Grid Economics and Business: Meeting the Challenges

George Thanos[1], Eleni Agiatzidou[1], Juan-Carlos Cuesta[2], Alan Readhead[3], Davide Maria Parrilli[4], Karita Luokkanen - Rabetino[5]

[1]*Network Economics and Services Group, Athens University of Business and Economics, 76 Patission Str. Athens, Greece, Email: {gthanos, agiatzidou}@aueb.gr,*

[2]*Telefónica Investigación y Desarrollo, C/Emilio Vargas 6, 28043 Madrid, Spain, Email: jcuesta@tid.es,*

[3]*British Telecommunication plc, Antares Building, Adastral Park, Ipswich Suffolk, UK, Email: alan.readhead@bt.com,*

[4]*Interdisciplinary Centre for Law and ICT, ICRI-K.U.Leuven-IBBT, Sint Michielsstraat 6, Leuven, 3000, Belgium Email: davide.parrilli@law.kuleuven.be,*

[5]*Atos Origin, Diagonal 200, 08018 Barcelona, Spain, Email: karita.luokkanen@atosorigin.com*

Abstract

The technological advantages of a new technology, let alone, cannot quarantine its widespread adoption. The economic, business and legal factors should not be underestimated but rather examined cautiously together with the technological context. Based on this statement, this paper presents a number of valuable conclusions and hands-on advice for new players that wish to enter the market by adopting Grid technology. The authors discuss the main challenges to be dealt with, provide a set of business advices and suggestions and place this discussion in the context of new architectural paradigms such as Cloud computing. The paper has been built on the experiences of a business and legal consultancy team with the responsibility of assisting the adoption of Grid technologies in the EU.

1. Introduction

A lot of efforts have been made in various technical research directions in the last years in order to establish Grid technology as a successful and promising architecture for distributed computing and data resources. However, undeniably, the path to adoption for a new technology requires parallel efforts in regard with business aspects by analyzing current market conditions, defining a number of viable business plans and creating a sustainable economic environment for their implementation.

The latter has been among the objectives of the European Union's 6th Framework Program (FP6) [1]. The largest EU project in the area, BEinGRID [2],[3], gathered more than 100 potential Grid adopters, mostly Small and Medium Enterprises (SMEs), from diverge business sectors and assisted them through dedicated expert teams in the technical and business domains in order to build and implement profitable business cases.

This paper which is authored by selected members of the business consultancy team of BEinGRID discusses some of the basic lessons learnt after 3 years of interaction with the new Grid players and after having evaluated a number of real-life business plans.

Following this introduction, the methodology of the business consultancy team is presented. In Section 3 the challenges of going into Grid Business are discussed followed. Section 4 then presents some practical advice for adopters . Finally, after focusing on some crucial legal aspects in Section 5, Section 6 briefly puts this discussion in the context of other emerging technologies before concluding the paper.

2. Team formation and methodology

BEinGRID is a unique project in this research sector as its main purpose is to promote the adoption of Grid computing. To fulfil this purpose the project provides the framework to support pilot implementations of Grid technologies in actual business scenarios. The first step followed was to comprehend and expose to the wider community the benefits that Grid technology can offer to the commercial environment. This was complemented in parallel with an analysis and evaluation of the market and the current adoption level of Grid technologies by businesses. Furthermore, technical and business support was given for the implementation of critical mass Grid-enabled pilots.

Those Grid pilot applications referred as Business Experiments (BEs) constitute the core of BEinGRID

project. Each, 25 in number [2], addresses a concrete business case in which the main actors of the value chain such as the end-user, the service provider and the Grid service integrator, are represented. They represent scenarios from a large number of industry sectors, such as Advanced Manufacturing, Media, Financial, Retail and Logistics and finally Environment and E-science, each one having different needs in terms of technological and business Grid challenges.

In order to extract best practices and success stories, a team of consultants was assigned to guide the BE partners in different areas, such as in technical, legal and business issues. The major purpose of the business consultants was to assist the BEs in the whole process of identifying their business plans and assist them in tackling any problems that might face during this challenge.

The process overviewed above provided the business consultants with the necessary information and experience in order to proceed in a holistic business modelling analysis and evaluation Grid adoption in EU and identify associated hurdles. The evaluation resulted in some general observations and challenges applicable to all sectors, which are discussed in the remaining of this paper.

