SEOUL NATIONAL UNIVERSITY
College of Engineering
Technology Management, Economics and Policy Program

Technology Management, Economics and Policy Papers

Cloud Computing Value Chains

Understanding Businesses and Value Creation in the Cloud

Ashraf Bany Mohammed, Jörn Altmann,
Junseok Hwang

TEMEP Discussion Paper No. 2010:61

서 울 대 학 교
공 과 대 학, 기술경영경제정책 대학원과정
151-742 서울시 관악구 관악로 599

Technology Management, Economics and Policy Program
College of Engineering, Seoul National University
599 Gwanak-Ro, Gwanak-Gu, Seoul 151-742, South-Korea
Phone: ++82-2-880-9140, Fax: ++82-2-880-8389

Technology Management, Economics and Policy Program (TEMEP) is a graduate program at Seoul National University. It includes both M.Sc. and Ph.D. programs, which are integrated into the graduate programs at the College of Engineering.

The *TEMEP Discussion Paper Series* is intended to serve as an outlet for publishing research about theoretical, methodological, and applied aspects of industrial economics, especially those related to the institute's areas of specialization, namely management of technology, information and communication technology, telecommunication, services, health industries, energy industries, as well as infrastructures for development. In particular, paper submissions are welcome, which analyze current technology and industry related issues, discuss their implications, and suggest possible alternative policies. The objective is to gain insights into important policy issues and to acquire a balanced viewpoint of policy making, technology management, and economics. It will enable us to identify the problems in industries accurately and to come up with optimal and effective guidelines. In addition, another important aim of this series is to facilitate communication with external research institutes, individual researchers, and policy makers worldwide.

Research results disseminated by TEMEP may include views on policies for information and communication technologies, technology management, telecommunication, energy, health, and development economics, but the institute itself takes no institutional policy position. If appropriate, the policy views of the institute are disseminated in separate policy briefs. Thus, any opinion expressed in the TEMEP Discussion Paper Series is those of the author(s) and not necessarily the opinion of the institute.

Finally, the current editor of this series would like to thank Prof. Dr. Almas Heshmati for establishing this working paper series in January 2009 and for guiding its development during the course of the first 55 issues. In particular, Prof. Heshmati provided invaluable contributions for setting up the local IT infrastructure, registering the series with RePEc, disseminating the working papers, and setting the quality requirements.

Jörn Altmann, Editor

Office: 37-305
Technology Management, Economics and Policy Program
College of Engineering
Seoul National University
599 Gwanak-Ro, Gwanak-Gu
Seoul 151-742
South-Korea

Phone: +82-70-76787-6676
Fax: +1-501-641-5384
E-mail: jorn.altmann@acm.org

Cloud Computing Value Chains

Understanding Businesses and Value Creation in the Cloud

Ashraf Bany Mohammed, Jörn Altmann, Junseok Hwang

Technology Management, Economics, and Policy Program
Department of Industrial Engineering
College of Engineering
Seoul National University
Seoul, South-Korea
ashraf_bany@yahoo.com, jorn.altmann@acm.org, junhwang@snu.ac.kr

June 2009

Abstract: Based on the promising developments in Cloud Computing technologies in recent years, commercial computing resource services (e.g. Amazon EC2) or software-as-a-service offerings (e.g. Salesforce.com) came into existence. However, the relatively weak business exploitation, participation, and adoption of other Cloud Computing services remain the main challenges. The vague value structures seem to be hindering business adoption and the creation of sustainable business models around its technology. Using an extensive analyze of existing Cloud business models, Cloud services, stakeholder relations, market configurations and value structures, this Chapter develops a reference model for value chains in the Cloud. Although this model is theoretically based on porter's value chain theory, the proposed Cloud value chain model is upgraded to fit the diversity of business service scenarios in the Cloud computing markets. Using this model, different service scenarios are explained. Our findings suggest new services, business opportunities, and policy practices for realizing more adoption and value creation paths in the Cloud.

Keywords: Cloud computing, value chain, business models, Grid computing, service oriented computing, value networks, software-as-a-service, Grid economics, services, service sciences.

JEL Classification Numbers: D02, D21, D23, D46, D85, L14, L23, L86, M15, M21.

1. Introduction

The IT market is evolving quickly, driven by the increasing need for costs cuts and more agile and effective business processes. Cloud computing emerged as a promising computing model for providing utility-based, on-demand IT infrastructure services for anyone, anywhere and anytime [1] [2].

The developments realized in the past few years in computing techniques, especially in Grid computing, enabled the emergence of numerous computing models: Utility computing, ubiquitous computing, cyber-infrastructure, e-science, e-infrastructure and, above all, Cloud computing. Although many believe that these Cloud-based technologies hold the potential to revolutionize the Internet [3], actual adoption of Cloud computing services in industry and business is still way under expectations. It seems that the transition from classical enterprise IT models to Cloud-based computing is still the biggest challenge in businesses and industry, despite all the advancements that supported this transition

Complexity in existing value structures and modes for attaining cost efficiency practices are main shortcomings in the Cloud. These problems are believed to be the chief factors in contributing to the weak business and industry deployment, low adoption, and missing sustainability.

Understanding the structure of the Cloud and its potential value creation schemes is challenging due to the diversity in requirements, inherited technical complexity, and unstructured service schemes. This complexity made the provisioning and utilization of many Cloud technologies and services a very difficult task to anticipate, especially by non-IT businesses. For example, the deployment of services, composition of services, and troubleshooting of many Cloud services needs special preparations even for IT experts. In addition to this, top management officers in enterprises or governments need to understand how costs are accumulated and how value is added without going into deep technical details of deployment or provisioning. Therefore, clarifying the value structure and corresponding primary and support activities in the Cloud value chains would help both, the business and the Cloud community, in accelerating adoption and creating more value.

Following the line of argument, this paper aims at addressing the following questions:

- What is the value structure in the Cloud market? What are the "primary and support service activities that contribute to value creation in the Cloud?
- How do money and knowledge flow between stakeholders? And how can we minimize cost, maximize profit, and increase return on investment for Cloud stakeholders (providers and consumers)?

In order to tackle these questions, this research uses a case study analysis. Cases were reviewed and analyzed from available Grid and Cloud market services, projects, tools, applications, business models, and technologies. Based on the value chain theory, this analysis is used to create a reference model for Cloud value chains.

From the provider's perspective, the proposed Cloud value chain model helps Cloud Service Providers (CSP) to realize where they stand in the Cloud market and how they relate to other CSP. It particular, it helps CSP to identify their needs, anticipate potential alliances and create new service provisioning scenarios. This would also facilitate new entrants understanding of potential markets, formulate their value model based on market needs and fully utilize existing services. From the consumer's perspective, consumers will be able to identify the different potential costs for using and customizing the Cloud based on their business needs, and foresees diverse service scenarios from a strategic point of view.

To ensure the integrity of the model, the Cloud value chain reference model is later validated against hypothetical business scenarios. The validation also considers the value creation process and the flows of money and knowledge between the different stakeholders in the Cloud. As a result, a clear differentiation between main and support activities has been achieved, highlighting potential costs and opportunities in the Cloud.

The remainder of this chapter is organized as follows: In the next section, we review the literature on value chains and present the state-of-the-art in Cloud value chains. Section 4 describes the Cloud value chain reference model while section 5 provides the business scenarios. Section 6 draws policy recommendations and section 7 concludes this work.

2. Literature Review

2.1. Porter Value Chain

The value chain was first described by Michael Porter in [4]. According to Porter, the value chain is a ``system of independent activities, which are connected by linkages. Linkages exist if the way, in which one activity is performed, affects the cost or effectiveness of other activities". Linkages illustrate how a single activity affects other activities, thus serving as an important source of competitive advantage and value adding [5]. The value chain classifies activities into primary activities and support activities. Products (i.e. services) should pass all activities of the chain sequentially and, at each activity, the service gains some value and the chain of activities gives the product more added value than the sum of all single activities [6].

2.2. Upgrading the Value Chain

In the Internet era, value chains bear more advanced networking capabilities, adaptability to external changes, accessibility to virtual company structures, and more dynamic management capabilities [7]. In fact, many industries value creation processes are dynamic, flexible, non-linear and multi-dimensional, crossing horizontal and vertical (inter- and intra-) industry domains. Porter's original value chain is believed to be linear and fixed [8] [9] [10]. Consequently, Value Networks [8] emerged to provide a platform for modeling non-linear complex set of social and technical resources, working together via relationships.

