5 Grid Business Models

George Thanos, Eleni Agiatzidou, Costas Courcoubetis, George D. Stamoulis

5.1 Introduction

A business model (BM) establishes a framework for the transformation of economic inputs (e.g. resources and technological knowhow) into economic outputs (e.g. goods and services) required by customers in a market (Chesbrough and Rosenbloom 2002). In simpler terms, a business model describes the way the business expects to make money by interacting with customers and other players in the market.

Such a model can also be thought of as a mediator between technology development and value creation. The ultimate role of the business model is to ensure that the technological core delivers value to the customer. In order to achieve this, a number of factors and functions must be analysed and specified, such as the value proposition of the new product, the target market, the potential value chain for the delivery of the product or service, an estimation of the cost-structure, and profit potential (Peterovic et al. 2001, Weill and Vitale 2001).

A well articulated BM is the foundation of the company's business plan. The business plan serves as a decision-support tool and includes the additional level of detail that needs to be identified and proved (as well as can be prior to execution) in order for the business to attract money from potential investors. It specifies measurable goals, the reasons why they are believed to be attainable, and the plan for reaching those goals (Siegel et al. 1993, Wikipedia 2009a). It may also include background information about the company and a marketing plan. As it becomes apparent, both are to a great extent related and equally important; without a good business model, a business plan cannot be brought to effect and vice versa.

If you have developed a business model or plan, you already have a business case established as this is a prerequisite of the aforementioned. That means you have a business idea that once turned into a project (i.e. financed!) can lead your business to a profitable product or service or in other terms you have a value proposition for your customers. For example, when referring to the term "Grid business case" in this document we imply that a company has defined a project where the provisioning of a product or service and/or its value proposition is based on exploiting the benefits of Grid technology. The pathway from that idea to the realisation and sustainability of the actual project is described through a specific business plan.

The purpose of this chapter is to present an overview of the business models adopted by Grid application and services providers in the market based on a study and analysis of Grid business cases. The goal is to provide the reader with an overview of BMs from the perspective of a potential business adopter as well as of a user/customer of Grid technology. To achieve that, we briefly discuss how the Grid BMs evolved from traditional ones; we explain how a business case can be established

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for Grid services; and explain the relationship to a BM and business plan. Next, we present the different business cases that can be found in the market today and link them to associated BMs. Finally, a more detailed analysis of particular cases for the market today is presented.

5.2 Setting the Scene

Grid technology promises a new way of delivering services across IP-based infrastructures. These services range from common ones, such as existing mass multimedia services, to more complex and demanding customised industrial applications. The start-up and key drivers behind the adoption of Grid by industry has been the performance advantage this technology promises to deliver, that in business and economic terms is translated into reducing costs, simplifying local infrastructure and speeding up processes. Under rapidly changing IT technologies and the pressure of highly-competitive global markets, the importance of these drivers is particularly high. Besides the aforementioned advantages, the Grid can be even considered as a “Green-IT” technology. Indeed, IT resources can be distributed over the world and be utilised dynamically and interchangeably based on climate and environmental conditions (e.g. by “chase the moon” (Berry 2007)), to minimise the energy consumption and consequently the associated costs.

The notion of Grid and its associated technological and business advantages has further evolved during recent years and the underpinning performance enabler advantage has been complemented by the collaborative benefits of this new technology. The early business models related to Grid have been based on either computing utility provisioning or on software products supported via in-house high-performance Grid facilities. The former case, i.e. the use of computing power as utility, is not a new idea; and some even argue that is actually a backwards move to the past in terms of mainframe and terminal architecture. This approach promises to satisfy (via cost-effective means) the continuously increasing need for more computing resources and scalability by industries, not previously belonging to the IT centric domain. Despite the fact that the core idea, that computing resources should be offered in the future as a utility (like the electrical power Grids), was broad enough to cover the single home user, this was later abandoned. Eventually, the market clearly showed that the target market should be the research institutions and Small and Medium Enterprises (SMEs), i.e. organisation that had intermittent need for high power computing resources

The case of software services provided to customers through in-house Grid-facilities was soon demarcated as two correlated very promising business cases. First, the *Application Service Provisioning* (ASP) one, where a provider hosts, operates and supports applications for his clients in a Grid-powered infrastructure. The aim was to relieve them from maintenance costs and offer them scalability, agility and reliability together with high performance. The second business case was based on the provision of services according to the Software-as-a-Service (SaaS) paradigm. In this scenario, the service is hosted for the provider (which can be an SME) by either an in-house Grid infrastructure or by utilizing the resources of an external resource provider such as Amazon, Sun Microsystems and IBM. The difference to the previous case is that the service is now offered through the web and charged via a monthly (rental) fee i.e. no license is needed from the customer's side. Furthermore, no specific software needs to be installed in the client machine as a standard web browser is all that is required to access the service.

