Development of a Generic Value Chain for the Grid Industry

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Abstract. Grid middleware provides the fundamental framework for the provision of Grid services. However, Grid middleware is complex software that consists of several modules. The modules for a specific grid middleware exhibit in many cases complementary features and are produced by different software providers. Thus, in order to provide a complete grid solution for business customers, it is necessary to establish a complete value network comprising all relevant suppliers. Business aspects of grid, such as business models and value networks have not been considered broadly in research yet. This paper contributes to fill this gap by describing the value network of a grid case study and by aggregating the results into a generic grid value chain.

Keywords: Grid business models, Grid value networks, Business Grids

1 Introduction

Under grid we understand a specific middleware, which provides the necessary functionality required to enable both sharing of heterogeneous resources and virtual organizations [1]. Up till present, research in grid has mainly concentrated on technical aspects and development. In addition, the initial and core application area of grid technology is eScience. There are ongoing international (for example EGEE) and national initiatives that are dedicated to developing and running grids in specific data and processing intensive scientific areas.

The business market of grid (i.e. the market of grid services for companies) has not been fully exploited yet. Based on first successful examples from the eScience application area, grid technology is entering a new level of maturity and is getting productized with the aim to enter the corporate market [2]. In order to enter the corporate market, suitable business models are required [2], [3]. Providers of grid solutions need to evaluate suitable value chains, pricing and licensing approaches, and

market development and entrance strategies [2]. Up till present, less attention has been paid to these aspects of grid technology. Economic oriented research questions have only been considered in the research area "Grid Economics" [4]. Grid economics considers, however, the application of economic paradigms for resource allocation on the technical level (for example application of auctions for market distribution of available resources in a grid) and does not consider the research questions regarding creating successful business models for a profitable market entrance of grid technology. Thus, there are no guidelines available for grid technology providers, such as how to choose the appropriate business model and value chain [2], [3].

This paper provides a contribution to the business-oriented research of grid. It focuses on value networks of grid solutions for the corporate market. The findings regarding major players on the grid market and their relationships resulting from a broad literature review and in-depth case studies of the value chain of 18 representative grid industry pilots are aggregated to a generic value network for the provisioning of grid services and products.

The content of the paper is structured as follows: section 2 provides an overview of the research approach. Section 3 comprises a description of the grid case study. Section 4 contains a description of the concept for a generic grid value network. Section 5 concludes the paper with a summary and outlook.

2 Research Approach and Definitions

2.1 Value Chains and Value Webs - Definition

A first step in the construction of a business model is the study of the process of creating and exchanging value. The analysis of the value creation system helps organizations to understand how the different entities work together to produce value. The value chain analysis is a very efficient tool for tracing product flows, showing the value adding stages, identifying the key actors and the relationships with other actors in the chain.

The value chain analysis goes back to Porter's traditional linear model of value chains [5]. The liner model of value chain that consists of a sequence of value-enhancing activities has been an important and sufficient instrument for analyzing the value creation process in a company or industry during the last century. However, in the current networked economy relationships among companies are more complex and value creation is rather multidirectional than linear [7]. Given this, the linearity of the value chain proposed by Porter impedes the correct understanding of key processes such as relationships, alliances, and partnerships among the involved firms. Among the most important assets that are exchanged in the network are not only the monetary flows but also knowledge, trust relationships, intellectual property and leadership [6]. Several concepts have been presented that extend the concept of value chain towards value networks in the literature. For example Tapscott et al. [6] propose the concept of value web. Pil and Holweg [7] propose the concept of value grid. Further terms to denote the concept of extended value chain are: value network,

business web and similar. In this paper we will use the term value network. Based on an aggregation of elements of different definitions for value networks [6], [7], the term value network will be defined in this paper as follows: A value network is a web of relationships that generates economic value and other benefits through complex dynamic exchanges between two or more individuals, groups or organizations.

A value network analysis can be performed from the perspective of a company or an industry. An industry-level value network serves as a model of value creation and relationships in the industry. It is composed of all the value creating activities within the industry. To identify the aggregated value network of an industry requires a good understanding of the complementary products and services to provide a complete solution and what kind of relationships among players are present or possible.