In those value networks, value is created through the exchange of resources via relationships between roles. Although value networks represent a new approach to describe tangible and intangible value creation processes [6] [8], value networks modeling becomes complex, since the structure grows exponentially. This leads in many cases to many difficulties in foreseeing economic competitiveness, new opportunities, or anticipating costs.

A more advanced concept, known as "value grid" (the grid is not to be confused with Grid Computing), has been introduced in [9]. This model allows expressing innovation strategies and coordinated operations in multidimensional, grid-like value creation schemes. In fact, the ``value grid" extends the concept of value chains. In a value grid, the vertical dimension describes multiple tiers from primary inputs (raw materials) to end users. The horizontal dimension describes opportunities at the same tier across parallel value chains; and the diagonal dimension describes opportunities for integrating value chains" [9]. This gives the value creation model an evolving structure, where the flow of knowledge and intangible benefits can take place between any number of stakeholders anywhere and anytime. At the same time, it maintains an organized and systematic structure.

In general, whatever representation for value creation is being used, value chain models should allow all stakeholders to explore the diverse scenarios for generating value and to find their unique added value, guaranteeing their competitiveness, the maximum return on their investment, and their economic sustainability.

2.3. State-of-the-Art: Cloud Value Chains

A number of projects studied different aspects of value chains in the "information technology industry". Most recently, the "BEinGRID" project developed a Generic Grid Computing Value Chain and a corresponding value network model based on the analysis of industry case studies [10],[11]. In their classical Generic Grid Value Chain, different Grid stakeholders are described.

However, the organizational aspect of value creation has been overlooked and more attention has been paid to value networks. Same overall value creation process in the Grid technology market was also reported in [12]. Although it addressed the complexity of the value creation in the Grid industry in its early days, this model can not capture the Cloud market and suffered from same drawbacks as described in [10].

Another related value chain model has been created and analyzed for the ubiquitous computing environment [13]. Yet, within this work, the abstraction of the value chain model to five stages (context, information devices, networks, service providers, and digital content) is too simplistic. Despite this pioneering work, the linearity and highly abstracted representations were not able to proxy the value creation processes and potential value creation paths in the Cloud. Finally, a related work presented a detailed taxonomy and description of the stakeholders and their roles in the Grid [14]. Yet, this work was not oriented towards value chains and Cloud computing.

In summary, although these models provide a solid foundation for the development of Cloud value chains, they were not cloud-centric and none of them depicts the value transactions in an organized and systematic scheme that accounts for all stakeholders' inter-relations and value creation structures in the Cloud.

3. The Cloud Value Chain Reference Model

3.1 Data and Methodology

The data for the value chain analysis was collected through market surveys and case studies available online at Cloud, Grid and Internet service providers, project Web sites, descriptions of tools for Cloud computing, application specifications, and business models of service providers. A data set comprises information about the product and/or service, price, business linkages between partners and suppliers, cross layer linkages, as well as a description of the value creation process. Using value chain analysis techniques of Porter [4] and Hergert & Morris [31], this data was processed as follows:

- Determined the boundaries of the business segments to be analyzed.
- Identified critical activities and assigned activities to the Porter value chain model.
- Defined the product and value structure.
- Identified linkages and inter-relationships and, therefore, the relative position within the structure model.
- Determined the value of an activity.

Based on this procedure, the linkage, the layers, and sub-layers were set for each service. A fraction of this list of services and products is given in annex 1, the complete is list is available on our Web site.

3.2 Model

Building on the foundations of Porter classical model, value networks, and "value grids", the following Cloud value chain reference model was developed. The model breaks activities (services) down into three main virtual layers. Within those layers, services are organized as independent sub-layers. Each layer border represents a profit and knowledge margin. Linkages between layers or independent services can take horizontal, vertical, and diagonal paths. Value is accumulated by flow of money and knowledge through these linkages. Through this organization, service packages can be created in a flexible and cost effective way. Figure 1 shows our proposed Cloud value chain reference model.

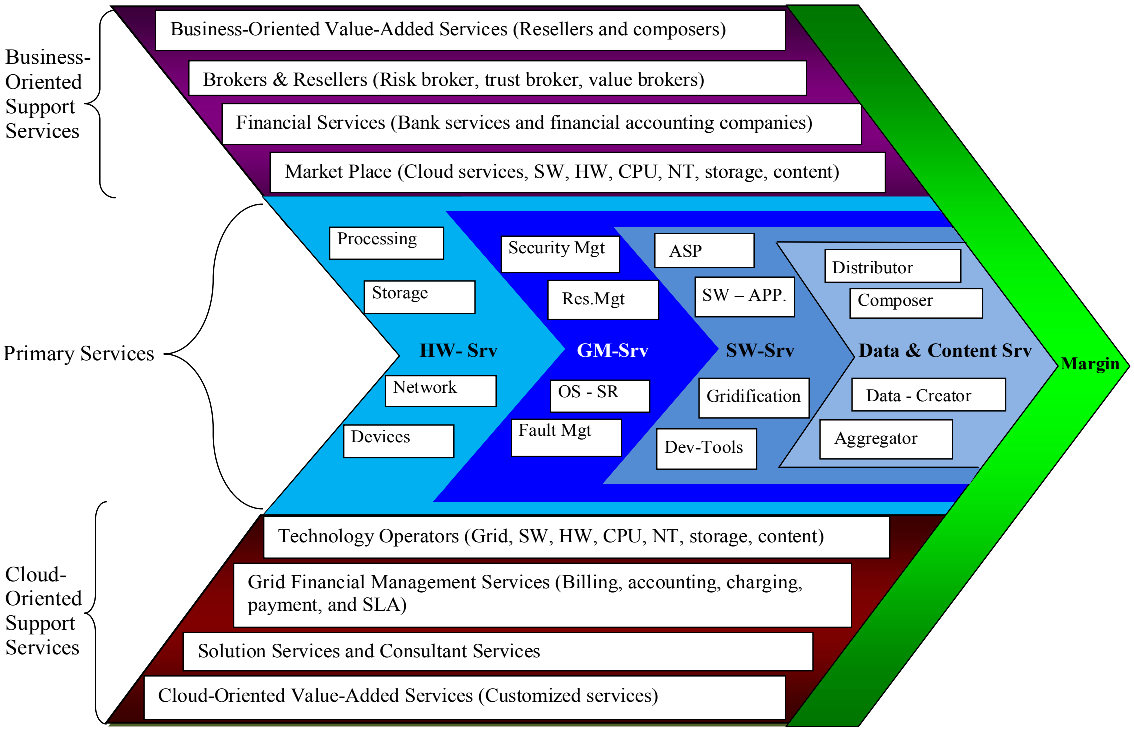

Figure 1.Cloud Value Chain Reference Model

- **Primary (Core) Services Layer:** This layer incorporates core infrastructure services, required for the development of any Cloud service model (enterprise Grid, high-performance computing Grid, business Cloud, or public computing Cloud). The structure of this layer resembles the Open Grid Services Architecture (OGSA) [32].

  This layer consists of the following sub-layers: The hardware services (HW-Srv) or fabric sub-layer includes networking, processing, storage, and other device services. Generally, a wide range of these services is provided as standalone systems from classical technology providers such as Sun Microsystems, IBM, CISCO, and HP.

  The Grid middleware services (GM-Srv) layer is commonly considered the founding Cloud layer. This layer mainly includes resource management services (R.Mgt.-SR), security, privacy, fault management, Grid execution, and operating systems services (OS-SR). Services in this layer range from complete packages such as Globus [15] [16], Legion [17], gLite [18] [19], UNICORE [20], Xen [41], Grid Application Toolkit (GAT), a Grid programming framework [34] to standalone system services.

  As the fabric sub-layer services, the software sub-layer services are usually provided by countless software companies, ranging from big players to an open source software community. The software services (SW-Srv) sub-layer includes software applications (SW-APP), Gridification services (e.g. Grid Execution Management for Legacy Code Architecture - GEMLCA) [33], developing tools (Dev-Tools) and application support services offered by Application Service Providers (ASP).

Finally, the data and content services (Data & Content-Srv) sub-layer includes data creation, aggregation, and distribution services. Data libraries, 3D multimedia data, and research databases are some of the technologies in this layer. Providers for such content services can vary from professional data service companies, universities, and research centers to end-users.