As we enter a technological era where solutions based on *Service Oriented Architectures* (SOA) and *Cloud Computing* will constitute a large segment of the market for business services, it is most likely that Grid-related services will be integrated into this framework. Therefore, the business models will evolve and be adapted accordingly. For example, SaaS will become more dominate over the *Software-as-a-Product* (SaaP) model for Grid services provisioning and the added-value of these services will be focusing around the collaboration benefits, rather than just in the performance related benefits. A similar emerging B2B collaboration scenario, that could drive new models, would be the services related to Virtual Organisations (VOs). In a VO, different organizations share resources, either computational or data, to achieve all partners' goals. VOs can be easily created and administrated by utilising Grid services e.g. by taking advantage of the Globus Open Grid Services Architecture (OGSA, http://www.globus.org/ogsa/) framework.

To summarise, looking at the Grid service and application provider's perspective, the well-established business models such as the SaaS, SaaP, Open-Source, and Value-added-Services (VAS) ones still apply in the Grid environment. However, there are a number of important factors that must be taken into account by a new business when adapting these traditional scenarios to the Grid, especially in regards to licensing, pricing models and legal issues. For example questions like these should be taken into account: what is the right license and pricing model to use for Grid SaaS? How do I protect the Intellectual Property Rights in a geographically dispersed collaboration scenario? How do the relationships and flows (tangible and intangible ones) in a value network change in the case of a VO where the common benefits are spread over a number of participants?

In order to build a successful business case all the previous questions need to be answered. This can only be achieved through a process of building a business model and planning, through 1) careful analysis and evaluation of the technical requirements 2) the surrounding business environment and market conditions and the 3) target market. An example process for that purpose tailored to the Grid case is presented next.

5.3 Establishing a Business Model Based on the "Grid Benefit"

As discussed in the previous section, a business model seeks to transform economic inputs into valuable economic outputs. In order to achieve that, it needs to provide and support information and propositions on several fronts starting from the analysis of the requirements for developing the product, to explicitly defining the value proposition and the target customers. Furthermore, it needs to elaborate on the financial terms of the case and justify the revenue projections. These can be seen as building blocks in figure 5.1 (Osterwalder 2004).

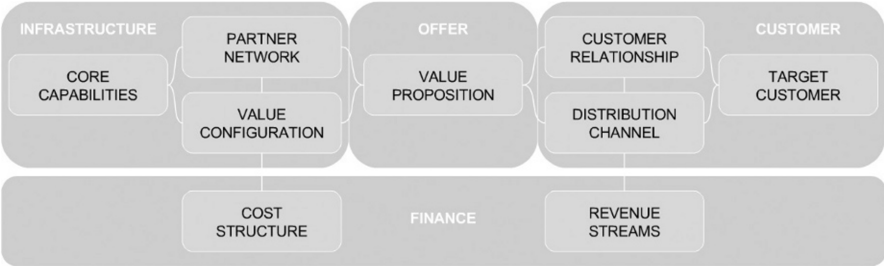

Fig. 5.1: Business model design template: Nine BM elements and their relationships

When designing a model regarding a new or emerging technology, especially when it is not yet proven in the market and thus more risky, some of these components will be found to gain more value than others. Once a good level of understanding of the new technology has been reached, the whole process should start from the value-proposition definition. This is a step that must be successfully achieved before proceeding further. This is the whole essence of a new technology: what new benefit can it deliver to the customer? Then follow the questions: what do the customers exactly want, how this can be delivered and if the required competence and resources are available. This incremental process, together with the questions to be answered at each step, is demonstrated in figure 5.2.

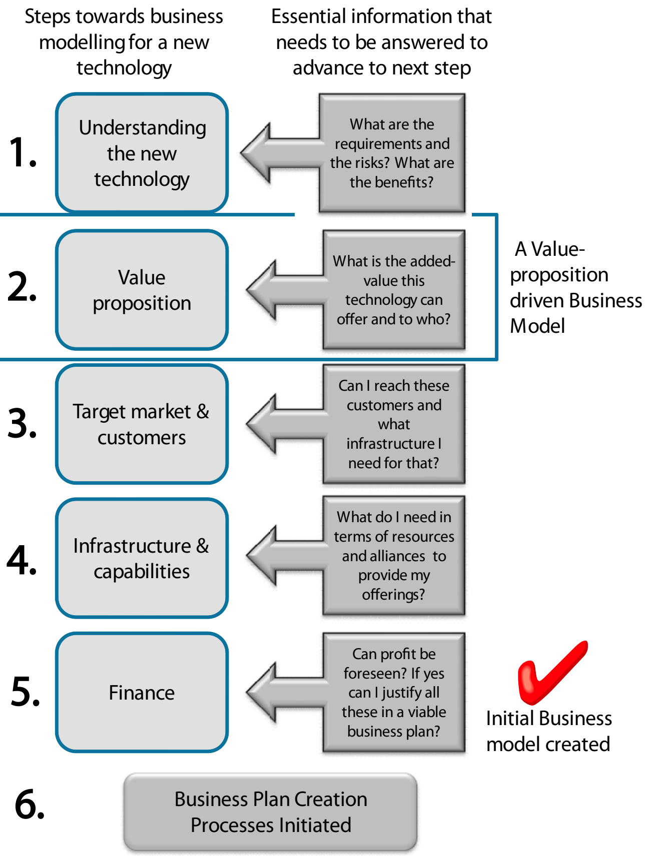

Fig. 5.2: Business model creation for a new technology

The first and most important requirement i.e. the value proposition, is a set of business enablers, in terms of Grid benefits that a successful business case could be based upon and subsequently generate economic outputs to the participants. These business enablers or "Grid benefits" are:

1. The *"Common Use of Resources and Infrastructure as a Service (IaaS)"* business enabler: economic benefits are expected to arise from offering dynamic resources using a Grid infrastructure. This enabler also accounts for those cases that Grid is used in IaaS architectures. As an example, we can think of a single organization that may require processing power that cannot be provided by means of stand-alone machines. By interconnecting multiple machines in a Grid, high processing power can be provided even for just a single application. Thus, the organization achieves both a high peak processing capacity and a high average utilization of the processing power available, since this can be flexibly allocated to multiple Grid-enabled applications. These features should also lead

to increased cost-efficiency for the infrastructure deployed. This is particularly important for a large organization with several departments scattered around the world, each possessing their own computing infrastructure. Connecting these via a Grid can generate significant enhancements, a higher exploitation of resources, cost-efficiency and economies of scale, due to the fact that the interconnection of all machines, improves the utilization of each one (Thanos et al. 2007).

2. The *"Collaborative and VO"* business enabler: economic benefits are expected by offering services or software that take advantage of the collaborative environment and functionalities that Grid can offer in a VO context. Consider a group of organizations, each of which possesses its own resources, which are complementary to each other. For example, organization A possesses a powerful database server, while B has a huge amount of data and C possesses an application running over its server that requires data such as that of B. Clearly, when collaborating in the form of Grid, all organizations can bring together a powerful outcome, while each of them exploits its own resources in a cost-efficient way, without needing to invest in the missing resources that are now contributed by others. In this case, the collaborating organizations enjoy economies of scope, since bringing all their resources together by means of Grid broadens their scope of applicability (Thanos et al. 2007).
3. The *"Software as a Service (SaaS) and advanced software architectures"* business enabler: 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. Here, by the term "grid-enabling" we mean the redesigning of an existing application in order for it to be offered in a Grid environment. Also this category accounts for the cases that Grid services are offered (via SaaS) with the purpose of being integrated to SOA and Cloud Computing architectures. A SaaS version of an application is more affordable to infrequent users of that application, who now have a benefit compared to investing on the corresponding software license and/or computational infrastructure. Therefore, both these users and the service provider gain, because this version increases the demand for the service by making it affordable at lower costs (Thanos et al. 2007).

In the next sections we will discuss with examples how these 3 enablers can be spotted today in the market and how they can lead to building a successful business model.

5.4 Popular Business Cases in the Market Today and Associated Benefits

After defining the 3 aforementioned categories as enablers for doing business with Grid we will now examine how these can be found in the most popular business cases in the market today. These are categorised and presented in the next table.

Table 5.1: Popular business cases in the market today, their enablers and involved actor

Most popular Grid Business Cases in the market	The Grid benefit (value-proposition or added-value)	Main actors involved
1. Company utilises an internal Grid solution as a virtualisation technique to improve the utilisation of resources (also known as the "Enterprise Grid")	For the company: Performance differentiation and collaboration benefit in case of inter departments (VO-like) virtualisation of resources.	The company Grid s/w and application providers Systems integrator (can be the same with the Grid s/w provider)
2. Company rents external computing resources through the internet with Grid being the underlying infrastructure on the provider's side	For the company: Performance differentiation	The company Resources provider (e.g. Amazon & Sun) – See case No. 5
3. Company Grid-enables existing application or develops an application optimised to run over the Grid (BEinGRID BEs cases) and offers it to external clients	For the company: performance differentiation, new markets through SaaS provisioning For the user: new services not foreseen or affordable before	The service or application provider (the company) The user that either buys or rents the solution The Grid software provider Systems integrator (can be the same with the Grid s/w provider)
4. A group of organisations forming a VO in order to gain benefit from common use of resources (CERN is an example of this). Case also known as "Partner or Collaborative Grids"	– Collaboration benefit – New services from the VO partners to internal or external users, not possible before.	The users (VO participants) Grid s/w and application providers Systems integrator (can be the same with the Grid s/w provider) Resources provider – if external computing resources are utilised (e.g. Amazon & Sun)
5. Company acts as a computing resources provider e.g. the "Amazon", "Sun", "IBM" etc cases	For the user: Resources provided on demand. Performance differentiation – See Case No.2 For the company: revenue generation and reduced costs of offering such a service through virtualisation	The resource provider (the company) The users that buy resources on demand – See Case No.2
6. Company provides Cloud Computing Services with Grid as the underlying infrastructure (most popular emerging scenario). E.g. the "Amazon", "Google", "IBM", "Microsoft" etc cases	For the user: Provision of Cloud computing services (IT-as-a-Service) For the company: high utilisation of resources through virtualisation	The Cloud Computing provider The users that purchase Cloud Computing services

As can be seen from table 5.1, six distinct business cases are commonly found today. As illustrated in the second column, it is important not only to identify the benefits from the provider's side, but from the user's perspective as well. For example, in the third case we have a company (e.g. a SME) that Grid-enables an existing application or develops an application optimised to run over the Grid and offers it to external clients. From the perspective of the company, there are two Grid benefits: The first one is about the exploitation of common resources, category 1 as discussed in the previous section. For example, in the case that the new application offered by the company can be provided more efficiently over a Grid infrastructure i.e. it can be offered to a larger number of customers/users without compromising or needing to upgrade the existing internal infrastructure. Furthermore, in the case of a new service, this can be offered utilising the SaaS paradigm, thus opening a window of opportunity to additional economic capabilities for the company which is a category 3 enabler according to our classification.