3. The path from the idea to the realisation

The first step for a company considering the delivery of a Grid-associated product is starting from an idea to accurately define the business case and based on that compile a viable business plan. This section highlights some issues that should be taken into account in that very first step.

3.1 Defining the technological value

When defining a business model for a business case that involves the utilization of a new technology that has not yet proven its merits in the market, the associated risk factor is very high and thus a cautious approach has to be followed. Various definitions can be used to describe the business model term ([4], [5], [6]). For our purposes we will have in mind that a business model is simply a framework to transform the technological value to generate economic outputs.

Therefore, the first target that a newcomer must accomplish before designing her model is to having accurately defined the technological value. This is the basic lesson learnt and advice that we would give to a new adopter. At the end of the day it is this value that would be the driving force and at the same time the adoption driver behind this technology.

Applying that to our case for the Grid and by performing an analysis of the current market and business models we can suggest three main drivers, envisioned as the added-value of Grid that can be used as the basis for the definition of a business model.

1. The "Common Use of Resources and Infrastructure as a Service (IaaS)" benefit & driver: economic benefits in such a business case can be expected from offering dynamic resources using a Grid infrastructure. Also this model accounts for those cases that Grid is used in Infrastructure as a Service (IaaS) architectures.

2. The "Collaborative and Virtual Organization (VO)" benefit & driver: here, the economic benefits can be expected by offering services or software that takes advantage of the collaborative environment and functionalities that Grid can offer.

3. The "Software as a Service (SaaS) and advanced software architectures" benefit & driver: economic benefits are expected by Grid-enabling existing services in order to offer them using the SaaS delivery paradigm or developing new Grid services, designed to be provided using the SaaS. Also this model accounts for the cases that Grid services are offered (via SaaS) with the purpose of being integrated to SOA and Cloud Computing architectures.

We will next discuss a few practical examples of how to reach the desired Grid benefits, the technological and economic advantage from the aforementioned value-added driven business models.

A commonly found business case (belonging in the first category) is that where an internal Grid solution by a company is utilized as a virtualization technique in order to improve the exploitation of the resources, acquiring in this way a performance differentiation from other companies. This is particularly important for a large organization with several departments scattered around the world, each possessing its own local infrastructure. Interconnecting these in a Grid attains the aforementioned performance enhancement, high exploitation of resources, cost-efficiency and economies of scale, due to the fact that interconnection of all machines improves utilization of each individual one [7]. In this case the company uses the service which a Grid application provider sells as a service or as a product (SaaS, SaaP).

Another way to reach the value-added from Grid technology is for a company to rent external computer resources through the Internet, from companies such as Amazon [8] or Sun [9] which use Grid as the underlying infrastructure. The gained benefits are limited to the performance differentiation but with minimum costs. The most preferable business case constitute the one that adapts/Grid-enables the existing

applications (or develops new ones) to run over the Grid and offers it to external clients. This business case gives to companies the opportunity to find new markets through SaaS provisioning.

Another business case concerns a group of companies that are forming a Virtual Organization in order to gain added value from the common use of the resources and possibly provide new services to external users that were not feasible before. In this case, the collaborating organizations enjoy economies of scope and/or scale, since bringing all resources together by means of Grid broadens their scope of applicability. CERN is a typical example of this despite the fact that is mostly considered as an academic Grid; nevertheless it does adhere to a specific business model in order to be financially sustainable.

Table 1 presents the potential products and related models for each of to the discussed drivers.

Grid value-proposition	Potential end-products and relation with associated traditional business models
Common Use of Resources and IaaS	• Services offered as SaaS (resources offered over IP) • SaaP (software for enabling common resource utilisation in an organisation) • Open source software (as above but offered through an open source license)
Collaborative and VO	• Services offered as SaaS (services for collaborative environments) • SaaP (software for enabling the creation or administration of collaborative environments) • Open source (as above but offered through an open source license) • Value-added services (adding value to collaborative environments)
Software as a Service SaaS and advanced software architectures	• Services offered exclusively as SaaS (of various types) • Value-added services (enabling new services offered exclusive as SaaS) • Services offered from ASP providers (very similar in this case to SaaS)

Table 1. Grid value-proposition and associated end-products and models

In the course of our research we have analyzed and evaluated the business plans of various value chain actors belonging in all of the aforementioned cases and have identified and addressed various shortcomings. Some of the observations are discussed in Section 4.