Note that all of the primary layer and sub-layer services are provisioned as packages or independent services, outsourced and/or built in-house. Deciding for any of these approaches always depends on the anticipated opportunity cost and the value added to the provider or customer.

- **Cloud-Oriented Support Services Layer**: This layer incorporates all activities developed solely to support and enable the Cloud in real world markets. Services in this category are normally developed and deployed based on customized or specific needs. Whereas some Clouds need all these services others may need just few. In many cases, services from this layer are bundled with core activities (particularly in Grid middleware sub-layers) and are provided as a full package offered by Cloud Service Providers.

  The support services layer consists of the following service sub-layers: a) Cloud financial management services. They incorporate basic Cloud-based charging, accounting, billing, payment, and SLA management systems. An example of these services is SLA@SOI (see appendix); b) Solution providers, consultant, and composer services.

  Examples of this type of service include infrastructure for service delivery from RESERVOIR (see appendix); c) Technology operator services. These operators do not own the resources but operate the resources for the benefit of another party. Their services include activities of running, operating, and troubleshooting core services (e.g. software, hardware, network, storage, and content services). This service is especially important for big businesses and industries; d) Cloud-oriented, value-added services (customized services). This layer represents support services that address emerging needs in the market by supplying niche services. An example of this service could be customization of existing support services.

- **Business-Oriented Support Services Layer**: This layer represents all (non-technical) business services that support businesses and Cloud industry business. This layer includes services in existing, real-world markets, customized to the business side of Grid computing.

  Some of these business support services (e.g. banks and brokers) exists since a long time and served many industries. These activities include the following sub-layers: a) Financial management services (e.g. banks and financial solution companies); b) Brokers and resellers services (e.g. sellers, distributors, insurance companies); c) Marketplace services such as GridEcon [21] [37] [40], Gridipedia [11], and Amazon [22]; and d) Business-oriented value-added services, which are anticipated for innovative future business services. These include a wide range of systems. A good example of such services is TXTDemand, a demand forecasting system provided by SORMA (see appendix). A detailed description of many of these services and stakeholder roles can be found in [14] and [38].

3.3 Model Structure and Relations

To maintain efficient processes, structures, and linkages in value creation and service scenarios, the reference model holds the following properties:

- **Structure and Organization:** The model is made up of a virtual layer of ser vices and sub-layers organized according to core, value-added, and support services. This will help maintaining readability and structure in value creation process.
- **Inter-Layer Heterogeneity and Intra-Layer Homogeneity:** Layers and sub-layers make services share common knowledge bases, comprise strong relationships, carry out related functionality, and serve closely related goals. Consequently, spillovers, bundling, and packaging has more probability to take place between direct and nearby layers and sub-layers.
- **Knowledge Flow:** Services of each layer and sub-layer have knowledge spillover effects that span beyond its borders, allowing value to be shared and ex changed between them. Knowledge flows will add more value and help minimize the costs. For instance, the flow of knowledge between solution providers and financial service providers or between brokers and market place service providers can have these effects.
- **Flexibility in Service Composition and Value Creation:** Each Grid value creation process or service scenario has its own distinctive and different requirements. Therefore, the model relaxes the linearity condition of the Porter model and allows vertical, horizontal, and diagonal combination of services. This enables anticipation of service scenarios that are simply based on value and cost effectiveness.

Figure 2 shows an instance of the proposed Cloud value chain reference model. In particular, it shows sample services available in the market in each layer of the value chain. Each service is associated with a price and attributes to meter the total cost. Service costs vary according to the service type, quality, and usage model. By matching the services available in the market to the value chain, customers or providers will be able to foresee different scenarios for deploying or developing their Cloud services.

In detail, figure 2 illustrates three composed services that are composed of sample services. For instance, the vertical, dash-lined rectangle shows an example of a service, which is composed of a set of infrastructure services and which costs 2000$/year. This service consists of: hardware (storage and devices), maintenance and operation, charging, and consulting, belonging to the primary and Cloud support layers. These costs are added to the costs of brokers, accountants and market services. Another service is illustrated in the upper right corner of the figure, which offers a wide set of customized and user-oriented services. Finally, the horizontal dash-lined rectangle illustrates an enterprise Cloud service that integrates all primary services. As these examples show, examining services with the proposed Cloud value chain reference model will help stakeholders in understanding value structures and foresee opportunities, while minimizing costs.

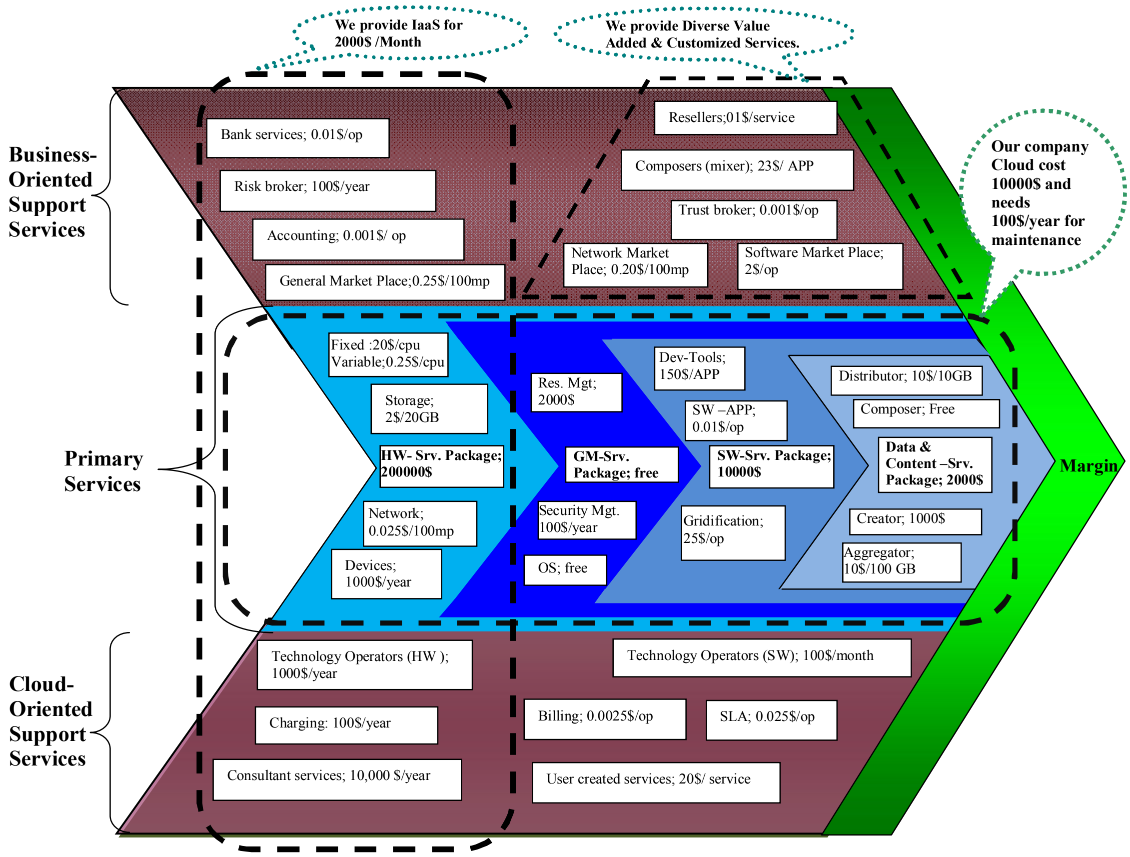

Figure 2. Instances of Cloud Value Chains

3.4 Service Scenarios

To illustrate the workings of the Cloud value chain reference model, this section describes five different Cloud value creation scenarios that are explained based on the reference model. These scenarios are either existing Grid service scenarios or are potential future scenarios.

3.4.1. Utility Cloud. In this scenario, services are provisioned in a similar way to any other utilities (electricity, gas, and telecommunication). The Cloud service provider offers a complete end-to-end package of Grid services that consist of primary, Cloud support, and business support services to fulfill the requirements of a targeted class of users. Services here are provided on-demand and metered based on consumption parameters (quantity and quality). Therefore, the user role here is limited to plug-and-play with no additional huge fixed investments or worries about complex structure, maintenance, or support.