2.2 Research Approach

In order to identify the major players and their relationship in the grid market the following research approach was followed:

- In a first step a broad literature survey on the subject was conducted.
- In a second step an in depth-analysis of the value web of 18 representative grid industry pilots was performed. For the purposes of the paper one example belonging in the financial sector is presented. All the grid pilots form part of the Integrated Project (IP) "BEinGrid" (http://www.beingrid.com/) that is funded by the European commission under FP6. One of the main objectives of the European project BEinGRID is to consider and develop in systematic manner a repository of knowledge and guidelines regarding business and market aspects of grid technology. In the heart of the project there are 18 business experiments that are piloting grid technology in various key industrial sectors such as the textile, gaming, ship-building, film-making, logistics, and retail management industries.
- In a third step the findings from step 1 and step 2 have been aggregated to produce a generic value network. The generic value network can potentially be applied by grid technology providers to position them and to evaluate which partners they need.

2.3 Results from the State-of-the-Art Research

The state-of-the-art analysis revealed that the topic of business models and value networks for grid technology has not been considered broadly yet. On the one hand there are several market studies available that are provided mainly by market research institutions [8], [9], [10], [11] or papers that elaborate on potential diffusion and adoption strategies for grid in enterprises [14]. These types of publications provide either descriptions of concrete cases or a general overview of the market and diffusion potential for grid technology. On the other hand there are first examples of papers considering the market entrance of grid technology, but on a general level [13], [14]. All papers identify in general two major business models for grid technology:

- Selling grid technology as combined software and consulting product.

- Providing grid enabled application and grid services according to the paradigm Software as a Service (SaaS).

The first business model is structured around grid software as a specific software product that can be offered either in a commercial manner or in an open source manner. However, the transition to grid computing in companies is a major endeavor that requires considerable changes in existing processes, application and governance of the information infrastructure [2], [15]. Thus, an indivisible part of grid software is respective consulting for companies how to master that transition.

The second business model is based on the SaaS paradigm [16]. SaaS is a relatively recent model of software access. It builds on the latest advances in technology within the software industry in order to offer a radically different model for accessing and using software. As the name states, SaaS is a way of accessing software products as services. This is significantly different to the traditional means of accessing software and raises a number of problems, both from the technical and legal perspectives. In this model a user can combine services or even software components (as in the service-oriented architecture paradigm) from different Grid providers and build his service. Providers on the other hand can provide their software in different packages and prices to meet the customer needs. Software can be accessed remotely and run over the grid infrastructure of the provider. This is in contrast to the traditional software model where software would be purchased from a retailer, generally in a box with a manual and some storage media containing the software binaries. SaaS makes software accessible according to a service/utility model.

The research question related to potential and available value networks for specific grid solutions for different application areas was considered in several research projects:

- The Akogrimo project (http://www.mobilegrids.org/) proposes a consolidated value chain for grid in mobile application [16].
- The project GRIDEcon (http://www.gridecon.eu/) explores potential value networks for different grid scenarios [17].
- The project GridASP (http://www.gridasp.org/wiki/) focuses on value networks for grid utility computing, i.e. for the SaaS business model [18].

However, the value chains and networks proposed within the projects are either dedicated to a specific application area or specialized for a specific business models. The most comprehensive study about grid value chains for both type of business models described above was conducted by Forge and Blackmann [2]. They propose the following value chain (c.f. 1):