To add to that, the user can now enjoy new web-based services (e.g. through SaaS) not possible before, that eventually might be exploited for his own purposes; for example, in the case the user that purchases the service is another company or institution he may be able to optimise his own service provisioning in his own market. In this example, as in others, there are more than one associated enablers involved according the very exact model chosen. For the purposes of presenting the whole picture we have grouped them together under each case.

In order to establish the associated business models in each case, it is important to identify the actors constituting the basic value chain of the offering. This is exactly why the third column has been included in this table. However we are not going into detail in these value chains and networks here as this is the subject of the next chapter of this book. Nevertheless we need this in order to analyse the products and outcomes of each actor in the subsequent cases in the next chapter.

5.5 Offerings and Business Models for the Involved Actors in the Business Cases

In a typical value chain, such as the ones established in the aforementioned examples, each actor contributes in a tangible (e.g., with an intermediate or supplementary product) or in an intangible way (e.g., technology expertise essential for a Grid installation) to the resulting end-product. Based on each contribution there is a linked business model established for this actor in order to earn economic benefits. For example, in the case of a technology integrator that sets up a Grid infrastructure, the resulting earnings come from offering IT services, that are one of the core competences and services portfolio of that particular company, to its customers. These are presented by case in the "Associated Products or Services" column of table 5.2.

Table 5.2: End products and associated models for the different scenarios

Most popular Grid Business Cases in the market	**Main actors involved**	**Associated Products/ Services**	**Applicable BMs per actor**
1. Company utilises an internal Grid solution as a virtualisation technique to improve the utilisation of resources (also known as the "Enterprise Grid")	The company	None. Solution is utilised for minimising costs	None directly.
	Grid s/w and application providers	Software (e.g. middleware)	– Software or Application provisioning (SaaP) – Open source
	Systems integrator (can be the same with the Grid s/w provider)	–	– IT services – VAS (e.g. consulting)
2. Company rents external computing resources through the internet with Grid being the underlying infrastructure on the provider's side	The company	None. Can be used indirectly to support other services provisioning or to optimise internal processes and products	- None if used to optimise internal processes – IT/Web services/ SaaS if used as infrastructure for a solution
	Resources provider (e.g. Amazon & Sun) – See case No. 5	Services offered as SaaS – See case No. 5	SaaS/HaaS/IaaS based
3. Company Grid-enables existing application or develops an application optimised to run over the Grid (BEinGRID BEs cases) and offers it to external clients	The service or application provider (the company)	Service or Application	– SaaP if offered through a license – SaaS if offered for renting over the net
	The user that either buys or rents the solution	May use the application to deliver new products/services or optimise existing	Many options such as VAS
	The Grid software provider	–	– Software or Application provisioning (SaaP) – Open source
	Systems integrator (can be the same with the Grid s/w provider)	–	– IT services – Value-added services (consulting)

4. A group of companies forming a VO in order to gain benefit from common use of resources (CERN is an example of this as well). Case also known as "Partner- Grids"	The users (VO participants)	– None if used for current processes and products optimisation – Services offered as SaaS	– N/A if used for optimisation – SaaS for new services
	Grid s/w and application providers	Software	– Software or Application provisioning (SaaP) – Open source
	Systems integrator (can be the same with the Grid s/w provider)	–	– IT services –Value-added services (consulting)
	Resources provider – if external computing resources are utilised (e.g. Amazon and Sun)	Services offered as SaaS	– SaaS/IaaS based
5. Company acts as a computing resources provider e.g. the "Amazon", "Sun", "IBM" etc cases	The resource provider (the company)	Services offered as SaaS	– SaaS/IaaS based – Utility computing based
	The users that buy resources on demand – See Case No.2	None. Can be used indirectly to support other services provisioning or to optimise internal processes or products	– None if used to optimise internal processes – IT/Web services/ SaaS etc if used as infrastructure for a solution
6. Company provides Cloud Computing Services with Grid as the underlying infrastructure (most popular emerging scenario). E.g. the Amazon, Google, IBM, Microsoft etc cases	The Cloud Computing provider	Cloud Computing Services provided mainly as SaaS	– SaaS based – SOA based – IT-as-a-Service – VAS (e.g. consulting)
	The users that purchase Cloud Computing services	–	– None if used to optimise internal processes – SaaS/SOA etc if used as a service component for another solution

Furthermore, there are cases like that of example 1 where the company adopts a Grid solution for internal purposes. In these cases there may not be a directly resulting product to be offered to external customers. However, this should result in optimisation of internal processes or offer more efficient and economic provisioning of other products. Depending on the particular scenario we can match existing or known business models to the different players as listed in the last column of this table.

