. Each agent behaves independently, and the model only acts as a holder for all the agents.
2. The link is the actual communication. For the purposes of this model, it has only a value from one to five, as explained above, and a type: broadcast, i.e. one agent sends to everyone within range, and each recipient then decides whether to accept or reject the transmission; or point-to-point, where the recipient of the data is specified by the sender.
3. The space represents the metro platform that is the scene for the communication. This is a 40 x 40 grid, in which agents are represented by filled cells. To make the simulation more realistic, agents can only communicate within a certain range (the range for Bluetooth for example is typically 10m). Movement of agents within the space was considered but has not yet been implemented. This is an acceptable approximation for relatively small data sets that are exchanged quickly relative to the rate of change of the network topology.

At each step, some agents are created to simulate their arrival at a metro platform, whilst others are destroyed, i.e. they leave or their devices are no longer transmitting. The number arriving and the number leaving are randomly distributed around the same mean. This implies that, over a long period of time, the number of agents will average the initial number – currently set to 80. However, very large fluctuations are possible, particularly as the creation of new agents does not happen at every step, which resembles the actual pattern of people arriving at station platforms. The simulation can at times approach capacity (1600), at other times be almost empty. The range of agent lifespans, and frequency of creation of new agents, can be configured. If new agents are created at every step, the number of agents will

¹⁰ Streaming services do not fall in the category of transmission data, since they provide a continuous set of data. For example p2p voice .

¹¹ The cost of setting up the network is zero (ref is the work from Nokia on transactional cost on distributed networks)

tend to be even over time. If however there are a number of steps between the creation of agents, there will be greater fluctuations.

A link has a lifespan and a random value within a configurable range. The value is added to the agent only when the link dies naturally. If an agent is destroyed, any links that have not reached their natural lifespan will be destroyed and their value will not be realised. This represents the case where someone is transmitting some data, but leaves (e.g. gets on a train) before finishing the transmission, and the partial transmission is then useless.

In the case of point-to-point transmissions, the value is added to the sender and to the receiver, whilst for broadcast transmissions it is the receiver who gets the value. This is because point-to-point transmissions are typically part of two-way communication, which have value for sender and receiver, whilst in the case of broadcast data the recipients do not respond.

8.4.3 Visualising the Model

BEBS has used the Repast built-in user interface facility for graphical emulation in 2D – topological format – of the agent network and transaction model. A graph and table of the total value of the system are also shown (See Figure 8.2). The agents are shown as squares and the links represented by lines between them. The colour of the line represents the value and type.

8.4.4 Parameters inputs to the Model

The aim of the model is to see how the total value of the system changes over time. It is run with various sets of parameters:

Parameter	Usage in model
Max lifespan of agent, <i>lmax</i>	Lifespan is a random value from 1 to <i>lmax</i>
Max lifespan of link, <i>lmax</i>	Lifespan is a random value from 1 to <i>lmax</i>
Max distance transmitted, <i>dmax</i>	Transmission within radius <i>dmax</i>
Chance of reception of a broadcast transmission, <i>cbroad</i>	Sender sends to all nodes within <i>dmax</i> , but there is a chance of <i>cbroad</i> that it will be accepted
Chance of creating new agents, <i>Ccreate</i>	Agents will on average be created every $1/Ccreate$ steps

8.4.5 Outputs of the simulation

Keeping in mind the general aim of this simulation to illustrate and quantify the value of transactions in an actor-network exchange, the following outputs help to achieve those aims:

1. A graphical display of the nodes and their generation
2. A graphical display of the nodes' attributes and their properties
3. A display of the simulation running over time, showing links and active channels of transmission
4. Calculate for each actor the value of a transaction over the simulation period and a selected time
5. Calculate total overall value of the network over a certain period of time

The model generates an initial number of agents, whose lifespan is allocated at birth as a random number of steps between the minimum and maximum values set. Agents that die are

not immediately replaced. Instead, new agents are generated at a random step interval. The number created is approximately the sum of dead agents since the last generation, but varies between 0 and the double of this number, such that the average number replaced is equal to the average number leaving. Say, for example, agents are replaced at step 9, 5 agents die at step 10, 6 at step 11 and 10 at step 12, then are replaced again at step 13. That means that 21 die in this time. The number of agents replaced is then random, evenly distributed between 0 and 42. The reasoning behind this is that in a network, the people represented by agents tend to arrive in groups but leave individually [LA+00].