Validating this scenario against the Grid value chain model, we find that the Utility Cloud Service Provider (UCSP) needs to carry out all primary activities, which include hardware infrastructure (bandwidth, servers or other special devices needs), Grid middleware (resource management system and security), and software services. Besides, the UCSP needs to provide financial services for the users of his Cloud service (such as charging, Service Level Agreement (SLA), and metering schemes). At the same time, the UCSP has to provide business support activities and define payment and billing services, broker's services, and market services. The first generation of such a UCSP (since much more comprehensive services can be offered in the future) is Amazons Elastic Compute Cloud (Amazon EC2) and Suns Grid Compute Utility Service [22, 23].

3.4.2. Enterprise Cloud. Large enterprises (e.g. Wal-Mart, which have more than 400-billion-row tables, which ultimately top a trillion rows" [24]) require huge computing power for intensive data analysis. Enterprise Clouds offer a cost effective solution for utilizing the internal computing resources to satisfy this huge demand. In this scenario, the Cloud is constructed for supporting internal business needs for the enterprise. The enterprise in this scenario has its own hardware, software, and business applications. That means that much of the primary activities are already in place. With dependable Grid middleware systems, which can be either in-house developed or outsourced from technology providers along with Gridification systems, the enterprise Cloud will be basically operational. Nevertheless, some business and Cloud support activities (e.g. consulting services, wrapping services, and SLA services) will still be necessary to purchase from the Cloud.

The final decisions will depend on enterprise value models and vary from case to case. Nevertheless, using Cloud value chain modeling will help technology offcer to foresee their costs and justify their arguments to executive management. During the past years, many firms transformed their information systems to Clouds. Charles Schwab, the financial services provider has been using IBM servers with Globus middleware for its Grid for a while. Acxiom, a global marketing services firm, is using Red Hat Lunix operating system and JBoss Enterprise Middleware for its Grid processing environment. A list of other examples can be found in [25].

3.4.3. Research Grids. In this service scenario, the Grid is constructed to support academic and research communities. Validating this scenario against the value chain model easily shows that most primary activities such as hardware resources, networks, and many other requirements are already in place. However, middleware is needed, which is developed internally in most cases rather than outsourced to the market (not considering that the research community collaborates and shares their middleware). Since applications are developed in-house as well, no additional cost is incurred. Access and usage policies are usually set on non-monetary bases (mutual sharing of resources). Consequently, services and systems are required from both, the business-oriented support layer and the Cloud-oriented support layer. For instance, while financial and broker services are not required, a clearing-house service is needed to balance accounts with respect to contributions and consumptions. However, in variation of this scenario, if research Clouds become open for businesses in the future, financial accounting, metering, and charging services will be needed.

Many examples of research Grids exist. Some of the notable examples include: TeraGrid, EGEE, LA Grid, and D-Grid. The TeraGrid is a scientific research infrastructures launched by the National Science Foundation in the United States. TeraGrid provides more than 250 teraflops supercomputing services capability, 30 petabytes data resources, as well as high-end experimental facilities for researchers from diverse disciplines. The Enabling Grids for E-science (EGEE) is an EU project connecting more than 240 institutions in 45 countries world-wide. EGEE infrastructure provide seamless computing services for e-Science that consists of 41,000 CPU in addition to about 5 PB of storage, and maintains 100,000 concurrent jobs [18]. The LA Grid is a joint Grid effort of the United States, Latin America, and Spain [26]. At a national level, the German Grid Initiative (D-Grid), which has been launched in 2004, is comprised of a number of projects that designs, builds, and operates a network of virtualized high-performance resource services [27].

3.4.4. Public Clouds (Desktop Grids). In this scenario, end-users collaborate in constructing their computing resources. A user-collaborative Cloud is built of what is referred to as the collective power of members. The primary activities consists of user PCs (being the main computing resources), the Internet (being the backbone network), and the freely downloadable middleware (BONIC) and application. Based on intangible incentives for participants with very little Grid supported services from project moderators (who are researcher and volunteers) and with no business-based services except SLAs, this model showed a huge success. SETI@home, a public desktop Cloud, has been standing as a symbol for successful sharing of distributed computing resources in search for extraterrestrial intelligence [28]. Following this success numerous similar projects were initiated worldwide (e.g. Einstein@home [29], Rosetta@home [30]).

3.4.5. Virtual Clouds (VC). This scenario describes a future service scenario, where the Virtual Cloud Service Provider (VCSP) is not the owner of any physical resources. The VCSP builds his value-added service by composing services from different providers and create his Cloud services. Similar to the business model of Application Service Providers (ASP), services are provisioned on-demand to customers. Yet, in this scenario, services have a wider scope (hardware, software, applications, content). In this case, the knowledge of organizations and the management of services is crucial. Issues such as quality of service, security, and privacy would be top concerns. Yet, ideally, the user should experience a plug-and-play service without any worries about the underlying details, which will be the responsibility of the VCSP.

The Cloud value chain reference model gives a comprehensive picture of the whole market structure and supports VCSP in understanding and identifying the diverse requirements at each layer, enabling the VCSP to build a working Cloud service. Moreover, the VCSP can anticipate his potential costs, foresee how his revenue model is structured, and improve his business model by optimizing alliances with other service providers.

4. Discussion and Policy Implications

The reference model for value chains in the Cloud is anticipated to serve as a check-list for building Cloud services. By validating this model against existing and hypothetical service scenarios, this model could largely explain the different types of activities and service combinations by which value is created in the Cloud. Yet, this model assumes and requires that:

- More and more activities in the Cloud are developed and introduced as independent, interoperable, and standardized services, allowing to realize flexible diverse and cost effective service scenarios. In fact, the work of Spohrer in [35] provides a promising effort that explores this mutual understanding, the value co-evolution, and the merging of service science with new computing models.
- While vast attention has still to be paid to technical layer development, more and more business-support services are developed [39]. For example, Cloud market places need to be in place to support trading of excess resources [36]. Accounting and charging services are needed to support financial settlements between trading entities (i.e. providers and customers). In general, business-support services are needed to accelerate the transition to a business-oriented, open Cloud to generate the critical mass of users.

Realizing such a future Cloud, we can forecast the following implications for the future technology market with respect to:

- Supporting Services: In accordance with the "hourglass" model [16], we strongly believe that support activities will take the highest share of cost and profit, dominating over middleware system services.
- Service Composition: Better cost minimization and profit maximization schemes will come from services that allow diverse compositions and service scenarios built from sub-layer services.
- State-Less Stakeholders: Customers will easily be able to become service providers. Users will be able to cooperate with other users and sell user-created services into the market. Future killer services will be user-created.

5. Conclusion

Within this paper, we analyzed existing Cloud business models, its structures, and value creation activities. Based on this analysis and the existing value chain theory, we introduced a reference model for the Cloud value chains. The reference model is used to anticipate the Grid structure costs and service scenarios.

With the help of the reference model, we analyzed some service scenarios. We found that, as more standardized, interoperable and open technology services are realized, new business models and service scenarios will be created in the Cloud. Huge opportunities for technology providers, particularly in supporting activities, are to be seen and will contribute to more Cloud adoption in business and industry. Support activities are vital for enabling user created services, developing new services, and leading the Cloud sustainability process. Finally, we believe that as the Cloud develops in both technical and business aspects, more participation and user-oriented applications will be realized in the Cloud service market.

References

[1] Next Generation Grids Expert Group. Future for European Grids: GRIDs and Service Oriented Knowledge Utilities. Third Report.(January 2006). ftp://ftp. cordis.europa.eu/pub/ist/docs/grids/ngg3_eg_final.pdf.

[2] European Commission.2006. From Grids to Service-Oriented Knowledge Utilities A critical infrastructure for business and the citizen in the knowledge society. SOKU brochure. Office for Official Publications of the European Communities. Luxembourg. ftp://ftp.cordis.europa.eu/pub/ist/docs/grids/soku-brochure_en.pdf..

[3] European Commission.2003. Grids Challenges and opportunities for business & industry. European Commission Information Society Directorate-General. Final Report of the European Study Contract No. 30-CE-065970/ 00-56. ftp://ftp.cordis. europa.eu/pub/ist/docs/grids/ist_grids_brochure_oct_2003.pdf..

[4] M. E. Porter. 1998. On Competition. A Harvard Business Review Book. Boston.

[5] M. E.Porter. 1985. Competitive Advantage. Creating and Sustaining Superior Performance. P33. Free Press. New York.