The list of possible BMs as observed from the table includes the following:

- Already existing and utilised models in the market or minor adaptations of them like the VAS, SaaS, SaaP (mainly for Grid middleware) or the IT-Services one for offering consultancy services.
- The already used Open Source BM, where a version of the software such as Grid middleware is provided for free with benefits arising from the community further developing the product and contributing with ideas that can help evolve this into a more complete product. Also economic benefits may be expected from the reputation gained for the company and economies of scale and scope.
- Emerging models such as the IT-as-a-Service or SOA based services where the new products are designed to run in new architectural environments, such as Cloud Computing and SOA, and are expecting to derive revenue from the users of these architectures and services.
- Evolution or alternative configurations of existing models such as the Utility computing or ASP evolving into HaaS (Hardware-as-a-Service) or IaaS to match the requirements of Grid in a Cloud environment. Many of these concern the transformation of infrastructure capabilities as fixed costs into variable costs by applying the SaaS business models to infrastructure.

The next section elaborates more on the scenarios presented in the table by discussing specific examples from the market today.

5.6 Analysis of Examples of Business Cases

The previous two sections were dedicated to the most popular business cases in the market, the main actors that are involved and the added value Grid can bring to these business cases and the associated products or services. In this section several different examples are introduced in order to demonstrate and highlight such business cases. These examples are real business cases that already use Grid internally or in the offerings/products of their companies. Next, after presenting the Grid business case a correspondence of the main actors and the applicable business model by each actor is briefly presented (Gridipedia 2008).

5.6.1 The eBay (Business Case 1)

One of the most representative companies for the first presented business case in table 5.1 is eBay's auction site (http://www.ebay.com/). eBay is the Internet company that runs ebay.com, the well-known online auction and shopping website, where people and businesses buy and sell goods and services worldwide. eBay provides a safe online marketplace where anyone can go to trade products reliably. This is the main service that is offered and the customers are charged a small fee. The main characteristics of eBay's infrastructure are the massive growth, the constant change, the low latency in all processes and the capability to support a very high rate of transactions.

In 1999 eBay faced a series of service disruptions. In particular, over three days, overloaded servers shut down temporarily without warning, meaning users couldn't check auctions, place bids or complete transactions during that period. This led the company to re-design its IT infrastructure, rebuilding its data centers according to a Grid-type architecture in order to achieve a more flexible, scalable and reliable infrastructure (Gil 2009).

The eBay Grid infrastructure consists of many small servers supported by some higher-processor-count servers for a federation of back-end databases. eBay can actually run on as few as 50 servers, which can be Web servers, application servers and data-storage systems. Each of these servers runs separately, but communicates with the others, thus each of them is notified if there is a problem in the network. Growth can easily be achieved by adding servers to the Grid accordingly to demand. Despite that, an infrastructure of only fifty servers is quite adequate in order to run the site, eBay has one hundred and fifty servers more, in sets of fifty, in three different locations, which are spread all over the world. These servers store the same data, so if the main system crushes there are three other mirror systems to pick up the slack. This new architecture based on Grid allows very high fault tolerance, the elimination of the single point of failure, and easy growth together with low operating costs (Gibson 2004, MacFarland 2006).

eBay's business case is a representative example of a company that utilizes an internal Grid solution to improve the utilization of its resources. Its revenues are not originated from the Grid itself but from other sources (auctions, advertizing etc). However Grid is used to increase the performance of the operation while also reducing its expenses. Interconnecting all those servers in a Grid attains the aforementioned performance enhancements, the high exploitation of resources, cost-efficiency and economies of scale, due to the fact that interconnection of all machines improves the utilization of each one. The main actor in this business case is the company itself since it constructed its own Grid.

Table 5.3: Example of Grid business case 1: The eBay

Grid Business Case	**The Grid benefit (value-proposition or added-value)**	**Main actors involved**
1. Company utilises an internal Grid solution as a virtualisation technique to improve the utilisation of resources (also known as the "Enterprise Grid"): **eBay**	For the company: Performance differentiation, cost-efficiency, high exploitation of resources.	The company: **eBay** Grid s/w and application providers: **eBay**

5.6.2 CERN (Business Case 4)

The example of this section corresponds to the fourth category of table 5.1 and table 5.2. A representative real-life scenario of this specific business case is CERN, the European Organization for Nuclear Research, one of the world's largest and most respected centers for scientific research. Its subject is fundamental physics, namely finding out what the Universe is made of and how it works. The world's largest and most complex scientific instruments are used in CERN to study the basic constituents of matter, i.e. the fundamental particles. By studying what happens when these particles collide, physicists learn about the laws of Nature. One of the largest experiments that is currently in progress is the Large Hardon Collider project (LHC). The main purpose of LHC is to discover more about how the universe began and what it's made of. This will be achieved by colliding beams of protons and ions at a velocity approaching the speed of light. Those records generated by this experiment are predicted to occupy 15 Petabytes of memory every year, an enormous amount of data that cannot be accommodated either by a single IT infrastructure nor by a supercomputer. However, thankfully, Grid technology provides a solution to effectively store and process this huge amount of data.