With every step, a link with a random value from 1-5 is made by each agent to another agent. If the agent is within a given distance, the link is accepted; if not, no link is made. It is possible to receive any number of incoming links. Furthermore, one agent broadcasts a link with a value of 1 to all the other agents in its vicinity, which they may accept or reject.

Figure 8.1 Shows a stage in the simulation run in BEBS. The green dots are the nodes or agents exchanging information. The links have different colours depending on the type of communication exchange. The broadcasting of some type of communication is shown by the links in blue: one agent sends to many a message, the number of agents accepting the message increases the value of the node sender. In the following section a summary of the main ways this programme can be used are presented.

8.5 Results and Limitations

The simulation illustrates how transactions change over time and shows changes in the number of agents located in a certain area exchanging data. While currently it is not possible to attach real values to these exchanges, the flexibility of the program allows it to be executed many times, based on values that can be calibrated according to expectations determined by the agents. This will only be possible when there are running applications in BIONETS that are able to collect data about the eagerness and volume of transmissions within nodes.

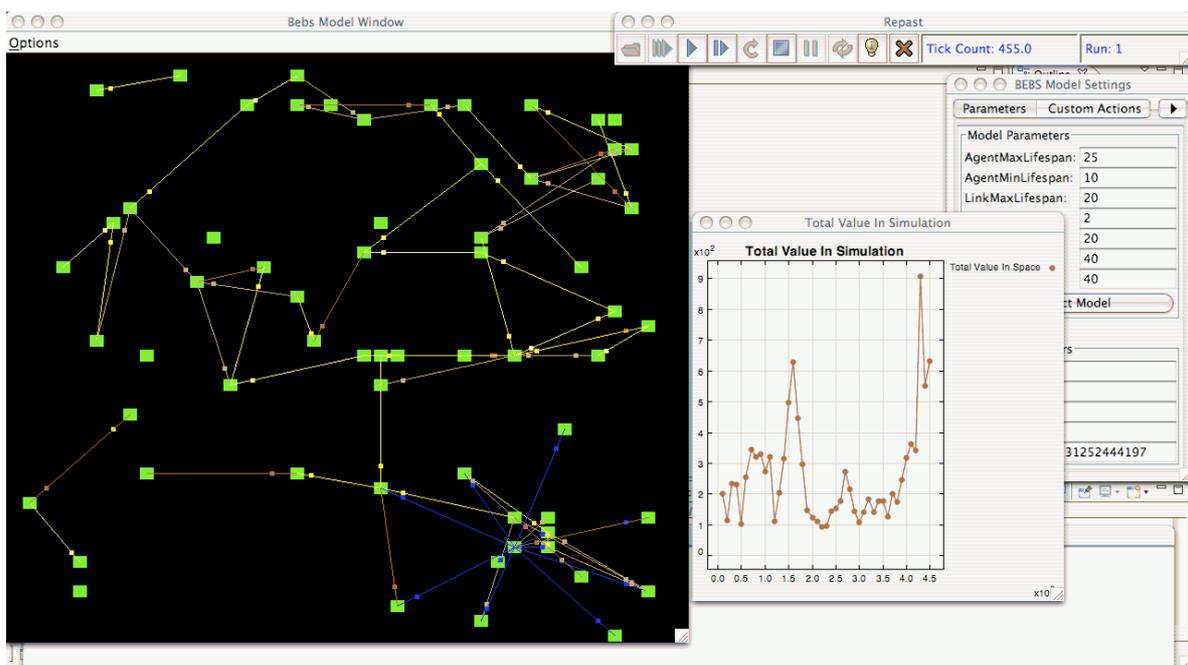


Figure 8.1: View of the model in Repast

The main limitation of the model is the lack of real data to be able to test it. This is due in part to the lack of applications but also to the need to build a computational interface that allows the feed from the application data to the BEBS model of the relevant variables in order for the program to execute its calculations. Some of those shortcomings have been overcome through the use of random functions generating the values used in the simulation.