3.2 The challenges

Grid computing is now a state-of-the-art computing technology, but the world is still waiting for Grid computing to enter the main stream IT services market. This is partly because potential users don't ask for Grid-based products and services per se. Instead they seek for cost effective solutions to business needs. Therefore, Grid-based products and services have to compete with products and services based on all the other computing technologies.

This sub-section summarizes the most significant challenges of Grid-based business and tries to answer the question: which main challenges can keep a Grid-based business from being successful?

Challenge 1: The market need. In a nutshell, if there isn't an unsatisfied market need, there isn't a business opportunity. Most BEs in our case addressed this key success factor by working very closely with a potential customer who helped to steer the work and who would (in due course) provide a reference site. However, this can lead to the BE working too closely with the potential customer's IT organization and not sufficiently with the four key roles within a customer's organization: the business manager, the business users, the IT manager and IT staff. It's obvious that the introduction of new services can only be initiated by the business manager, hence the need to focus on - and deliver - real benefits to the customer's core business.

Challenge 2: Reluctance to adopt Grid-based services. Many companies are rightly wary of new (and possibly unproven) technologies. They prefer what they already know. They may have a need for applications that can best be delivered over a Grid platform but the need for a transition is an added concern to them because, if not handled properly, transition can mean disruption. A service provider for Grid-based services has to be aware of the reasons for the reluctance of his potential customers and in order to be successful these issues have to be addressed in the market approach. Only those service providers who support their customers in going through this transition process to use Grid-based services and make it as easy for the customer to hop on the Grid train will be successful on the long term.

Challenge 3: The innovation cycle. A crucial aspect to consider for potential providers of Grid-based services is the innovation cycle. Grid technology is innovative for most markets. The same applies to Grid-based services. According to Geoffrey Moore [10] there are four phases of evolution of IT capabilities: invention, innovation, standardization and commoditization. Many customers are still on their way to move into a service based organization, which makes use of service oriented IT architectures, hence they're still on their way to "be enabled" for Grid-based services. This means that it will take time for the new technologies to achieve commercial grade performance and productivity levels. It's obvious that the introduction of Grid-based services is strongly connected with the introduction of SOA, a process which has not made as much progress as some people expected over the last 5 years. This suggests that the innovation cycle is not as compressed as the purveyors of new technology would like. In parallel with the

innovation cycle there is the adoption cycle from innovators to early adopters to the early majority to the late majority to the laggards. The two cycles are inter-dependent. As a general rule, the majority will wait for standardization and the laggards will wait for commoditization.

Challenge 4: Unclear Return-On-Investment (ROI). Given a product/solution which satisfies the customer's business needs, and given a customer who is willing to go through a transition process to make use of Grid-based services, most companies are still unconvinced about the Grid's ROI potential. According to a 451 Group report [11] "much work is still required to convince the most risk adverse majority of users across all verticals that Grid investments will pay dividends". Although this report was published in 2004 this question lingers on - and there is reason to be cautious. There is still uncertainty about the numbers. Companies need to differentiate between the hype, of which there is much, and hard facts, of which there is much less. Changing business processes is a subject that needs to be worked through in rigorous detail. If it's not done thoroughly, the chances of failure are much increased. Wasting money is easy; saving money is much harder.

Challenge 5: Unreliable business and technical assumptions. No competent businessman will want to risk falling foul of one or more of the well known fallacies of distributed computing: the network is reliable; the latency is zero; the bandwidth is infinite; the network is secure; the topology doesn't change; there is (only) one administrator; he transport cost is zero; and the network is homogeneous [12]. So they will want to make sure than none of these well known fallacies can and/or will undermine their Grid-based project. The experienced business man knows that reducing costs in one area can sometimes increase costs in another, so they need to look at the whole picture.

This means that a Grid-based solution will only be the best solution where the cost benefit analysis forecasts the best outcome and the advantages outweigh the disadvantages. For Grid computing to succeed it has to tick more of the better, cheaper, faster, simpler boxes than the alternatives, and the ticks must be based on verifiable facts not unsubstantiated claims. Clearly, the result will depend on the particular circumstances of each project. Each project will have to prove it offers the best cost benefit outcome against alternatives that are also trying to prove they offer the best cost benefit outcome.