[6] Wikipedia. 2007. Website. Accessed in (November, 24, 2007). http://www. wikipedia.org.

[7] Breite R. and Vanharanta, H.2002. Value Chain Management in the Internet Environment. In: Twelfth International Working Seminar on Production Economics. Igls/Innsbruck, Austria, Volume 2 . (February 18-22, 2002) http://www2.ipe.liu. se/rwg/igls/igls2002/Paper044.pdf.

[8] Allee, V. 2003. The Future of Knowledge: Increasing Prosperity through Value Networks. Butterworth-Heinemann

[9] Pil, F.K. and Holweg, M.2006. Evolving from value chain to value grid. In: MIT Sloan Management Review, 47(4): 72-80.

[10] Stanoevska-Slabeva K., Talamanca C. F., Thanos, G. A., and Zsigri, C.2007. Development of a Generic Value Chain for the Grid Industry. In: Grid Economics and Business Models. Volume 4685/2007, Pages44-57. Springer Berlin / Heidelberg.

[11] Gridpedia, 2008, Website, accessed 21/12/2008. http://www.gridipedia.eu/index.php?id=690

[12] Forge, S. and Blackmann, C. 2006. Commercial Exploitation of Grid Technologies and Services - Drivers and barriers, Business Models and Impacts of Using Free and Open Source Licensing Schemas. Final Report of the European. Study Contract No. 30-CE-065970 /00-56.(November 2006).

[13] Lee, H. J. and Leem, C. S.2005.A study on value chain in a ubiquitous computing environment. In: Computational Science and Its Applications ICCSA 2005. Volume 3483/2005. pp. 113-121. Springer Berlin / Heidelberg.

[14] Altmann, J., Ion, M., and Bany Mohammed, A. 2007.Taxonomy of Grid Business Models". In: Grid Economics and Business Models. Volume 4685/2007, Pages29-43. Springer Berlin / Heidelberg.

[15] Globus project,Website, accessed 21/12/2008. available at http://www.globus.org.

[16] Foster, I. and C. Kesselman, 1999. Globus: A Toolkit-Based Grid Architecture. In The Grid, Blueprint for a Future Computing Infrastructure", I. Foster, 196 and C. Kesselman, Editors, Morgan Kaufmann, San Francisco, pp. 259-278.

[17] Grimshaw, A. Ferrari, A. Knabe, F. and M. Humphrey. 1999. Legion: An operating system for wide-area computing. IEEE Computer, 32((5)) .

[18] Enabling Grid for E-sciencE (EGEE), 2008, Website, accessed 21/12/2008 www.eu-egee.org.

[19] gLite 3.0.0, home page, 2007. http://www.glite.org.

[20] Dietmar W. Erwin and David F. Snelling. 2001.UNICORE: A Grid Computing Environment" in R. Sakellariou et al. (Eds.): Euro-Par 2001, LNCS 2150, pp. 825-834.

[21] J. Altmann and D. J. Veit. 2007. Grid Economics and Business Models. LNCS 4685, ISBN 0302-9743. Springer-Verlag, Berlin, Germany. http://it.i-u.de/schools/ altmann/gecon.

[22] Amazon .2007. Web Services. Accessed 21/9/2007. http://www.amazon.com/gp/browse.html?node=201590011.

[23] Sun Grid. 2007. Website., Accessed 21/9/2007. http://www.sun.com/service/sungrid.

[24] Harris D.2007. My Day at SC07. In Grid today. Vol. 6, No. 46. (November 19, 2007).

[25] Pena, S.2007.Outsourcing of Grid Computing. A Project Report, Department of Computer Science, Louisiana State University. (May 23, 2007). http://www.cct.lsu.edu/~gallen/Students/Pena_2007.pdf.

[26] La Grid.2007. Website. Accessed 25/10/2007. http://latinamericangrid.org.

[27] D-Grid .2007. Website. Accessed 25/10/2007.www.d-grid.de.

[28] Seti@home. 2007.Website. Accessed 27/10/2007. http://setiathome.berkeley.edu.

[29] Einstein@home. 2007. Website. Accessed 27/10/2007. http://einstein.phys.uwm.edu.

[30] rosetta@home. 2007.Website. Accessed. 27/10/2007. http://boinc.bakerlab.org/rosetta.

[31] Hergert M & Morris D. 1989. Accounting data for value chain analysis. Strategic management Journal, Vol 10, p175.

[32] I. Foster, H. Kishimoto, A. Savva, D. Berry, A. Djaoui, A. Grimshaw, B. Horn, F. Maciel, F. Siebenlist, R. Subramaniam, J. Treadwell, J.V. Reich.2005.The Open Grid Services Architecture, Version 1.0, Open Grid Services ArchitectureWG, Global Grid Forum.

[33] Gemlca. 2008. Website. Accessed. 1/15/2008. http://www.cpc.wmin.ac.uk/cpcsite/index.php/Gemlca.

[34] E. Seidel, G. Allen, A. Merzky and J. Nabrzyski. 2002. GridLabA Grid application toolkit and testbed, Future Generation Computer Systems 18 (8), pp. 11431153.

[35] J. Spohrer, L. C. Anderson , N. J. Pass , T. Ager and D. Gruhl . 2008. Service Science. J Grid Computing(6). PP 313-324.

[36] M. Risch, J. Altmann. 2008.Cost Analysis of Current Grids and its Implications for Future Grid Markets. GECON 2008, Workshop on Grid Economics and Business Models, Springer LNCS, Las Palmas, Spain.

[37] J. Altmann, C. Courcoubetis, G. D. Stamoulis, M. Dramitinos, T. Rayna, M. Risch, C. Bannink. 2008. GridEcon - A Market Place for Computing Resources. GECON 2008, Workshop on Grid Economics and Business Models, Springer LNCS, Las Palmas, Spain.

[38] J. Altmann. 2000. A Reference Model of Internet Service Provider Businesses. ICTEC2000, 3rd International Conference on Telecommunication and Electronic Commerce, Dallas, Texas, USA.

[39] J. Altmann, I. Constantiou. 2004 .Towards a Pro_table ISP Business in a Competitive Environment. book chapter titled for the book Social and Economic Transformation in the Digital Era. IDEA Group Publishing, USA, 2004.

[40] J. Altmann, D. Neumann, T. Fahringer. 2008. Grid Economics and Business Models. LNCS, Springer-Verlag, Berlin, Heidelberg, Germany.

[41] Xen, 2009. Web site. Accessed. 5/15/2009. http://www.xen.org.

Appendix

Product & Service Name	**Provider**	**Description and Range of service**	**Service / product**	**Price or free**	**Value chain layer & sub-layer**	**Website**	**Comments**
Platform Accelerate and Platform Manager	platform	Packages for High Performance Computing (HPC) management software solutions and accelerate compute and data intensive applications and manage cluster and Grid systems.	Product and service	Price	End-to-end solutions that Span over Divers level layers from primary to Grid and business support layer.	http://www.platform.com	Underplaying partnerships and Alliance with other service providers.

AppLogic Grid operating system	3tera	Software, on demand and Utility computing	Product and service	Price	Primary, Grid and business support activities	http://www.3tera.com/Utility-Computing/	Example of integrating service companies
EnFuzion	axceleon	Resource Management and Workflow Automation, Smart File Transfer and Network Utilization, , job scheduler and monitoring, Intuitive GUI,, Extensive Administrative and Reporting Tools.	Product and service	Price	Primary and Grid support layers.- applications and software packages with horizontal and vertical integration	http://www.axceleon.com/products.html	
JBoss Enterprise Application Platform, and Red Hat Enterprise MRG, JBoss Enterprise Middleware and cluster suite	RedHat	Wide range of Grid application and data managements systems. Cloud computing and Grid computing services.	Products and service	Price	Primary and Grid support layer activities: SW, MW and applications and consultation	http://www.redhat.com/products/	
Gridworks, PBS and Portable Batch System	Altair	On-Demand Computing Software Environment, Workload management, and Resource-based scheduling	Product	price	Primary - Middle ware – scheduling, management,	http://www.pbsGridworks.com	- Support by Multiple hardware and software -partner with intel, windows, hp , Ibm AND OTHERS
Hyperworks	Altair	Optimization, Modeling and Assembly, Virtual Manufacturing, FEA Solvers, Process Automation, Visualization and Reporting, Data Management A complete Entreprise Simulation Suite	Product and Service	price	1- Primary – middleware - management 2-Gid support layer – operators and solution providers	http://www.altairhyperworks.com	Partner and supporter of multiple platforms
HiQube	Altair	Software package for high-performance business intelligence (BI) software	Product (as well Pay-For-What-You-Use" service)	price	Grid support layer – software Business support layer-application	http://www.hiqube.com/	
GridServer, FabricServer, VersaVision, Federato, DART	DataSynapse	Dynamic manage, and optimize scalable enterprise-class application services as well as metering and runtime control of applications across physical and virtual infrastructure	Products and service	Price	Primary layer – SW applications and Grid support layer.	http://www.datasynapse.com/	