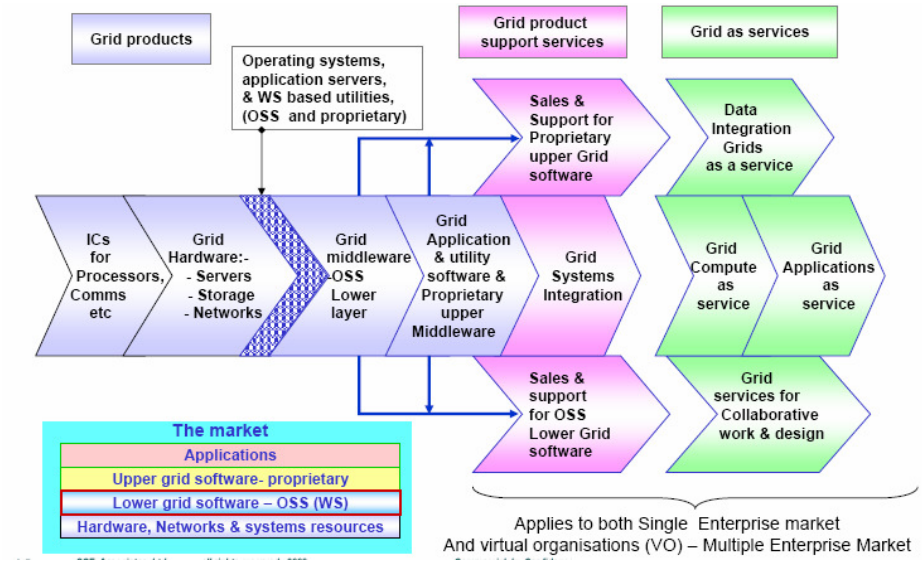

Fig. 1. The grid value chain according to [2]

The above value chain provides a structured overview of the specific competences, products and services necessary to provide a complete grid solution for the business market. It is a valuable picture of how grid services are assembled to a complete product. However, it does not provide an overview of involved players and how the competences and value adding activities are divided among them. It also does not provide information about the relationships among involved players and it is not granular enough to provide a basis to understand how competences can be bundled. Given this, the value chain proposed by [2] and the other projects mentioned above has provided the basis for an enhanced value network including actors as well as their competences and relationships presented at the end of this paper.

3 Example of a Value Network in a Grid Pilot for Financial Portfolio Management

3.1 The Motivation of the Financial Industry for Grid in Portfolio Management

Over the past decades portfolio and risk management techniques have adapted to increasingly complex financial instruments and risk scenarios. The rapid growth in derivative financial instruments and the derivatives losses reported in recent years have intensified concerns regarding reliably measuring financial instrument risk exposure.

In this respect, one of the biggest challenges is the surge in data volumes that have to be manipulated for risk and performance calculations. Market conditions as well as compliance requirements - both of which require additional sources of information to be included in the risk calculation - are the major reasons for this increase in volumes. Consequently, the risk computation cycle time increased significantly, almost stretching into the start of next day's trading cycle. As a result, the operational risk in this environment also increased considerably.

The financial market is under considerable and mounting pressure for more transparent and reliable risk reporting. To meet this demand, managers need a whole risk and evaluation infrastructure at their fingertips and this implies systems, technology and data. It is clearly an issue that is essential to all financial products - such as bonds, options, credit products and structures- to access the full credit curve and the well defined volatility surfaces. From the managers´ point of view, the key is to generate meaningful risk reports; nevertheless, this requires new technological solutions and high computational resources.

3.2 The Involved Players

The aim of the grid pilot considered in this paper is to develop an application to run simulations on a grid infrastructure to support financial institutions in strategic decisions of financial portfolio management problems. According to a pre-defined level of risk, the tool will calculate the portfolio with the best performances. The involved players in the value network are:

User: This business pilot has two end users. They present two different ways of operating in the financial bank sector, which highlight different needs and applications for the new tool. One of them will implement the new application to manage the customers' portfolios, while the other will use the new tool to optimize the asset allocation of proprietary capital. In a commercial situation, the two users will use the new grid application to support decision-makers in the asset allocation of portfolio management problems.

Service provider: The service provider in the considered case is at the same time the technology provider and offers the following:

- Computation power through super computers and computational infrastructure.
- Grid software services built on top of the grid middleware (Grid portal, Data and Storage Services, Information Service).
- Consultancy, expertise and competencies on placing legacy applications on a grid environment and to design grid-aware applications as well as specific expertise on the design of the software architecture for the portfolio management application.

Application provider: The competencies of the application provider involved in the pilot are related to the design and implementation of quantitative decision support tools for several application fields. The methodologies adopted belong to different areas of mathematical programming, such as machine learning, stochastic programming and simulation/optimization.