Some interesting findings were obtained when running the simulation on trials using values selected by the developers of the programme. Figures 8.2 and 8.3 show how the program works and comments about results.

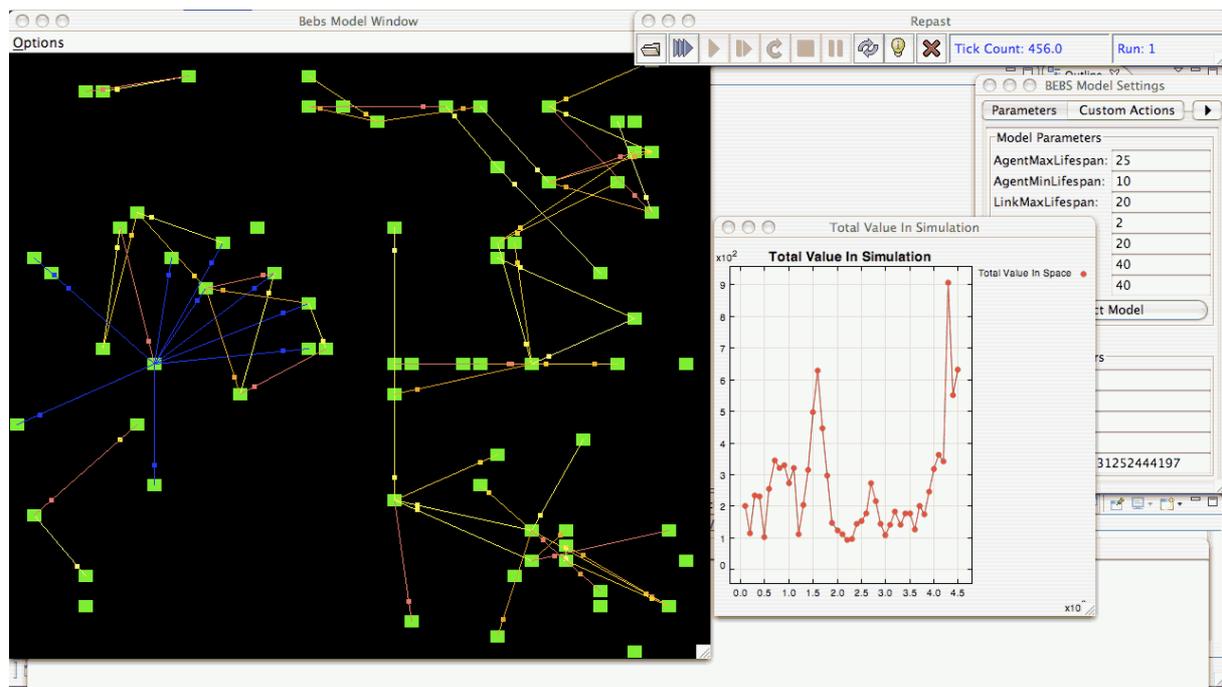


Figure 8.2: Exchanges over BEBS

In Figure 8.2 the aim of the simulation is to measure the change in total value over time, and to see patterns in the variations where different parameters are employed. The time on the x-axis is plotted against the total value on the y-axis. As time varies, the scale of both axes increases whilst the intervals reduce, so that the graph remains the same size. In order to compare graph shapes, a fixed number of steps can be run.

In Figure 8.3 the value of the nodes on a certain time are saved on a .csv file that can automatically be imported by Microsoft Excel or any spreadsheet package. During the development of the software many runs of the application were completed.

The most interesting configurable parameters are the maximum and minimum lifespan of a link and agent. Lifespans can be fixed within a wide or narrow range. Considering first a narrow range for both link and agent, link lifespans that are short relative to the agent lifespan tend to give a higher total value, since a larger number of short-lived links can be formed within the lifespan of the agent. Long agent and short link lifespans tend to lead to very gradual changes in value, since only a small proportion of the agents expire at any given moment.

