Turning Grid Research into Business - Identification of Commercialization Barriers

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Abstract. In order to foster the commercialisation of grid technology, several theoretical models and frameworks that guide potential sellers of grid solutions have been developed. This paper presents the results of a cross-case analysis of 25 business experiments aiming at the commercialization of grid technology. Barriers occurring when actually commercializing grid technology are identified and analysed.

1 Introduction

In the last five years, grid technology has been considered as one potential technology that would change the way of how computing is pursued in companies. The term grid technology summarizes technologies that provide powerful computing resources on demand, management of large amounts of data (storage, processing and distribution) and virtualized applications on top of a large-scale federation of heterogeneous resources that may belong to different organizational units.

The first application of grid technology was in e-science (see for example the international research initiative Enabling Grids for E-sciencE - EGEE) and the success achieved in e-science inspired scenarios for application in business. Grid technology is entering a new level of maturity and is offered increasingly on the business market in four forms [1]: 1) as open source or packaged grid middleware; 2) as utility computing, that is computing infrastructure based on a pay-per-use paradigm, 3) as grid-enabled applications that can be run on a grid infrastructure, and

4) as grid-enabled applications that are offered based on the Software as a Service (SaaS) paradigm. The growing interest in cloud computing enforces further the trend towards business usage of grid technology. Cloud computing refers more broadly to a computing architecture that, for example, can link computers in a grid and allows users to buy access to data and software stored on the grid or processing power that is harnessed for specific purposes by the grid of computers [2], [3]. Cloud computing comprises three broad segments: SaaS, Platform as a Service (PaaS), and Infrastructure as a Service (IaaS). This is very similar to already established utility computing and emerging SaaS grid offerings. Such grid infrastructures can therefore provide the foundation for more complex cloud offerings.

Despite of earlier optimistic forecasts for the application of grid in business [4], [5], [6] and the favorable cloud computing hype there is no significant success of grid technology on the market that can be observed yet. According to [4], [7], [8], [9], the main barriers for companies to invest in grid technology are: doubt that grid technology can meet high security standards, i.e. high requirements related to assuring security of sensitive data and sensitive applications, organizational challenges as for example creating a shared environment and accounting for it properly, lack of standards and interoperability, lack of grid-enabled applications, unclear economic issues, complexity of the technology and difficulties to find the right offerings, complex licensing models as well as legal and tax issues. While some of these obstacles are clearly of technical nature, others point to deficiencies of how grid technology is presented on the market. There is a growing body of theoretical knowledge related to grid business models, necessary value chains and case studies of grid application in companies [10], [11], [12], [13], [14] that should guide grid technology providers on how to successfully commercialize grid technology However, there is less research analyzing specific concrete efforts of emerging grid technology providers to commercialize grid technology. The aim of this paper is to contribute to fill this gap by exploring the major obstacles of commercializing grid technologies, based on 25 business experiments (BEs) involving emerging grid technology providers.

The remainder of the paper is organized as follows: Section 2 provides an overview of the methodology applied. Section 3 contains the overview of results from the cross-case analysis. Section 4 concludes the paper with a summary of results.

2 Research methodology

The research presented in this paper involved two steps of analysis: case studies of commercialization strategies of grid technology providers developed and demonstrated in 25 business experiments and a cross-case analysis of the findings from the individual case studies. The case studies followed a holistic multiple-case design according to [15]. The main **unit of analysis** of the case studies were the commercialization strategies of emerging grid technology providers developed and involved within 25 BEs of the BEinGRID project. The BEinGRID project is a major international project supported by the European Commission that provides the framework to support pilot implementations of grid technologies in actual business scenarios. In the context of the BEinGRID project, a BE is a real grid pilot application that addresses a concrete business case in which all the main actors of the grid value chain are represented: end-user, grid technology provider and grid service integrator, reflecting the business and technical requirements of both the end user industry and technology providers.

91 partners from around Europe have been involved in the development of the BEs, being 66% from industry and 34% from academic institutions, which includes both universities and public research centres. The users of the BEs (e.g. Ducati, Hospital of Santiago, Piraeus Bank, Pizza New, Vodafone and others) represent a diversity of industry sectors, from advance manufacturing to media sector, financial sector, retail and logistics, e-science, telecom, tourism and e-health.

The main **sources of information** for the cases were business plans and commercialization strategies of the technology providers involved in each BE. In order to assure triangulation of data, further information was collected from publicly available company sources as well as secondary market research information.

The results of the BE case studies were input to the **cross-case analysis** [16]. One tactic for a cross-case comparison is "to select categories or dimensions, and then to look for within-group similarities coupled with intergroup differences" [16]. For within- as well for cross-case analysis, the comparing dimensions were chosen based on the structure proposed by the MCM-Business Model reference model (c.f. 1).