This market player offers its own experience in the design of effective and efficient quantitative tools to support end-users in the Portfolio Management applications. In particular, it assists end-users in the definition of mathematical representation of specific applications and provides the kernel to deal with the different phases of the decisional process, from a mathematical standpoint. The developed solutions exploit the advantages provided by the grid technology.

In a commercial situation, the role of this party consists in consulting and providing additional services on demand, like customization and tuning of the decision support system for additional requirements. Moreover, the provision of enhancements of the mathematical model and of the solution approach, according to the academic results in this field.

System integrator: The integrator's role is to act as interface between the end-users and the tool developer. In the pilot, this party participates in defining the requirements of the new application and assists the end-users in the data gathering activity and during the pilot phase. Therefore, it fosters the whole process of transforming the early pilot into a new business, promoting it successfully in the marketplace.

In a real business scenario, the integrator has two main roles: (i) promotion and commercialization of the new application and service through its network (reseller); (ii) consultant for business process reengineering to integrate grid applications and personnel training.

The value and contribution of the Integrator is the support to the end-user for the integration of grid technologies in its business processes, and also the re-design of the business models. The value of a new grid application depends from how well it is integrated in the business processes and how effectively it is used. A re-engineering of the business processes and even the re-design of the business models can increase the value of the same grid application. In fact, the economic viability of a new application depends not only on its intrinsic value, but also on its efficient use and proper integration.

3.4 The Value Network of the Pilot

During the pilot phase, the value network is reduced to the basic supplier–end-user relationship, with the service provider running the grid infrastructure and the new application, and the financial institutes representing the end-user and simulating the different portfolio combination. Figure 2 describes the same value network in a commercial environment. The relationships among the involved players are more complex and multi-faced. The service provider is the "main interface" to the customer and bundles the services of the application provider and the system integrator. He hides the complexity of the solution for the end customer and resolves potential problems as synchronization of licensing strategies and bundling of different component into a complete solution. Considerable intangible advantages can be achieved for each involved player in the value network. For example the application and service provider can leverage on each others customer base. In addition, the system integrator provides technical know-how to the solution provider and can leverage his customer network.