CERN leads a major Grid project, the LHC Computing Grid, which is dedicated to providing the processing power and storage capacity necessary for the LHC. Grid was adopted because of the benefits Grid provides, such as the much lower cost, the flexibility and the ease of upgrades, compared to a single large and complex machine. In order for the network of computers to be able to store and analyze data for every experiment conducted at the LHC, a special middleware for Grid architecture was developed.

The structure of the system is organized into three tiers. The first is CERN's computing system, which is dedicated to process the information at the beginning and divide it into chunks for the other tiers. There are twelve second-tier sites that are located in several countries whose purpose is to accept data from CERN over dedicated computer connections. When the LCG gets up to full capacity, it will be made up of around 200,000 processors, mostly located in 11 academic computing clusters around the world, as shown in table 5.4, that will let around 7,000 scientists conduct experiments related to the collider, submitting their calculations to the LCG, which will farm them out around the network according to the supply and demand for resources (Cern 2006, Johnson 2008, Ranger 2005).

Table 5.4: CERN Grid Nodes locations

University Partners	
Forschungszentrum Karlsruhe in Germany	KFKI Research Institute for Particle and Nuclear Physics in Budapest, Hungary
Istituto Nazionale de Fisica Nucleare with its National Computer Centre in Bologna, Italy	University of Tokyo in Japan
ACC Cyfronet, Cracow, Poland	Moscow State University and the Joint Institute for Nuclear Research in Russia,
Port d‹Informació Científica in Barcelona, Spain	Academia Sinica in Taiwan
Particle Physics and Astronomy Research Council (PPARC)	CCLRC Rutherford Appleton Laboratory in the UK
The Department of Energy (DOE), US	National Science Foundation, US
University of Prague in Czech Republic	IN2P3 Computer Centre in Lyon, France

The collaboration of so many institutions around the world for the same purpose form a Virtual Organization (VO) which uses Grid in order to gain benefits from the common use of their resources. In fact, even with the VO, the operation of this project could be hard due to the enormous size of data that need to be processed. The partner institutes who are the actors of this scenario – despite their worldwide distribution – gain through the use of Grid and their collaboration benefits from a performance that the current technology could not otherwise provide.

Table 5.5: Example of business case 4: CERN

Most popular Grid Business Cases in the market	The Grid benefit (value-proposition or added-value)	Main actors involved
4. A group of companies forming a VO in order to gain benefit from common use of resources: **CERN**	– Performance benefit through the collaboration. Enables a purpose which was not possible using the current technology and a classic architecture. –	The users (VO participants) as shown in Table 5.4

5.6.3 The Amazon and Sun (Business Cases 5 and 2)

In this subsection different examples of the same business case – namely 5 – are merged with examples of business case 2 and are presented together, in order to demonstrate the relationship between the two distinct business cases and to show how the same company can be a different actor in each different business case. Business case 5 of table 5.1 can be characterized as common since big IT companies that own a large infrastructure follow this business model in order to provide their under-utilised and/or specially provided computing resources to customers.

Amazon and Sun are examples of such companies that provide such computing resources.

Amazon (Amazon Web Services 2009) is an American electronic commerce company based in Seattle. Amazon owns Amazon.com that began as an online bookstore, but now sells DVDs, music CDs, computer software, video games, electronics, apparel, etc. Furthermore Amazon offers in its catalogue web services for access as well as for integration with other retailers like Target and Marks & Spencer. Amazon offers two interesting web services for developers, namely, Simple Storage Service (Amazon S3) and Elastic Compute Cloud (Amazon EC2).

Simple Storage Service (S3) allows any developer to store and retrieve almost any amount of data by accessing the same "highly scalable, reliable, fast, inexpensive data storage infrastructure that Amazon uses to run its own global network of web sites" (Amazon S3 2009). This allows developers to begin new businesses with little or no up-front investments or performance compromises. The provision of quick, always available and secure access to the company's data is inexpensive and simple. Any file type is allowed to be stored, up to 5GB and can be set as public, shared or private. The service is charged for $0.15 (USD) per GB of storage per month and $0,20 (USD) for each GB of data transferred upstream or downstream.

Elastic Compute Cloud (EC2) is a service that enables developers to use Amazon's computing power for their own needs. It is possible for the user to obtain and configure capacity with the minimum of effort and to have complete control of the computing resources. Also EC2 allows the quick scalability of the capacity of the system in both directions according to the changes in the computing requirements. The developer is charged only for the capacity that has been reserved and due to the very little time that is needed to increase or reduce server instances, it's possible to keep the actual capacity used very close to day to day requirements. EC2 provides developers the tools to build failure resilient applications and protect themselves from common failure scenarios. On the other hand, the architecture of EC2 is simple. The servers that provide the EC2 service are Linux-based virtual machines that are called instances. There are two instance families; the standard one which is well suited for most of the applications and the high-CPU one that includes instances that have proportionally more CPU resources than memory (RAM) and are better suited for compute-intensive applications. The charges for the instances that belong to the aforementioned families are shown in the table 5.6 (Arrington 2006, Garfinkel 2007, Hof 2006).