Considering now the range, a wide range of *link* lifespans with a narrow range of agent lifespans tends to lead to small and regular fluctuations in total value, but around a fairly steady and predictable mean. A wide range of *agent* lifespans, however, has the effect of

radically destabilising the model. There are likely to be long periods where the total value is static, but with sudden, irregular peaks which can be very high relative to the average.

8.6 Analysis and remarks on BEBS

In principle this is a first attempt to develop a quantification of business models for the BIONETS infrastructure. The aim is to be able to provide, in the longer term, a model that can be interfaced with the computational output from the infrastructure development, feeding in this way real data collected in transactions that will occur when there are applications available to be deployed using the outputs from the BIONETS computational and scientific research. This is a novel approach that could be developed further and merged or integrated with the work completed by other partners in the BIONETS project. In doing so, this simulation can be a powerful tool to illustrate the economic benefits for actors derived from the exchange type of business model in any future BIONETS-enabled environment.

Steps	Number Ager	Total Value	Peer-to-Peer	Peer-to-Peer	Peer-to-Peer	Peer-to-Peer	Peer-to-Peer	Recipient-of-Transmitter:1
0	80	0	0	0	0	0	0	0
1	84	114	10	4	0	6	8	32
2	85	186	14	12	6	10	14	20
3	86	304	20	20	12	16	24	24
4	86	384	24	28	14	24	30	16
5	86	476	26	38	20	28	38	12
6	86	562	30	44	30	30	42	24
7	86	640	30	46	34	42	48	8
8	87	702	32	54	40	46	50	8
9	88	820	40	68	40	52	56	36
10	89	890	42	68	48	60	58	38
11	90	964	44	74	54	68	64	18
12	93	1048	46	78	64	72	70	16
13	94	1132	46	80	66	80	76	28
14	95	1164	52	84	68	86	78	6
15	96	1242	54	90	74	98	84	14
16	97	1382	60	92	82	100	92	32
17	98	1528	66	102	88	110	104	34
18	99	1634	70	110	100	116	110	30
19	100	1742	78	112	108	126	118	22
20	100	1860	92	116	116	132	126	30
21	100	1972	102	120	124	140	138	8
22	99	1922	112	120	120	136	132	6
23	98	2048	114	124	128	148	134	40
24	102	2000	108	122	132	142	132	24
25	102	2088	114	130	138	148	138	18
26	102	2204	124	142	142	156	144	26
27	101	2292	134	144	142	160	150	14
28	102	2368	138	152	144	170	156	34
29	102	2462	144	158	156	176	162	20
30	104	2548	148	168	156	178	168	44
31	103	2572	142	160	162	178	178	22
32	103	2664	150	168	174	180	184	16
33	104	2734	150	170	178	186	188	26
34	104	2840	156	178	190	192	190	40

Figure 8.3: BEBS output tables

Until now the value of these trading networks has not been tried in mobile environments, and depending on their growth and sustainability some of these networks may in future evolve to have significant value, which will make them attractive to conventional sources of funding. Example: record companies releasing songs over metro stations, broadcasting companies (tv, film) distributing total or partial media files as teasers for actors to develop interest in the content, actors which can dedicate their resources to collect environmental variables that can be used later to tailor services or activities in a location according to user demand.

The software has been released as a Java applet on the project website and the source code will be made available under the LGPL license¹².

There are not many research computer modelling models specially created to recreate social networks economic behaviour, such as able to exchange information over distributed networks and allocate to those transactions token values. And since the simulation is

¹² The Licence used was automatically generated using the tool available at <http://creativecommons.org/license/>

sustained by a business model that is not centralized, this piece of work contributes to enhance the understanding of these types of networks, and its research paradigms.

Overall what is more important is the fact that there is a value of this trading that can, with calibration estimates, make a strong case for the implementation of applications and systems in which the sustainability of alternative business models can be assessed, and their viability and economic profitability verified, since the investment for establishing such networks is practically null from the point of view of traditional telecoms.

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