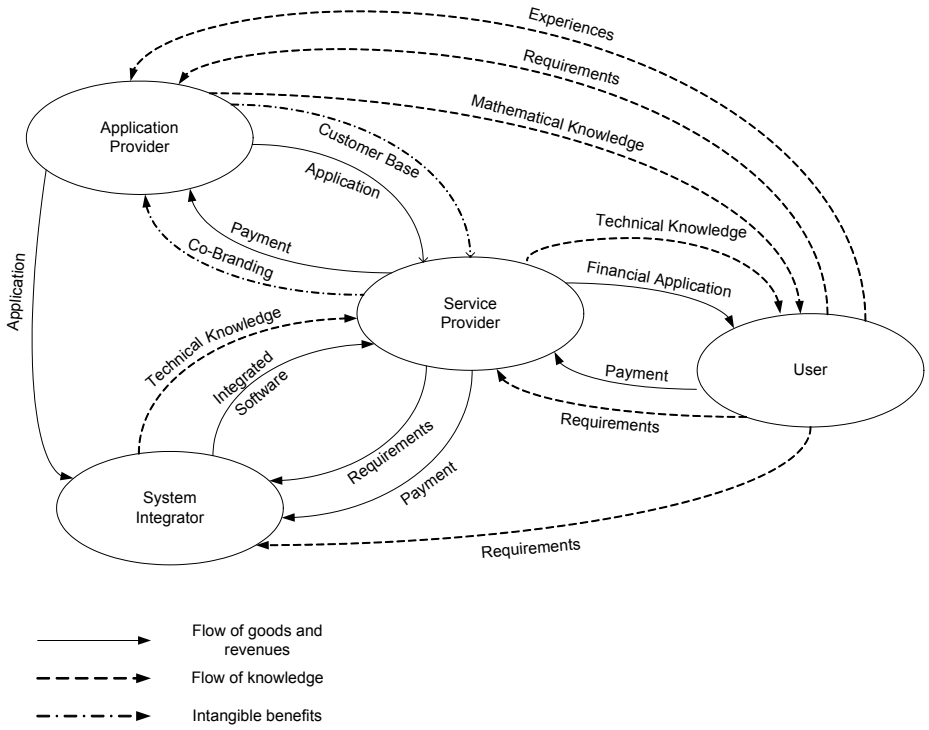

Fig. 2. Value network of the pilot

3.5 Future Potential Value Chains

Another possibility would be to extended the above described value network, by inclusion of additional players and by a different distribution of value creation activities among involved players. A multiplicity of new actors can enter in this simple value map, differentiating the services and creating new business models. For example, as described in figure 3, an intermediate financial service provider (FSP) can enter the network. The FSP owns an extensive database of financial data uses the grid infrastructure as a resource and sells on demand customized forecasts on financial portfolio arrangements to the banks and financial institutes. In this scenario the "main interface" to the customer is the FSP and the complexity of the technical solution is hidden from the end customer.

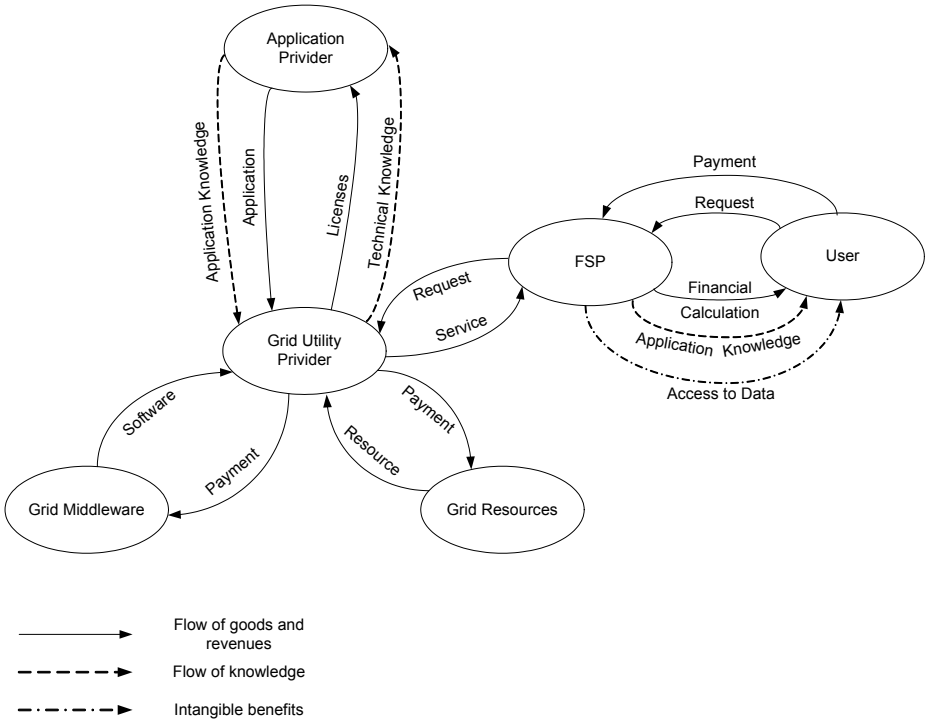

Fig. 3. Potential value network of the pilot

4 Integration of Results in a Generic Value Chain

In the previous section a value network of a specific grid pilot was presented and analyzed as an example. In a similar manner the remaining 17 Business Experiments of the BEinGrid project were analyzed. The findings were aggregated to the BEinGrid consolidated value network. The BEinGRID consolidated value network has been produced based on the identification of all the actors that appear in the different business experiments of the project and contribute to the creation of value and the interactions among them. The basic idea is to show how the content is distributed across a net of market actors reaching the different industries. Based on the generic value chain, specific value networks can be created.