4. Lessons learnt and practical advice for adopters

One of the key tasks of the BEinGRID project is to investigate, analyse and develop business knowledge in the context of the development of Grid business models. This section summarises the lessons learnt by the business consultants as a consequence of the direct and continuous support given to the 25 Grid business pilots for their development over nearly three years. These lessons are classified into three categories:

- *Value proposition*
- *Marketing strategy*
- *Implementation of the solution*

4.1. Value proposition

This section contains advice and suggestions relating to the definition of the offering for the customer. The recommendations are:

Grid technology is well suited for computationally intense tasks but its usage is not limited to it. Consider Grid as a technology that can be applied in many areas beyond just cluster computing or resource sharing.

Offering a Grid enabled application is not a competitive advantage or a Unique Selling Proposition (USP) just because it is Grid-enabled. Grid enabled offerings compete with solutions based on other technologies and their degree of their success will depend on how they are able to match their proposal to the needs of their customers.

The reason for choosing Grid must be objective. Similar results can be achieved with other technologies. Grid computing will only be best for applications where the advantages outweigh the disadvantages based on verifiable facts, not wishful thinking.

It is not necessary to sell Grid in order to implement Grid. A Grid infrastructure can be used as the internal part of the provider's solution, even where this is not explicitly stated. The end-user is looking for the most efficient, cheapest, easiest solution to its problem. If it happens that a Grid middleware fits the needs of the applications, and is the most efficient way to deliver the result, it is then the way to go. Whether or not the vendor needs to tell the end-user that Grid is part of the solution is a marketing decision.

A user interface that suits the user's needs has to be part of the solution. Very often the Grid has to be hidden behind a web portal, or an existing user interface reengineered to access the Grid infrastructure. Most of the time, Grid is at its best when hidden from the end users.

4.2. Marketing strategy

Marketing strategy relates to the aspects to be taken into account before and after entering the market. The advice and suggestions here are:

Target the correct segment of market. First target the segment of the market you are most familiar with and then, once established there, move into new related segments where you have an advantage. It has to happen progressively.

The Grid market still needs to be developed, either solely or as part of another larger market such us Cloud Computing. For the next few years, Grid-based businesses may be limited to niche applications. In order to reach a wider market, customers need reliable service with the appropriate SLAs and a certain number of providers in a competitive environment. Mainstream enterprise adoption will take a few more years at least, and longer with SMEs, who are often wary of new technologies.

Understand the competition. Don't be too narrow in scope by identifying only competitors that also sell Grid-based solutions. The customer wants the most cost effective solution, irrespective of the underlying technology. Understand that the current solutions, substitutes and alternatives form the competition in the market, whatever technology they use.

Communication strategy has to take into account the following advice. The target audience has to be identified and the message has to be adapted. It must answer the "Why, what, who, how, when" questions. The best time has to be found to reach target audience and to have the best impact. The key messages have to be repeated regularly to make the audience remember it. Relationships with the media are very important and can be really useful when done properly.

4.3. Implementation of the business idea

Implementation of the solution analyses the internal factors that are key to achieving the business's objectives. The recommended practices are:

Strategic visioning must have a balance between short and long term goals. Rather than making a Grid-based solution for the first customer, focus on making a Grid-based product suitable for a specific group of customers. It's important to meet the requirements of the first and/or reference customer and, at the same time, have a road map of how the product is going to meet the requirements of its second, third, fourth customer, etc. A roadmap showing a plan to progress from the short term objectives to the long term objectives is recommended.

A new application designed from the beginning to run on the Grid might be a better choice than a Grid-enabled application. Later, this application could be easily integrated as part of a Cloud Computing solution as it is built on the same architectural principles.

Providers transforming their offerings into Grid-enabled applications may have to carefully change their licensing model from per user or per CPU models, to pay-per-use pricing models that include licensing costs. It is a challenge to set the prices and to diminish cannibalization of the same application that is not Grid-enabled. Multiple pricing schemes targeted at different customer profiles should be chosen if possible. A cautious strategy is often necessary, in order to keep existing customers who don't want change and to meet the requirements of new customers who do want change.

To deliver a successful Grid solution you need to have the whole value chain in-place. The value network for Grid-based services is different from traditional service provisioning and can be quite complex in terms of contractual agreements, licensing models, SLAs, accounting and billing. Careful planning is necessary and a clear distribution strategy must be defined. A complete solution may be composed of more than one applications running on more than one infrastructure. For a strong business model, all value chain players should be analysed in terms of their relations with each other, the financial and technological dependencies, and the benefits.