Table 5.6: Instance types and prices

Instances	Description
Family: Standard ***Type:*** Small Instance Price: $0.10 per instance hour	1.7 GB memory 1 EC2 Compute Unit (1 virtual core with 1 EC2 Compute Unit) 160 GB instance storage (150 GB plus 10 GB root partition) 32-bit platform I/O Performance: Moderate
Family: Standard ***Type:*** Large Instance Price: $0.40 per instance hour	7.5 GB memory 4 EC2 Compute Units (2 virtual cores with 2 EC2 Compute Units each) 850 GB instance storage (2×420 GB plus 10 GB root partition) 64-bit platform I/O Performance: High
Family: Standard ***Type:*** Extra Large Instance Price: $0.80 per instance hour	15 GB memory 8 EC2 Compute Units (4 virtual cores with 2 EC2 Compute Units each) 1,690 GB instance storage (4×420 GB plus 10 GB root partition) 64-bit platform I/O Performance: High
Family: High-CPU ***Type:*** High-CPU Medium Instance Price: $0.20 per instance hour	1.7 GB of memory 5 EC2 Compute Units (2 virtual cores with 2.5 EC2 Compute Units each) 350 GB of instance storage 32-bit platform I/O Performance: Moderate
Family: High-CPU ***Type:*** High-CPU Extra Large Instance Price: $0.80 per instance hour	7 GB of memory 20 EC2 Compute Units (8 virtual cores with 2.5 EC2 Compute Units each) 1690 GB of instance storage 64-bit platform I/O Performance: High

Amazon clearly belongs to business case 5. It offers computing resources to its clients and enjoys revenue from renting its own infrastructure. Clients of Amazon can be any individual or company that needs more storage or CPU, especially if needs may change dynamically. The business model that Amazon is following in this specific example is IaaS since it provides Infrastructure as a Service to its customers.

As we mentioned before, Amazon's customers could be any individual or company that needs to use storage or CPU without provisioning its own computing resources either because of the capital cost or because of dynamically changing demand. In the following paragraphs we will present such a customer of Amazon's web services S3 and EC2.

The New York Times (NYT) recently decided to make available to the public all the newspapers that have been published from 1852 to 1922 online. They called this collection of full-page image scans in PDF format as TimesMachine where all 11 million articles are included.

The amount of data to be processed was enormous. It was a series of large TIFF images associated with metadata and article text of the newspapers for 70 years. That meant terabytes of data that had to be processed and stored. Using Amazon S3 they managed to upload and store the 4TB of data while EC2 provided them with the necessary CPU power for the concurrent use of hundreds of machines to read the data, create the PDFs and store them into S3 again, from where the public could reach it within 36 hours (Gottfrid 2008a, Gottfrid 2008b).

By using the infrastructure provided by Amazon, the NYT was able to offer their clients a new service not previously available; the experience of a window into the past from their computers. By using S3 and EC2 from Amazon, the NYT avoided the purchase of the resources required to process and store such an enormous amount of data. In this way, the NYT succeeded in providing a new and exciting service at a set-up low cost. This company follows the second business case as indicated in table 5.1. It rents external computing resources from Amazon, with Grid being the underline infrastructure, and gains all the aforementioned benefits. Both the business cases 5 for Amazon and 2 for the NYT are shown in the table 5.7 indicating how these two companies undertake their specific roles. It is worth noting that the NYT is the user for the fifth business case, while for the second business case is the provider of a service to other users.

Table 5.7: Example of business cases 5 and 2: Amazon

Most popular Grid Business Cases in the market	The Grid benefit (value-proposition or added-value)	Main actors involved
5. Company acts as a computing resources provider: **Amazon**	For the user: Resources provided on demand. Performance differentiation, cost efficiency, service differentiation For the company: revenue generation and reduced costs of offering such a service through virtualisation	The resource provider: **Amazon** The users that buy resources on demand: **The Times New York**
2. Company rents external computing resources through the internet with Grid being the underlying infrastructure on the provider's side: **The Times New York**	For the company: Performance differentiation, cost efficiency, service differentiation	The company: **The Times New York**

Given the success of companies renting external computing resources from large infrastructure providers, this section presents another example of these two business cases. Sun is an American vendor of computers, computer components, computer software, and information-technology services that now provides computing resources to its customers. The company was recently involved in Grid technology, with Sun Utility Grid (Sun 2009g, Sun 2009h) – recently re-branded and offered as a Cloud Computing service (Wikipedia 2009b). Sun Utility Grid is a large commercial Grid that consists of the first global pay-to-play resource. It allows its customers to create jobs and submit an application (Gohring 2006, Singer 2004a, Singer 2004b). Sun Utility Computing for Grid based solutions can start as low as $0.99 per dual CPU node, per hour with a click-through license and a four hour minimum usage requirement. For its all-inclusive, pay-for-use Sun Utility Computing for Midrange Sun StorEdge Systems, pricing can start at $0.80 per Sun Power Unit (SPU), per month. Designed as a Grid computing infrastructure, Sun reported that its pay-per-use offering is perfect for its high-performance computing markets shown in table 5.8.

