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Process-Logic Based Value Networks for Mobile Grid Technology as Business Collaboration Infrastructure

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Abstract: Business models in the Information and Communication Technology (ICT) domain must be evolved when innovative technologies emerge. To perform this in a dependable way, empirical studies (e.g. market studies or workshops with business and technology experts) must be complemented by means of deductive approaches based on economic theories. In this paper a corresponding approach is introduced leading from empirically identified value network participants to a clear theory-based understanding of business interaction in value networks that will not be established before long terms of time but that have to be described exactly because of early investment decisions by potential partners providing the respective innovative technology. Thus, a framework for analysing each value network participant's relationships is introduced and applied in the context of mobile grid technology leading to a confirmed process-logically structured value network.

1. Introduction

Current telecommunication providers are expected to evolve their own business models because selling bandwidth is increasingly becoming a commodity. Many opportunities were already proposed such as content or payment service provision and multimedia message services (MMS), for example. In most cases missing network effects inhibited the success of such technologies. The same is true for electronic business collaboration approaches with their decisive lack of strategic business model and process design considerations (e.g. customer relationship management systems in their first generation) [1].

One of the latest upcoming business collaboration infrastructures currently being developed in an EU funded project are mobile grid services [2]. This novel technology presents an approach of integrating many business opportunities as they were mentioned above. However, this time they are based on dependable, flexible, and mobile accessible computing resources for end customers with changing needs.

Nevertheless, even if mobile grid technology is highly integrated there is certain evidence that its high complexity does not allow any single provider such as earlier rather monolithic telecommunication providers to be active at all value-adding levels. Instead, there will rather be a whole value network for this issue and evidently it is not possible to simply ask today's telecommunication companies' executives, which will be the cost-minimal entrepreneurial integration degree. One reason is the overall complexity and fragmentation of any future mobile grid value network. Companies that are highly experienced in the field of grid technology have to be integrated and intermediaries that are able to coordinate the market and offer customer-oriented services must evolve.

This is why already today (i.e. probably several years before its technology roll-out will take place) the overall mobile grid value network has to be analysed in order to depict its opportunities and its risks for all companies or at least all generic providers (as the current

companies need not to be the future companies) currently planning their strategic investment into highly innovative technologies. Based on such considerations, each company in this future market can decide whether there is enough benefit regarding its individual effectiveness and efficiency [3]. This is no trivial task as on the one hand product managers mostly focus on rather short-term business opportunities and thus are not able to provide significant information, and on the other hand business models cannot be protected by law so that empirical studies are not sufficient as well.

Apart from very few particular approaches [4] qualitative approaches regarding economic implications of highly innovative information technologies are limited to enterprise focused approaches of investment and productivity calculation as well as portfolio methods [5], a big number of business modelling approaches mainly classifying the landscape [6], rather traditional value chain approaches [7], research projects on Internet economy [8], or rather universal business engineering [9], just to mention some of them.

2. Objectives

This paper proposes an *initial set of generic participants in the Mobile Grid value network* that were identified from a technology experts' perspective as those researchers currently have the clearest vision of mobile grid opportunities. Furthermore the *dyadic relationships between the generic participants* that mostly can already be found in today's telecommunication value networks are examined by means of an operationalised framework based on the new institutional economy (i.e. transaction cost and principal agent theory). Finally, a hypothetic *process-logic of a mobile grid value network* is confirmed.

3. Methodology

The objectives of our paper are quite challenging compared to the high innovation degree of mobile grid technology and the related time horizon that goes far beyond the focus of potential real-world value network partners. This is why a deductive approach is chosen after the first objective has been accomplished by means of a workshop with technology research and development oriented practitioners and scientists. The deductive part of our work starts from general considerations of inter-organisational value networks, combined with the identified generic value network roles. The work is based on economic theories, in particular on transaction cost and principal agent theory. Both theories are operationalised using a framework to analyse hypothetic dyadic relationships between generic participants in electronic business collaboration infrastructures. After this is exemplarily performed the confirmed relationships justify some initial process logic of the value network.