Sun Grid Engine	Sun	Services and Software package for Grid management and middle ware resource sharing - Multi-clustering Accounting and Reporting Advance Reservation	Product	price	Primary activities – resource management Grid Support activities – applications and financial and accounting applications	http://www.sun.com/software/sge	Wide range of Grid applications
Sun Blade	Sun	Hardware Servers	Product	price	Primary activities – hardware	http://www.sun.com	
Sun VDI Software 3	Sun	Storage Software	Product	priced	Grid support activities	http://www.sun.com/storagetek	
Sun Cloud	Sun	End-to-end computing services from Software and hardware on demand	Service	price	End-to-end : utility scenario	http://www.sun.com/solutions/cloudcomputing	Hardware , Software OS , middleware Virtualization
AppZero's software	AppZero	Wide set of applications for cloud computing ,and server-side application virtualization	Product	Price	Primary : MW, SW and Grid support activities	http://www.appzero.com/c	
Aneka	Manjrasoft	Enterprise Grid/cloud computing systems	Product	Price	Primary – middleware – Grid support – financial and economic support	http://www.manjrasoft.com	
SIMtone SNAP	SIMtone Cooperation	Cloud computing : end-to-end Universal Cloud-Computing Platform that allows network operators, service providers and businesses of any size to deliver all types of computing as services to any device	Service DaaS/SaaS)	price	End-to-end	http://www.simtone.net/snapbook.htm	
SIMtone's HPC ASPEED	SIMtone Cooperation	Application	software product	price	Primary activities – package for resource management and - Grid support activities	http://www.simtone.net/	
XtremWeb	IN2P3 (CNRS), INRIA and Universisty PAris XI	Middleware Software	Product	free	Primary activates - Middleware	http://www.xtremweb.net/	
Oracle Grid Products	Oracle	Database management, middleware , VM and enterprise solution	Product and services	Price	Primary layer: MW – data management and Grid applications, Grid support layer	http://www.oracle.com/technologies/Grid/Grid_products.html	
asiGRID© BETA	Andrescavage Software Inc.	Service-Oriented Infrastructure, to manages deployment, routing, scalability, fault-tolerance, security, monitoring, and upgrading of Gird	Product	Price	Primary and Grid support layer : application	http://www.Gridnow.com/	
Unified Computing System	Cisco	network, storage, server and virtualization	Product Service	price	Primary and Grid support activities	http://www.cisco.com	

VMware	EMC2	Virtualization	Products and service	price	Grid support activates	http://www.emc.com/services/index.htm	Provide a wide set of applications, consulting and implantation service that support the Grid
Vine Toolkit and GridSphere 3	GridSphere project	Wide range of Grid applications	Product and service	free	Grid support activities	http://www.Gridsphere.org/	Many applications and service for facilitating Grid business adoption
Dell cloud computing solution	Dell	Hardware and Applications including Designed -TO-Order Project Management and data center customized services	Service and product	price	End-to-end	http://www.dell.com/cloudcomputing	
g-Eclipse	g-Eclipse consortium	Middleware, applications (Migrating Desktop, the GridBench suite, the Grid Visualization Kernel (GVK)…) framework	Product	free	Primary activities-middleware and management	http://www.geclipse.org	
3PAR Utility Storage	3PAR	utility storage, and enterprise IT utility services	Service	Price	Across layer Primary , Grid and business. Vertical value.	http://www.3par.com/about_us_overview.html	
The P-GRADE Grid Portal	Computer and Automation Research Institute Hungarian Academic of Sciences	web based environment for the development, execution and monitoring of workflows	Product	free	Primary activists	http://www.p-grade.hu/	Provide support for different workflow tools
VIRTERA's vSpectrum	VIRTERA	Provide professional services and consulting firm delivering virtualization technology solutions and services.	Product and service	Price	Grid support activities and business support activities	http://www.virteratech.com/	
Globus Toolkit	Globus Alliance	Middleware, solutions and Grid systems and applications	Product	free	Primary and Grid support activities	http://www.globus.org/	One of the most accepted and widely adopted middleware and software Standard industry solutions

Amazon Elastic Compute Cloud (Amazon EC2)	Amazon	Hardware and software services as Application Hosting, Backup and Storage, Content Delivery, High Performance Computing, Media Hosting, and On-Demand Workforce. see Amazon Web Services™	service	price	End-to-end	http://aws.amazon.com/ec2/	Multiple services for different customer classes
Grid Dynamics solutions	Grid Dynamics	Provide service consulting and development strategies, technology selection and implementation.	Service	Price	Grid support layer - consultants	http://www.Griddynamics.com	
COMPOSITE solutions	Composite software	Provide discovery, Federate and deliver real-time information without physical replication and consolidation. Data Virtualization Solutions	Products and service	Price	Grid support activities layer – added value	http://www.compositesw.com/	
ActiveVOS	Active Endpoints	Provide standards-based visual orchestration system SOA-based process orchestration and business process management (BPM) system.	Product	Price	Grid support layer : applications and developers	http://www.activevos.com/	
Grid Computing solutions from IBM	IBM	Hardware and software solutions	Mainly Product – based, services also available	price	Primary layer activists and Grid support activities	http://www-03.ibm.com/Grid/	target business SME's and enterprises
cloud-based virtual lab	Skytap	Diverse solutions for cloud computing that include applications that support and integrate with other like Xen	Product and service	Price	Primary layer activists : SW. and Grid support activities	http://www.skytap.com	
OGSA-DAI	EPCC at the University of Edinburgh and at NeSC	data management middleware	Product	Free	Primary layer activities – SW application	http://www.ogsadai.org.uk	
Momentum™ Framework	GridwiseTech	Range of service and products for Grid that design, integrate and operate Grids.	Product and service including consultation.	Price	Primary layer activities – Grid support layer activities –consultation and solution	http://www.Gridwisetech.com/	Provide advise and integration for other providers products as GE-GT Adapter, Globus Toolkit , Moa, Platform LSF Family, Sun Grid Engine and, gLite

aCelera Virtual Appliance	Certeon	deliver acceleration, virtualization and manageability when remotely accessing applications throughout a distributed enterprise	Products and support service	Price	Primary layer activities : SW and Grid support activities applications	http://www.certeon.com/	
Coadunation	Brett Chaldecott	Cloud computing operating system	Product	free	Primary activities- SW sub layer applications	www.coadunation.net	
UniCluster and Grid MP products	Univa UD Inc.	Diverse product that address many if not all address of Grid. Served as stand alone or suit of solution and products as UniCluster, UniPortal,Grid MP, Grid MP, DataCatalyst, and UniSight.	Product and service	Price	Primary, Grid and business, support activities	http://www.univaud.com/	Has set wide range of partnership with Technology Partners , Enterprise Partners , Resellers & Systems Integrators
Multicore optimizer ReplicatorVM and simpliGrid	EXLUDUS	Replication systems and optimizer	Product	Price	Primary activities – replica and data management	http://www.exludus.com/	
Xen hypervisor	Xen Community	Provide Paravirtualization and open source for virtualization supporting a wide range of guest operating systems including Windows, Linux, Solaris, and various versions operating systems	Product	free	Primary activities layer : SW layer and Grid support solutions	http://www.xen.org/	
Elastra Enterprise Cloud Server	Elastra	Enterprise Cloud Management System	Service	Price	Primary activities – Grid and business layer	http://elastra.com/	
GRIDScaler File Storage System	datadirectnet	Hardware and software	Product	price	Primary layer- HW and SW and Grid support layer	http://www.datadirectnet.com/	
gLite	EGEE	Widely accepted Standard Grid computing Middleware	Product	Free	Primary layer – middleware	http://glite.web.cern.ch/glite/	
The Rackspace Cloud (Cloud Sites, Cloud Files and Cloud Servers)	Mosso	On-demand and scalable website, application and storage hosting Through an integrated suite of cloud solutions.	Services and product	Price	Cross layer primary, Grid and business layer activities	http://www.mosso.com/index.jsp	
UNICORE	Unicore	Provide middleware and Grid system including client and server software	Product	free	Primary – middleware	http://www.unicore.eu/	
A+ billing platform ,and industry solutions	Aira systems	financial management function, accounting, billing and charging	Products and service	price	Grid support layer – financial support sublayer	http://www.ariasystems.com/	
Xsigo solutions	Xsigo Systems	Provide wide range of hardware and software solution for Grid and cloud computing	Products and service	Price	Primary layer: HW, SW sub layer services	http://www.xsigo.com/	