Grid-based services rely on assumptions about distributed computing that may - or may not - be true and thus they must be carefully analysed in each case to make sure they don't undermine the Grid-based project. These assumptions refer, for example, to network and data transport aspects: the network is reliable, the latency is zero, bandwidth is infinite, the network is secure and homogeneous, the topology doesn't change etc.

The deployment and usage of Grid may require changes for customers regarding their technical infrastructure, organization and IT governance as well as the culture that comes along with modern IT services. The introduction of a Grid-based service can also result in major changes of the overall information lifecycle management.

5. Legal considerations and advice

Legal issues play a pivotal role in the adoption of Grid technologies by businesses and therefore they received great attention within our research. The experience gained with the pilot applications allows the

authors of this paper to provide some advices and suggestions that are valid for all adopters: first of all, the 'Law' does not have to be perceived as a barrier to the implementation of successful Grid-based businesses. Legal considerations shall be taken into account and managed, not avoided, and it should not be forgotten that usually compliance costs are lower than litigation costs or sanctions. In other words, it is cheaper and more efficient for an adopter to analyze the potential legal issues that may affect his activities rather than neglecting them.

This part of the paper will focus on four main axes, i.e. four legal issues that are of pivotal importance for any adopter.

Contract law: the relations between the parties involved in the Grid-based business activities, e.g. between Grid provider and service provider, service provider and customer, Service Level Agreements, etc will be regulated by contracts. Therefore it is necessary to draft agreements that are as complete and flexible as possible. In other words, there shall not be big gaps that may lead to litigation, termination of the relations or long discussions and negotiations between the parties and, at the same time, the contract shall be adaptable to the business circumstances if they do change during the relation. It is obvious, in fact, that a contract must be flexible enough to regulate also future situations (modifications of the service or the price, technological advancements, etc). Flexibility means also that an agreement cannot take into account and foresee all potential issues and problems but must offer the keys to solve them in a fast and efficient manner. To give concrete examples of this, a typical contract shall state how it has to be interpreted and applied (usually through a clause on the applicable law) and how future disputes shall be solved (i.e. through a provision regarding the competent jurisdiction or a system of out-of-court alternative dispute resolution). Special attention, then, should be paid to the clauses about liability: often the contracts between Grid providers and customers state that the former will not be liable (i.e. will not pay damages and compensation) if, for instance, the service will not be provided as promised or if the client's data will get lost or damaged for security failures. In these cases the damages for the customer can be relevant and the service credit system is not satisfactory for the customer. If possible, therefore, the adopter shall negotiate the clauses on liability and get a better 'contractual' treatment.

Intellectual Property Rights (IPRs): they play a very important role in the ICT sector and therefore cannot be neglected by the adopters of Grid-based businesses. If an open source solution is taken, it is necessary to carefully assess which license will apply and what is possible to do and not to do according to this license. Often, in fact, open source licenses are very good for academic purposed but they do not suit business needs and the commercial implementation and adoption of ICT solutions. From a different perspective, patents shall be taken into special consideration. In particular, any adopter should verify whether or not there are patents, granted or pending, in the country where the solution will be marketed. This is especially crucial for European businesses, provided that often, in the software and ICT domain, what is not patentable in Europe can be patented in other countries. A company that does not pay attention to this and does not perform an appropriate analysis may risk to enter into expensive litigation with the holder of the patent(s) in other countries and to be excluded from the market.

Privacy and security: the applicability of rules and regulations aimed to protect the privacy of individuals depends on the nature of the data that are processed by the adopter. If personal (or sensitive, like for instance in the e-health sector) data are processed, it is pivotal to carefully verify which legal requisites must be respected (e.g. requests for authorizations/consent to national privacy authorities or to the 'owners of the data'; security measures to be adopted; notifications to national privacy authorities; prohibition to send the data outside the country or the territory of the European Union, thus limiting the possibility to outsource the processing of the data; etc).

Taxation: with this regard special attention should be paid to indirect taxation, applied to the services provided by the adopter. In Europe, for instance, it operates the system of the Value Added Tax (VAT) and according to existing rules it is convenient for a non-European adopter (e.g. a company established in the US) that wants to enter into the European market to open a subsidiary in a Member State of the EU in order to operate as (and under the same conditions applicable to) a EU-based business, thus applying only one VAT rate (that of the country of establishment) instead of (potentially) 27 different rates (those of the countries where the customers are located).