4. Technology Description

Mobile grid technology – by leveraging the large base of mobile users – advances the pervasiveness of grid computing. Therefore, technology architects construct a next generation grid that exploits and closely co-operates with mobile Internet infrastructures. The technology especially leverages mobility, QoS, AAA, and security functionalities provided by corresponding network-related middleware systems of such infrastructures. At the same time mobile grid technology addresses issues unresolved so far concerning 'mobile and pervasive services in the Internet world' by looking at the grid and Internet with an integrative architectural view [10].

From a user's point of view, mobile grid technology provides technologies and concepts to establish a 'virtual home', with nomadic and mobile environments for solving complex problems across network technology and provider domains. In generalizing the core grid concept – namely the resource-sharing concept – mobile grid technology patterns these environments as 'mobile dynamic virtual organisations' that incorporate concepts of

personalisation, profiling, privacy, security, and trust. From the provider's point of view, the mobile grid world provides economic opportunities and risks. This is why inter-organisational value networks based on existing models with different participation types depending on their respective business strategy have to be considered. As already outlined, a framework based on economic theories is provided in order to forecast future business collaborations and thus equip the mobile grid value network with some initial process logic.

5. Developments

According to our methodology this section renders the main steps towards a process-logic based value network for mobile grid technology. For this reason we first introduce the generic participants of a mobile grid value network (section 5.1) whose hypothetic relationships will be analysed in a second step (section 5.2) to come up with a confirmed serialised mobile grid value network (section 5.3) that can be used for further economic analysis (cf. section 0).

5.1 Identification of Generic Participants in the Mobile Grid Value Network

In Figure 1 we introduce five types of generic value network participants that pursue different value generating strategies [11].

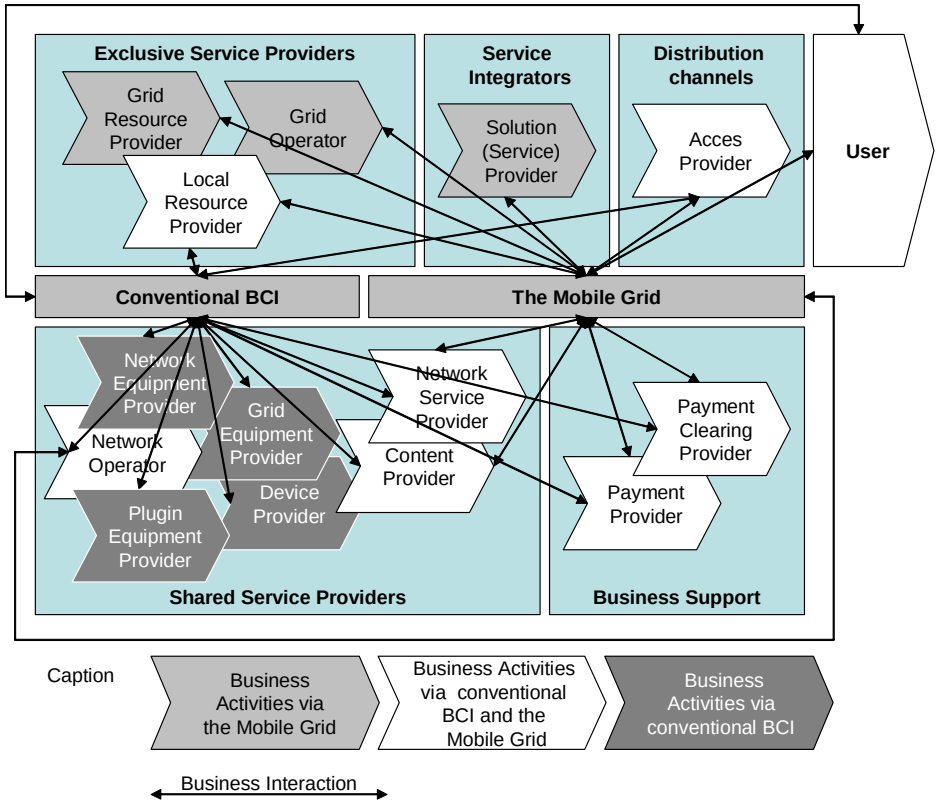

Figure 1: Generic Mobile Grid Value Network

Exclusive service providers are expected to follow specialist type business strategies (i.e. a differentiation strategy) while *shared service providers* follow factory type business strategies (i.e. cost leadership strategies). *Service integrators* succeed by means of customer intimacy type business strategies while *business support* and *distribution channels* mostly serve complementarily to the first three types of value network participants.