The Digipede Network	Digipede company	Job concurrency, Management APIs, sharing systems	Product	Price	Primary – Grid middle and software systems	http://www.digipede.net/	Works nicely with windows
MOAP utility /hosting suite	clusterresources	Software and Providing utility computing	Product	price	Grid support layer - End-to end software solution	http://www.clusterresources.com/	
Cast Iron Cloud	Cast Iron	On-demand SaaS an cloud computing	Product	Price	End-to-end utility and SaaS service	http://www.castiron.com/	
Condor	Condor Research Project (UW-Madison)	workload management system, queuing mechanism, scheduling policy, priority scheme, resource monitoring, and resource management	Product	free	Primary layer-middleware layer and applications	http://www.cs.wisc.edu/condor/	
Cassatt solutions	Cassatt	Data Management Virtualization, Software and services	Product and service	Price	Cross layer primary, Grid and business layer activities	http://www.cassatt.com/index.html	
EnginFrame Grid portal	NICE	Development of Grid portals and Application interfaces and Web toolkit	Product	Free	Primary layer – software and application	http://www.enginframe.com/	
Azure™ Services Windows Azure	Microsoft	internet-scale cloud computing and services platform.	Product and service	Price	Cross layer service primary Grid and business support activities	http://www.microsoft.com/azure/default.mspx	
Fura	GridSystems	Middleware including : Monitoring and Mete, Messaging , Agent Broker , Task Submission and data management systems	Product	Free and Price	Primary –middleware	http://www.Gridsystems.com	Use the concept of "module" or abstract Grid-enabled application
Commodity Grid (CoG)	Argonne National Laboratory	program, and administer Grids from a higher-level framework and build portals	Product	Free	Primary layer – software and application	http://wiki.cogkit.org/wiki/Main_Page	
FlexiScale	XCalibre	Storage service and Cloud Computing	Service	Price	End-to-end specific purpose	http://www.flexiscale.com/	
The Xen™ virtual machine monitor	NetOS-university of Cambridge	supports execution of multiple guest operating systems with unprecedented levels of performance and resource isolation	Product	Free	Primary layer-middleware activities , Grid applications	http://www.cl.cam.ac.uk/research/srg/netos/xen/index.html	
Tangosol Coherence cache	Tangosol later acquired by Oracle	Scaling service for company applications and data Grid technology	Product	Price	Primary activities – software and middleware	www.oracle.com/tangosol/index.html	
Grid and SOA enabled software	SAP	Support Grid software	software Products	Price	Grid support layer-value added services	www.sap.com	
Terremark's hosting service	Terremark's	On demand , utility, web hosting platform	Service	Price	Business and Grid support layer – applications and services	http://www.terremark.com/	Uses infrastructure, from Hp and Cisco
g-Eclipse	g-Eclipse team	integrated workbench framework and provide tools to customize Grid users' applications, to manage Grid resources	Product	Free	Primary and Grid support activities layer – wide range of applications on both layers Horizontal and vertical integration	http://www.geclipse.eu/index.php?id=11	Include Migrating Desktop, the GridBench suite, the Grid Visualisation Kernel (GVK)

Managed Virtual Infrastructure	Fastservers.net	Dynamic server services on-demand and software hosting services. specialized cloud computing services	Service	Price	Primary, Grid and business support layer services.	http://www.fastservers.net/products-services/	
Taverna Workbench.	myGrid e-Laboratory	Diverse Grid middleware tools and applications	Product	free	Primary layer – SW and Middleware Grid support activities.	http://www.myGrid.org.uk/projects/	
RIMM services	Netmagic	Wide range of services for Provide Remote Infrastructure Monitoring and Management (RIMM) Services to businesses	Service and products	Price	Grid support layer : operators sublayer	http://www.netmagicsolutions.com/rim/index.shtml	
Griddles	Monash eScience and Grid Engineering Laboratory	construction of complex Grid application using legacy software components	Product	Free	Primary activities - SW layer applications	http://www.messagelab.monash.edu.au/	
Parabon Computation Grid.	Parabon	Provide on-demand services as well as 1- Products. The Frontier® Grid Platform, APIs, tools, and applications. 2- Professional services. Software architecture, design, and development	Product and service	Price	End-to-end package for Grid: primary , Grid and business support layers	http://www.parabon.com/	Accounting and charging systems
Virtual Lab Automation, Enterprise Desktop Management	VMware	Desktop, datacenters, and cloud computing systems, application and virtualization and services . As well they provide training, consulting and certification services	Products and service	price	Primary, Grid support and business (resellers)	http://www.vmware.com/	Service from normal users to big enterprises
ExactTarget Solutions	ExactTarget	on-demand email, sms and voice marketing software solutions	Product and service	Price	Grid support layer – value added services	http://email.exacttarget.com/	
CM4all Technology of Content Management AG (CM-AG)	CM4all	web-based Content Management systems for the creation, maintenance and easy-updating of websites for internet and mobile devices	Product and service	Price	Primary – content management	http://cm4all.com	
ScaleOut StateServer, SessionServer and GeoServer	ScaleOut software	Data management and scheduling packages as well as Grid applications and service deployment products.	Product	Price	Primary layer activities : SW applications and MW Services Grid support layer activities	http://www.scaleoutsoftware.com/index.html	
LOMA	LOMA	Enterprise consulting and training Services	Service	price	Grid support layer – consulting	http://www.loma.org/	consulting, training and education
MOSIX, TXTDemand, and Video Recognition Environment	SORMA (Self-Organizing ICT Resource Management)	Provide Grid management and operating system. In addition to a demand forecasting application and a motion tracking application that creates a graphic real-time presentation.	Products	Priced and Free	Primary and Grid support activities : SLA based Resource management	http://sorma-project.org/	

SLA management framework	SLA@SOI (Empowering the Service Economy with SLA-aware Infrastructures)	Provide standard interface for e-contracting platform between service consumers and providers	Product	Free	Primary and Grid Support activities : SLA management	http://sla-at-soi.eu/	
RESERVOIR Technologies	RESERVOIR (Resources and Services Virtualization without Boundaries)	Provide Infrastructure for Service Delivery services that seek to leverage the diversity factor and achieve economies of scale (Virtual Execution Environment)	Services	Priced	End-to-end services + Grid support activities and business support activities: infrastructure Virtualization services.	*www.reservoir-fp7.eu/*	
GNIP	Gnip	Web data delivery added value based on the cloud	Service	Price	Primary activity : Content aggregator, distributor and composer delivery. Grid support layer: added value sub layer	http://www.gnipcentral.com/	
RightScale Platform	RightScale	enables companies to run entire web business on cloud computing infrastructures, including Amazon Web Services (EC2, S3, SQS), with reliability, scalability, and performance	Service and products	Free and Price	Business support layer – added value applications and services	http://www.rightscale.com/	Differentiated service plans and models for business
Gridcomputingplanet	WebMediaBrands Inc.	Information, ads and added value services	Service	Free	Grid support layer: added value services	http://www.Gridcomputingplanet.com/	
Kaavo's Infrastructure and Middleware On Demand	Kaavo Inc.	Provide utility computing service for normal user (100$/month) and enterprises platform for managing distributed applications in the clouds	Service	Price	End-to-end services that cross layer in horizontal , diagonal and vertical layers	http://www.kaavo.com/company	
Pentaho BI Suite	Pentaho	Provides self-service dashboard design for business users and cloud computing support for IT	Product	Price	Grid support layer – added value applications	http://www.pentaho.com/the_alternative/	
+ Joyent	Joyent Inc.	Delivering standards-based, non-proprietary, on-demand virtualized computing and storage solutions for Web application developers (45$/month).Partner with many HW and SW providers	Product	Price	cross layer in horizontal , diagonal and vertical primary, Grid and business layers	http://www.joyent.com/products	Differentiated and Diverse level services form the cloud
mindSHIFT Virtual Server management	mindSHIFT	Manage company virtualized servers. virtualization-as-a-service	Service	Price	Grid support layer : technology operators	http://www.mindshift.com/dynamic.aspx?id=2042	
Corporate Technologies solutions	Corporate Technologies	Provide Data Center Optimization, Virtualization, and Business Intelligence solutions, integration and storage services.	Products and services	Price	Primary and Grid support activities HW and SW Sub layers	http://www.cptech.com/lp_corporate.html	

TEMEP Discussion Papers

2009-15: Alireza Abbasi, Jörn Altmann and Junseok Hwang, “Evaluating Scholars Based on Their Academic Collaboration Activities: The RC-Index and CC-Index for Quantifying Collaboration Activities of Researchers and Scientific Communities”

2009-16: Dong-hyun Oh, Hans Lööf and Almas Heshmati, “The Icelandic Economy: A Victim of the Financial Crisis or Simply Inefficient?”