6. Lessons for a "Cloudy" future

It is common belief among business practitioners and researchers and shared by the authors of this paper that Grid did not succeed as becoming the dominant market paradigm for distributed resources provisioning for the single home-user as software and internet evangelists had envisioned. This can be attributed to a number of factors one of them being the inadequate business models as the poor market adoption also dictates.

The focus in the years to come will be concentrated in SOAs and Cloud computing. Of course that does not imply that Grid infrastructures will not be developed or utilised any more but most likely these will be integrated into these new software architectural paradigms. This is why it is very important that the lessons learnt from the Grid case are well understood and same mistakes be avoided in the future.

To better realize this let us first highlight the strong connection between the Cloud and the Grid. Grid Computing represents an infrastructure paradigm to manage virtualizations, whereas Cloud Computing represents a paradigm to use the managed virtualizations. Cloud Computing refers more broadly to a computing architecture. This architecture for example can link computers in a Grid and allow users to buy access to data and software stored on the Grid or processing power that is harnessed for specific purposes by the Grid of computers [13]. The Cloud paradigm thus requires a virtualization between the user and the resources and this is where exactly Grid and its competitors fit the picture.

In such a market existing Grid providers will have to adapt their business models accordingly to integrate their services as part of Cloud-based services in a win-win situation. Those models that are based on SaaS as described in Section 3 will dominate over the SaaP ones as SOA architectures will continue to evolve and be adopted by businesses and consumers. This evolution of business models is already visible in the market as major Grid players like Sun [9] are marketing their products as Cloud-based and others like Microsoft are planning to abstract their software from underlying infrastructure [11].

7. Conclusion

The aim of this paper is to raise awareness of the business view and to pinpoint and discuss some particular issues in respect to Grid computing. A number of practical business and legal advice and suggestions have been given for new adopters that can be re-used to a large extent for other emerging technologies such as the Cloud.

What has to be kept in mind as final conclusion is that the technical evolution of a new technology standalone is not enough for this technology to be widely adopted by the market. A holistic view is required from the early start that will take into account the business, legal and socioeconomic parameters. Only then efficient and sustainable business models and plans can be developed.

8. Acknowledgements

The research presented in this paper was part of the project BEinGRID (034702), which is supported by the European Commission in the sixth Framework Program. The authors would like to especially thank all the members of the Activity 2 consultancy teams for their valuable input.

9. References

[1] http://cordis.europa.eu/ist/, access date: 14 Sept. 2009
[2] http://www.beingrid.eu/ , access date: 14 Sept. 2009
[3] http://www.gridipedia.eu/, access date: 14 Sept. 2009
[4] Rappa, M.: Managing the Digital Enterprise. Available online: http://digitalenterprise.org/index.html , (2005).
[5] Afuah, A; Tucci, Ch. L.: Internet Business Models and Strategies. McGraw-Hill, New York, 2001.
[6] Osterwalder A. (2004): The Business Model Ontology. Ph.D. Thesis at the HEC Lausanne
[7] Thanos G., Courcoubetis C. and Stamoulis G.: Adopting the Grid for Business Purposes: The Main Objectives and the Associated Economic Issues, The 4th International Workshop on Grid Economics and Business Models, GECON 2007, Proceedings, Pages 1-15, Lecture Notes in Computer Science (LNCS 4685), Springer 2007
[8] http://aws.amazon.com/ec2/ , access date: 15 Sept. 09
[9] http://www.network.com/, & http://www.sun.com/software/sge/ , access date: 15 Sept. 09
[10] Geoffrey A. Moore, Living on the Fault Line: Managing for Shareholder Value in the Age of the Internet, Collins Business, May 2000
[11] The 451 Group, Grid Computing: Where is the Value?, the 451 Group, August 2004
[12] Arnon Rotem-Gal-Oz, Fallacies of Distributed Computing Explained, http://www.ddj.com/architect/, May 2006
[13] Geva Perry, "How Cloud & Utility Computing Are Different, at GigaOm." February 28, 2008. Available online at:http://gigaom.com/2008/02/28/how-cloud-utility-computing-are-different/. Accessed on July 21, 2009
[14] http://news.bbc.co.uk/2/hi/technology/7540282.stm , access date: 14 Sept. 2009