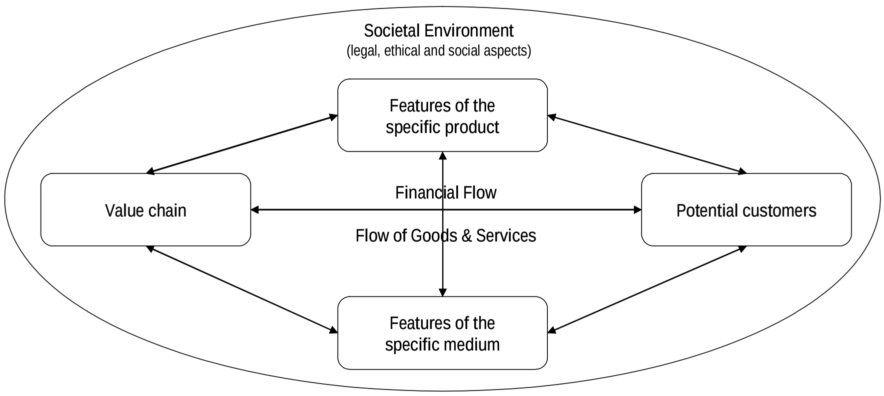

Fig. 1. MCM-Business Model reference model [17]

The MCM-Business model reference framework comprises typical elements of a business model, that need to be defined in detail, when commercialising innovative technology. These elements are summarized below:

- The **societal environment** component of a business model reflects all outside influences on the business models, such as the legal, tax and ethical aspects as well as the competitive situation of the market.
- The component **features of the medium** expresses the specific features of the applied and offered technology that may have impact on the business design of the concrete product.

- The component of **potential customers** covers all aspects of target customer segments as well as their requirements.
- The component **specific features of the product** expresses the exact design of the product or service and the way how it is experienced by its customers. It also explains what the specific benefits for the customers are.
- The component **value chain** reflects the directly involved players necessary for the production and delivery of the offered product or service and their interrelationships.
- The component **financial flow** explains the earning logic of the business model and makes it clear which elements of the value chain contribute from a financial perspective.
- The component **flow of goods and services** identifies all the processes within the company and the value chain necessary for the creation of the product or service.

This paper summarizes the results of the cross-case analysis with respect to the following components of the business model: definition of the product, identification of target customers and their segmentation, identification and establishment of the value chain as well as the specific approach of business experiments towards tax aspects of commercializing their products.

3 Results of the cases and cross-case analysis

3.1 Findings of the cross-case analysis regarding product

A major critical success factor of commercializing innovative technology is the initial definition of the product. With respect to products, four different kinds of grid products were observer at the business experiments:

- **Software as a Service**: Delivering pure grid services or grid-enabled applications in the form of SaaS, i.e. on a pay-per-use basis instead of licensed software.
- **Software as a Product**: Development of specific grid middleware that is sold as commercial, licensed software. In a similar way, several application service providers are pursuing a similar strategy by offering grid-enabled applications.
- **Open Source Software**: Grid middleware or additional middleware components offered as open source.
- **Value Added Services**: Provision of value-added services as integration of grid into the company infrastructure, integration of grid modules, consulting, etc.

Based on our analysis, the vast majority (88%) of the BEs' offerings include one or two product types. For example, a solution can be obtained either as a service or as a product, or software is complemented with value added services. One of five BEs' offerings include that type (see table 1). Open source is the least found product type and appears in all cases in combination with at least one other product type. Further, 83% of the 12 BEs whose offerings include only one product type, or 36% of all BEs, exclusively count on SaaS.

Table 1. Distribution of product types

Product type	Count	Percentage
Software as a Service	20	80%
Software as a Product	9	36%
Open Source Software	4	16%
Value Added Services	9	36%

While the software as a product commercialization approach was well known to most of the technology providers, majors barriers and problems were experienced regarding the definition of the SaaS offerings. For original SaaS applications that have not been available before in another form, the main question is the right choice among flexibility and pre-defined service features. While the end customers require flexible SaaS solutions, the provider tries to achieve economies of scale by providing the same service in the same form for all customers. Therefore, in order to increase the attractiveness of the SaaS offerings the service needs to be accompanied by additional value adding services as integration services and interface adjustment services. This might require from many emerging SaaS providers the establishment of the adequate know-how at their company. Providers that switched to SaaS from existing software as a product offerings face additional problems: On the one hand, the new SaaS offering might result in cannibalization of the existing software as a product and therefore needs careful design of the different product versions available and pricing strategies. On the other hand, offering SaaS might require also additional competences in establishing a computing infrastructure as a basis for offering the service in a good quality. In summary, with respect to emerging SaaS offerings based on grid technology, basic barriers towards commercialization are: building up competences to support a flexible SaaS offering, building up competences to establish either own or external computing infrastructure for offering SaaS and careful design of the different product versions with respect to scope of functionality, price and payment mode.

3.2 Findings regarding target customer segments

The analysis of the identified target customer segments of the technology providers involved in the various BEs revealed the following major barriers for grid commercialization strategies: limited market potential and significant differences in the requirements of customers with different magnitude.