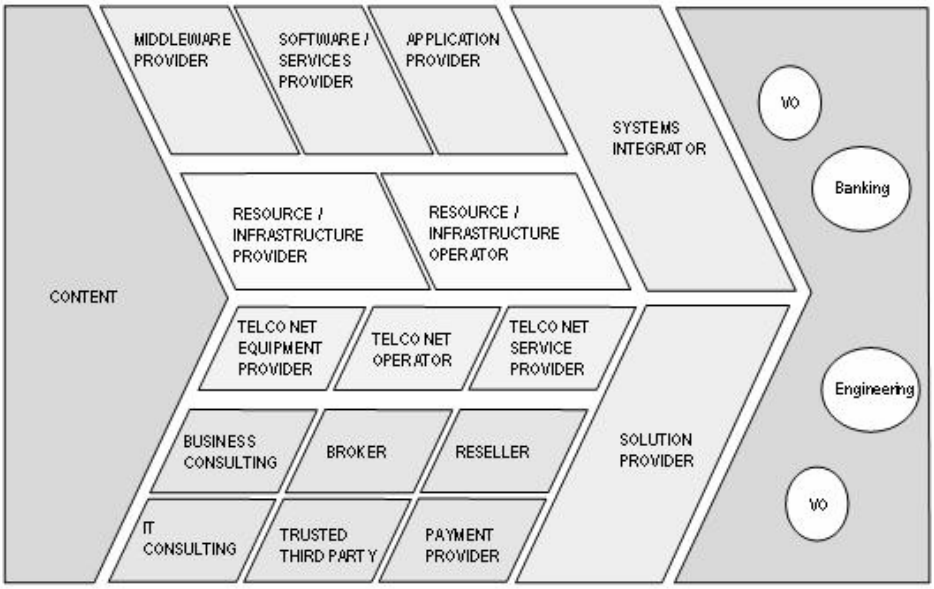

Fig. 4. The BEinGRID consolidated value chain

The following table describes the roles of the actors of the BEinGRID consolidated value chain:

Tab. 1. BEinGRID consolidated value chain roles description

Role	Description
Content (provision, aggregation, distribution)	Data, information and experiences created by individuals, institutions and technology to benefit audiences in contexts that they value. Content to be processed and transformed to build the final "product". The end-user can provide the content.
Grid middleware provider	Provides libraries, executable codes that implements the grid functionality. (standards + software (lower software + upper software)).
Software/services provider	Provides software that is usually added to platforms or targeted to special niche markets. (e.g.: Independent Software Vendor (ISV)) An ISV makes and sells software products that run on one or more computer hardware or operating system platforms. The "Service Provider" offers services that run on the

	technology in question. These Service Providers will likely have a strong relationship with the Application Providers or with the operators. The main idea behind this business participant is that external service provider can offer their services to operators and application providers.
Application provider	Is the first customer of a specific platform. The Application Provider can buy a development package to integrate its software on top of the respective technology. An application service provider (ASP) is a business that provides computer-based services to customers over a network. Software offered using an ASP model is also sometimes called on-demand software.
Resource/Infrastructure provider	Provides equipment (hardware) on which the grid implementations run. Other hardware, network and system resources used (e.g. HP).
Resource/Infrastructure operator	Provides access to and use of the equipment that it owned by the resource or infrastructure provider.
Telco network (equipment) provider	Provide equipment (telco hardware and network resources) that build the telco network (e.g.: Nokia, Siemens).
Telco network service provider	Sells bandwidth under specific business criteria. Many times the network service provider and the network operator is the same company (Telefonica, BT, Vodafone).
Telco network operator	Provides a broadband communication network, offering real time functionality and easy access. Enabler of communications. It also can play the role of end user when the grid technologies are used for the company business processes.
Business consulting	Offers a solution to your business problem, optimizes your processes, improves your "numbers" telling you how, and provides business models, advices you in business development and marketing. (e.g.: Accenture, Atos, Logica).