2009-17: Sungki Lee, Donghyuk Choi and Yeonbae Kim, “Contextual Effects on the Complementarities between R&D Activities: An Empirical Analysis of the Korean Manufacturing Industry”

2009-18: Younghoon Kim, Yeonbae Kim and Jeong-Dong Lee, “Corporate Venture Capital and Its Contribution to Intermediate-Goods Firms in South Korea”

2009-19: Yunhee Kim, Jae Young Choi and Yeonbae Kim, “Complementarity and Contextuality in the Adoption of Information Systems in Korean Firms”

2009-20: Marcel Risch and Jörn Altmann, “Enabling Open Cloud Markets Through WS-Agreement Extensions”

2009-21: Almas Heshmati and Rachid El-Rhimaoui, “Effects of Ownership and Market Share on Performance of Mobile Operators in MENA Region”

2009-22: Donghyun Oh, Almas Heshmati and Hans Lööf, “Total Factor Productivity of Korean Manufacturing Industries: Comparison of Competing Models with Firm-Level Data”

2009-23: Almas Heshmati, Dan Johansson and Carl Magnus Bjuggren, “Effective Corporate Tax Rates and the Size Distribution of Firms”

2009-24: Seong-Sang Lee and Yeonbae Kim, “The Impact of Efficiency Parameters on Firms’ Innovative Activities: Evidence from Korean Firm-Level Data”

2009-25: Junseok Hwang, Dongook Choi, Jongeun Oh and Yeonbae Kim, “Competition in the Korean Internet Portal Market: Network Effects, Profit, and Market Efficiency”

2009-26: Jae Young Choi, Yeonbae Kim, Yungman Jun and Yunhee Kim, “A Multivariate Probit Analysis of Korean Firms’ Information System Adoption: An Empirical Analysis on the Determinants of the Adoption and Complementarity among the Information Systems”

2009-27: Flávio Lenz-Cesar and Almas Heshmati, “Determinants of Firms Cooperation in Innovation”

2009-28: Firas H. Al-Hammadany and Almas Heshmati, “Determinants of Internet Use in Iraq”

2009-29: Jeong-Dong Lee, “Industry Dynamics and Productivity Research”

2009-30: Nam TRAN-QUY and Almas Heshmati, "Measurements and Determinants of Pay Inequality and its Impacts on Firms Performance in Vietnam"

2009-31: Nils Karlson, Marcus Box and Almas Heshmati, "Generality, State Neutrality and Unemployment in the OECD"

2009-32: Chang Seob Kim, Yoonmo Koo, Ie-jung Choi, Junhee Hong and Jongsu Lee, "Consumer Preferences for Automobile Energy Efficiency Grades"

2009-33: Jongsu Lee, Jae Young Choi and Youngsang Cho, "A Forecast Simulation Analysis of the Next-Generation DVD Market Based on Consumer Preference Data"

2009-34: Jungwoo Shin, Chang Seob Kim and Jongsu Lee, "Model for Studying Commodity Bundling with a Focus on Consumer Preference"

2009-35: Yuri Park, Hyunnam Kim and Jongsu Lee, "Empirical Analysis of Consumer Preferences for Mobile Phones and Mobile Contents in the Presence of Indirect Network Effects"

2009-36: Jörn Altmann and Juthasit Rohitratana, "Software Resource Management Considering the Interrelation between Explicit Cost, Energy Consumption, and Implicit Cost: A Decision Support Model for IT Managers"

2009-37: Marcel Risch, Ivona Brandic and Jörn Altmann, "Using SLA Mapping to Increase Market Liquidity"

2009-38: Amit K. Bhandari and Almas Heshmati, "Willingness to Pay for Biodiversity Conservation"

2010-39: Marcel Risch, Jörn Altmann, Li Guo, Alan Fleming and Costas Courcoubetis, "The GridEcon Platform: A Business Scenario Testbed for Commercial Cloud Services"

2010-40: Junseok Hwang, Jörn Altmann and Ashraf Bany Mohammed, "Determinants of Participation in Global Volunteer Grids: A Cross-Country Analysis"

2010-41: Ruzana Davoyan, Jörn Altmann and Wolfgang Effelsberg, "Intercarrier Compensation in Unilateral and Bilateral Arrangements"

2010-42: Ruzana Davoyan, Jörn Altmann and Wolfgang Effelsberg, "Exploring the Effect of Traffic Differentiation on Interconnection Cost Sharing"

2010-43: Ruzana Davoyan and Jörn Altmann, "Investigating the Role of a Transmission Initiator in Private Peering Arrangements"

2010-44: Ruzana Davoyan, Jörn Altmann and Wolfgang Effelsberg, "A New Bilateral Arrangement between Interconnected Providers"

2010-45: Marcel Risch and Jörn Altmann, "Capacity Planning in Economic Grid Markets"

2010-46: Dang Minh Quan and Jörn Altmann, "Grid Business Models for Brokers Executing SLA-Based Workflows"

2010-47: Dang Minh Quan, Jörn Altmann and Laurence T. Yang, "Error Recovery for SLA-Based Workflows within the Business Grid"

2010-48: Jörn Altmann, Alireza Abbasi and Junseok Hwang, "Evaluating the Productivity of Researchers and their Communities: The RP-Index and the CP-Index"

2010-49: Jörn Altmann and Zelalem Berhanu Bedane, "A P2P File Sharing Network Topology Formation Algorithm Based on Social Network Information"

2010-50: Tai-Yoo Kim, Seunghyun Kim and Jongsu Lee, "The Gene of an Accelerating Industrial Society: Expansive Reproduction"

2010-51: Almas Heshmati and Sangchoon Lee, "The Relationship between Globalization, Economic Growth and Income Inequality"

2010-52: Flávio Lenz-Cesar and Almas Heshmati, "Agent-based Simulation of Cooperative Innovation"

2010-53: Erkhemchimeg Byambasuren and Almas Heshmati, "Economic Development in Mongolia"

2010-54: Almas Heshmati and Subal C. Kumbhakar, "Technical Change and Total Factor Productivity Growth: The Case of Chinese Provinces"

2010-55: Bory Seng and Almas Heshmati, "Digital Divide and Its Variations Amongst OECD, NIE and ASEAN Countries"

2010-56: Kibae Kim, Jörn Altmann and Junseok Hwang, "The Impact of the Subgroup Structure on the Evolution of Networks: An Economic Model of Network Evolution"

2010-57: Kibae Kim, Jörn Altmann and Junseok Hwang, "Measuring and Analyzing the Openness of the Web2.0 Service Network for Improving the Innovation Capacity of the Web2.0 System through Collective Intelligence"

2010-58: Alireza Abbasi and Jörn Altmann, "A Social Network System for Analyzing Publication Activities of Researchers"

2010-59: Jörn Altmann, Costas Courcoubetis and Marcel Risch, "A Marketplace and its Market Mechanism for Trading Commoditized Computing Resources"

2010-60: Fatmawati Zifa and Jörn Altmann, "An Empirically Validated Framework for Free-Riding in P2P Networks Through the Use of Social Network Information"

2010-61: Ashraf Bany Mohammed, Jörn Altmann and Junseok Hwang, "Cloud Computing Value Chains: Understanding Businesses and Value Creation in the Cloud"