Table 5.8: Sun Grid's target market

Industry	Applications
Finance/Banking	Risk and portfolio analysis
Energy	Reservoir simulations seismic analysis
Entertainment/Media	Digital content creation, animation, rendering, digital asset management
Manufacturing	Electronic design automation, computation fluid dynamics, crash test simulation, aerodynamic modeling
Government / Education	Weather analysis, image processing
Health Science	Medical imaging, bioinformatics, drug development simulation

Sun, our example in this business case, is the resource provider actor, that offers computing resources and achieves at the same time high utilization through the Grid virtualisation technology. On the other hand the customers that buy resources on demand are the users of this service. The business model that Sun is following in this specific example is IaaS since it provides infrastructure as a service to its customers.

Having demonstrated the provider's view, we will attempt to present a user in this business case. A user, a company named Virtual Compute Corporation (Sun 2009f), utilizes the computing resources of Sun as its infrastructure to provide its services. At the same time this company provides its services, with the help of the Grid infrastructure rented from Sun. The business case into which this company falls is the second one. Virtual Compute Corporation is a global provider of on-demand high-performance computing resources and IT infrastructure management for commercial and government entities. Its target market consists of companies in the energy industry, space sciences and life sciences with the main purpose the provision of tailored solutions that meet customers' unique needs. Virtual Compute Corporation uses the Sun Grid Compute Utility to handle work from its energy industry customers that exceeds the capacity of its own IT infrastructure. The Sun Grid gives Virtual Compute Corporation the ability to quickly and efficiently run compute-intensive jobs for its customers. Using Sun Grid the company has now the required flexibility to meet variable demands instantly through on-demand compute resources and this effective and quick response to the requirements of the customers provides the company with a competitive edge. However this was not the only benefit since the company saved up to US$3 million and two months time by avoiding build-out of additional infrastructure to handle customer's projects.

The example of this company is a demonstration of a client of Sun as the fifth business case category indicates. At the same time the same company is a provider of a service as the second business case indicates. In this last case the company rents external computing resources through the Internet with Grid being the underlying infrastructure on the provider's side here being the Sun company. The company needs Grid for performance differentiation and uses it to provide services to other companies following a SaaS business model.

Table 5.9: Example of business cases 5 and 2: Sun

Most popular Grid Business Cases in the market	The Grid benefit (value-proposition or added-value)	Main actors involved
5. Company acts as a computing resources provider: **Sun**	For the user: Resources provided on demand. Performance differentiation, cost efficiency, service differentiation For the company: revenue generation and reduced costs by offering such a service through virtualisation	The resource provider: **Sun** The users that buy resources on demand: **Virtual Compute Corporation**
2. Company rents external computing resources through the internet with Grid being the underlying infrastructure in the provider's side: **Virtual Compute Corporation**	For the company: Performance differentiation, cost efficiency, service differentiation	The company: **Virtual Compute Corporation**

5.7 Conclusion

In this chapter we have presented an overview of the main Grid Business Models, namely those that can be adopted from the Grid application and service providers in the market. In order to achieve a deep understanding of these models the process of their creation needs to be defined. The first step in this process is the understanding of the new technology but the most significant one is the correct definition of the added value (the proposition) that this technology can offer to potential customers and/or users. Furthermore, a set of business enablers, or Grid benefits are presented;

these being driven from the aforementioned most important requirement. The Grid business enablers are: “Common Use of Resources and Infrastructure as a Service (IaaS)”, “Collaborative and VO” and “Software as a Service (SaaS) and advanced software architectures” Grid benefits. The actual economic benefits for each one of those categories stem from one or more of: a) the offering of dynamic resources using Grid infrastructure, b) services or software that take advantage of the collaboration environment and c) services that are designed or Grid-enabled to be provided as SaaS. These Grid benefits can be found in the most popular business cases today, which are presented in the chapter. Each business case is associated with the aforementioned Grid benefits and with the main actors involved that constitute the basic value chain. Taking into consideration the tangible and/or intangible way an actor is contributing to the resulting product, a Business Model (BM) is then established for this actor, in each business case. In particular, Grid services or products are currently offered according to existing BMs in the market or some adaptations of them like the Value-added Services, SaaS, SaaP (mainly for Grid middleware) or the IT-Services BM for offering consultancy services. Also free versions of software such as Grid middleware can be provided through a Grid BM. The benefits in this model arise from the additional development of the product from the community and the contribution of new ideas that can help this to evolve into a more richly featured product. Thus, economic benefits may be expected from the reputational gain of the company and economies of scale and scope. Another important BM is the IT-as-a-Service, where the new products are designed to run in new architectural environments such as Cloud Computing. Finally, Grid BMs based on existing models such as the utility computing or the ASP are currently evolving to or integrating HaaS or IaaS business characteristics and helping to give rise to Cloud Computing.