Most of the products and services developed in the BEs targeted grid-suitable but, from the perspective of prevailing information technology in companies, niche application areas. Examples of such application areas are: collaborative engineering, data exchange and sharing within supply chains, establishment of virtual organization among companies, in particular along the supply chain, and provision of specific computationally intensive data as for example environmental data, which cannot easily be collected by single enterprises. One common characteristic of this type of application is that they are not on the main stream of information processing in companies. They tackle niche application areas that do not guarantee a permanent and intensive usage and therefore a high market potential. Providers have to design their offerings in a way to solve the conflict among higher specialization for one industry and broader scalability and applicability. Thus, the offerings need to be designed in a way to be as flexible as possible to be able to target a broader market.

The analysis revealed furthermore that the market segments of small and medium-sized companies (SMEs) and large companies are very diverse. Only very generic offerings as for example generic support for establishment of virtual organizations can meet in a good manner requirements of both small and large companies. SMEs can furthermore not be expected to have a grid infrastructure on which grid-enabled application can run. This often limits them to customers that are relevant only for SaaS offerings that offer relevant services at affordable prices. Large companies might have clusters on which grid-enabled application can run, but this requires a change in the mind set how information processing is handled. In many cases the provider needs to be prepared to offer also change management help. Larger companies impose also higher security standards that are difficult to meet.

In summary, with respect to market potential it was observed that not all grid-based application that at the first glance seem to be attractive for business use can be scaled to a reasonable market potential. Grid-based offerings need to be flexible enough to be able to address broader market segments.

3.3 Findings regarding value chain establishment

The cross-case analysis revealed that grid products are complex products that require a vertical integration of several components. For example, a SaaS offering typically requires a vertical integration of the following competences: a grid-based infrastructure on which the SaaS offering is run, the SaaS application itself, and integration know-how for the initial set-up and integration of the SaaS application in the infrastructure of customers. Only few of the grid technology providers involved in BEs were able to provide all three core competences. Thus, the establishment of a high quality value chain is a key success factor. In particular providers of SaaS applications might have difficulties to establish a vertically integrated value chain in particular if they can offer only a small volume of transactions and a small target market. Established players in the utility computing market are rather interested in high volume of transactions. This again imposes additional requirements upon grid-based technology providers that cannot be met.

3.4 Findings regarding Taxation Aspects

Taxation is one of the most relevant issues to take into account when a technology provider wants to commercialise grid-based solutions, as it may be a major barrier to financial success of grid businesses. Taxation has to be analysed from many perspectives, and in this paper we will focus on direct (i.e. income) taxation. With this regard, the main issue to assess is the relation between grid and permanent establishment.

According to the principles commonly accepted at international level, and set forth primarily by the Organisation for Economic Cooperation and Development (OECD) a business presence (e.g. a branch or a factory: technically speaking, a permanent establishment) of a company in another State justifies the taxation, by the authorities of the State, of the profits generated by that permanent establishment itself [18]. This principle is likely to affect grid providers if they have servers, nodes, clusters etc (i.e. grid components) in several countries. In other words, in case of a transnational grid, the portions of profit generated by its components can be taxed respectively in all the countries where these components are located. This in principle means high compliance costs for grid providers, risks of litigation with the tax authorities concerned and, ultimately, a great uncertainty when calculating the portions of profit generated by each grid component.

These considerations are valid, of course, if those tax authorities believe that grid components are permanent establishments of the technology provider. The general principle, stated by the OECD and followed by many national fiscal administrations, is that servers (and therefore Grid components) are permanent establishments of the grid provider if they are fixed, they carry out totally or partially the business of the company and such activities are not of preparatory or auxiliary nature [19]. It must be assessed on a case-by-case basis if these conditions are met, but in principle we can say that grid components are deemed to be permanent establishments of the technology provider and, as a consequence, the profits generated by them will be taxed in the country where the components are located. From a comparative perspective, many countries (i.e. the United States, France, Italy, Spain, etc) follow this principle, with the notable exception of the United Kingdom (where servers are not considered to be permanent establishments) [20].

From the practical perspective, this risk can be mitigated through a careful tax planning policy regarding the location of grid components. Technology providers basically have two alternatives: (i) centralise the Grid in one country, so that no issues related to multiple taxation of the same profits and/or right assessment of profits among the components arise; or (ii) locate the grid components in countries where servers are not deemed to be permanent establishments of the grid provider.

The above described tax planning may also be linked to the tax-effective location of the headquarter of the grid provider. If and when the grid components can be remotely managed, in fact, the technology supplier can decide to be established (i.e. to locate the central place of management of the company) in a low-tax country while the grid or the grid components operate in countries that are attractive from the tax point of view and that have good network connections.

4 Summary and conclusion

The goal of the research presented in this paper was the identification of major barriers to commercialization of grid technology. Based on in-depth case studies of 25 BEs and a cross-case analysis, major barriers to commercialization of grid technology were identified with respect to definition of the product, identification of customer segments and establishment of integrated value chains. The identified barriers served as basis for identification of corrective design principles for grid-based products and guidelines for practice.

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