IT consulting	Expertise for assistance in the IT (information technology) processes, computing services, training.
Payment provider	Provides infrastructure and management enabling the payment transactions between actors. It can be a financial entity, a business consulting company, a broker, a network service provider, etc.
Reseller	Companies that resell/distribute an existing solution provided by another company. It can be the whole suite, or one or more of its components.
Broker	Intermediary, can also be the trusted third party. It advices on you on which grid solution fits better to your situation. Provides services based on specific quality levels required by the end-users.
Trusted third party	Deals with contractual arrangements, financial settlements, and authentication of users (e.g.: a bank or other financial entity).
Systems integrator	Integration of the different modules (software, hardware) required to build the grid solution. Brings the players together. Technical role, but may also do consultancy work besides installation, deployment and IT support.
Solution provider	Offers you a package of network, middleware and applications (e.g.: IBM). It may provide also consulting or grid expertise so that the solution of the problem can be determined.
Market	Targeted end-users or virtual organizations (VO) in different industries.

The list of potential players provided above shows that the value network for grid solutions is quite complex. Given this it might be organized in sub-clusters or networks that are represented by a lead player that bundle the offerings of several players and join them with the offerings of other players to a complete solution. The potential clusters that can form on the market are (c.f. 5):

One possible cluster can be lead by the systems integrator, who integrates the services and offerings of the application, middleware and resource provider to a grid application. Thereby he bundles the offerings, and resolves potential conflicts regarding licenses and pricing.

Another cluster - the telecom cluster - can be formed by the providers of services and equipment necessary to enable communication infrastructure for the solution. This type of cluster can be lead by the network operator or network service provider.

Finally the offerings of the system integrator and the teleco cluster can further be enriched with consulting services by the solution provider, who is the main interface to the customer.

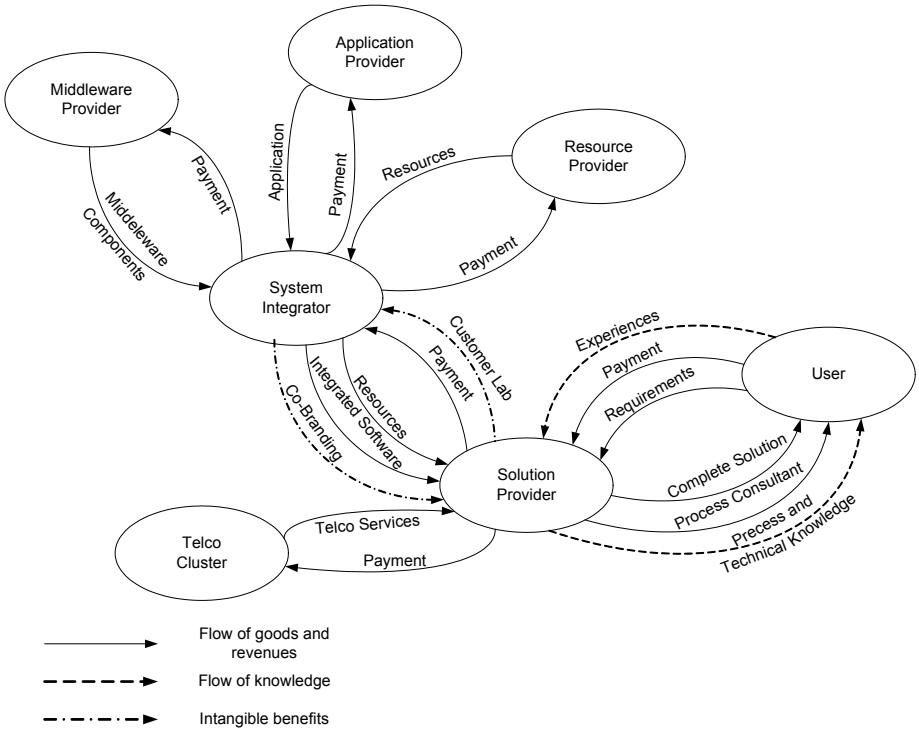

Fig. 5. The BEinGRID generic value network

5 Summary and Conclusion

The aim of the paper is the analysis of existing value chains and development of a generic value network for the grid industry. In order to achieve this, an in depth state-of-the-art analysis was performed. Then, based on a case study existing and potential value networks were developed. Finally, the results from step one and two were combined in a generic value chain for the grid industry. The generic value chain provides an overview of actors and their competences. It can be applied by providers of grid solutions or components for grid solutions to position themselves and to identify potential necessary partners to enter the business market.

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