According to these general types of value network participants, different generic mobile grid participants identified in an expert workshop with information and communication technologists are classified in Figure 1. This classification is based on participants'

descriptions, particularly on their input needed, their output and their respective value-added as depicted in Table 1. Thus, all participants in the context of mobile grid technology are qualitatively classified according to their competitive orientation.

Table 1: Short Descriptions of Generic Mobile Grid value Network Participants, their input needed, value added, and output. Participants that are highly mobile grid specifically oriented are grey shadowed.

Name	Description	Input	Value added	Output
Access provider (AP)	Brokering between different organisational entities in an electronic workflow; between resources communicating and exchanging information; between identifiable users	Authentication; user service profile; application/service specific data	Transparent use of the network; transparent aggregation of data, content, services and resources	Authentication status; authorization status; business process initiation
Content provider (CP)	Development of new content; content syndication, enhancement, hosting, fulfilment, optimization, etc.	Needs of SPs; relevant information	Content creation; content aggregation; content distribution	Content to the end user via the AP
Device provider (DP)	Provision of end users with intelligent and flexible devices, such as mobile phones, PDAs and PCs.	Mobile device	Enhancing of senses for mobile devices	Mobile device for the end user
Grid equipment provider (GEP)	Provision of technological environments for grid services (i.e. computing power and according software strongly related to the needs of GRPs.	Hardware resources, software, libraries, toolkits to build consolidated releases of grid software	Software combination and configuration for grid software toolkits, updates, documentation and support; legacy integration	Equipment for grid resource providers
Grid operator (GO)	Providing and running the mobile grid platform; enabling SPs developing software products	Resources provided by the GRP	Operation of the grid as a platform offering aggregated services and development	Development and operation of a grid platform for SPs
Grid resource provider (GRP)	Provision of the basic elements of virtual organisations (VOs) using grid software and hardware to deliver according to the policies and agreements of the VO	Grid solution based on grid software and fitting hardware	Delivery of grid resources offering capacities needed by GOs and SPs	Services or resources to virtual organisation, eventually with guarantees on quality and reliability.
Local resource provider (LRP)	Resource valuation used as a mechanism to attract or deter external users by utilizing the laws of supply and demand	User query	Remote access for user jobs on foreign resources	Result report
Network equipment provider (NEP)	Supporting mobile NOs and fixed NOs, providing them with network equipment	Not considered here.	Not considered here.	Equipment for the NO
Network operator (NO)	Telecommunication companies, providing network and communication services enabling mobile grid applications	Equipment from NEP	Implementation of a high speed wireless connection system with easy access and real-time functionality	Whole network infrastructure with its business models
Network service provider (NSP)	Selling bandwidth or network access by providing direct access to the internet and different access points	Equipment provided by NEPs or NOs	-	Network access
Payment clearing provider (PCP) and Payment provider (PP)	Asset management and secure exchange of payments, taking care of all financial transactions; charging payments against other payments for net balance; collection of charging information	Financial transaction data	Exchange of monetary values; accounting and settlement of payments; offering centralised services; aggregate different payment providers' systems	Financial transaction status data; presentment of balanced accounts; bill presentment
Plug-in equipment provider (PIEP)	Adding functionality to end users' mobile devices	Mobile device	Functionality to the user mobile device	Enhanced Mobile device
Solution (service) provider (SP)	Development and distribution of applications/services supporting end users with adapted solutions	Grid platform solution services; contents; mobile services	Input integration	Solution for the end user

5.2 Analysis of Dyadic Relationships between Generic Mobile Grid Participants

Even if we get some initial knowledge about the relationships between different mobile grid value network participants in section 5.1 and in particular in Table 1 we still must deepen these insights to forecast the development of the value network that already exists in today's telecommunication business in a comparable way [12]. We suppose that the new technology will lead to changes of transaction costs and safer principal agent relationships. Thus, some of the potential participants may adapt their existing business models and develop tighter relationships or get more and more loosely coupled. In this contribution this phenomenon is explained in a preliminary way by a couple of corresponding effects characterising the background of transaction cost and principal agent theory:

Together both theories predict that the higher the level of *uncertainty* surrounding the business context, the greater the *information asymmetry* between resource exchangers, the greater the *specificity of investment* required for the economic activity in question, the more difficult it is to relate the *marginal contribution of different resources* to the final value, and the greater the *conflict of interest* between resource exchangers, the higher the likelihood of the *establishment of an integrated or consolidated value chain* and vice versa. That is, the more likely it will be that a greater proportion of the value-added activities will be *organised within a few firms* [13].

Table 2: Criteria for Analysing Participants of a Value Network (VN)

Theory	Analysis Criteria		Description
Transaction cost theory	Uncertainty		partner shows deficiency of rationality → trend for integrating the VN
	Asset specificity		high specificity of machines, knowledge etc. → trend for integrating the VN
	Frequency of transactions		high frequency → trend for integrating the VN
	Control archetypes	Arm's length control	featuring outcome control based on market-derived standards or predefined contractual provisions in case of high uncertainty, specificity, frequency.
		Machine control	administrative control based on codification of behaviour or predefined performance targets in case of high uncertainty, specificity, low frequency.
		Exploratory control	working from converging insights that accrue and spread during the process in case of low uncertainty, specificity, high frequency.
		Boundary control	proscriptive in nature, emphasizing actions to be avoided if high uncertainty, low specificity, low frequency.
	Costs	Search and information costs	costs from discovering who it are that one wishes to deal with; high in case of high uncertainty, specificity, low frequency.
		Bargaining and decision costs	costs from conducting negotiations leading up to bargain and draw a contract; high in case of high uncertainty, specificity, low frequency.
		Policing and enforcement costs	costs from inspections needed to make sure that the terms of the contract are observed; high in case of high specificity, low frequency.
Principal agent theory	Information asymmetry	Hidden characteristics	before signing a contract there are lot of uncertainness for both sides; high screening costs if high uncertainty, low frequency.
		Hidden action and information	asymmetry of information is the problem in the post-signature phase of a contract; high control costs if high specificity, low frequency.
		Hidden intention	problems caused by intentions of the agent; high costs if high uncertainty, specificity, low frequency.
	Incentives		for a right behaviour of the agent if high uncertainty, specificity.
General criteria	Marginal contribution to the final product		difficult allocation to the different resources in the value network → trend for integrating VN
	Conflict of interests		high risk -_> trend for integrating VN

Starting from these theories we establish a framework for a detailed analysis of each participant's relationships in the value network. In Table 2 all describing and analytical criteria are introduced and explained. We differentiate criteria based on transaction cost theory regarding the *uncertainty of partners*, the distinct *asset specificity*, *frequency of transactions*, basic types to *control mechanisms* between participants, and *cost types*. The principal agent theory contributes to our framework by different kinds of *information asymmetry* and means of *incentives*. Finally, we consider *marginal contributions* to the final product as well as *conflicts of interests* for the respective relationships.

Table 3 presents the exemplary application of our framework introduced in Table 2 for generic solution providers (SP as described in Table 1) towards their most expected value

network partners, namely the end user [User], the grid operator [GO], and the content provider [CP]. All analysis criteria are evaluated in the context of the value network *before and after the mobile grid rollout* (columns 3 and 4). In Table 3 for each criterion and each hypothetic partner the relationship is evaluated. The items marked bold indicate a change in the relationship where the bold item indicate the higher level For example, Table 3 shows that uncertainty is mostly decreased while asset specificity and transaction frequency increase. (Privacy issues resulting from end users' data usage are considered in more detail for example in [14].) For analysis frameworks of the further participants of the value network see [15]. Consequently, control archetypes and cost types also change. Towards business partners information asymmetry decreases while it rises regarding the end customer relationship. This can be explained because of better information availability.

Table 3: Exemplary Transaction Cost and Principal Agent Theoretical Analysis of a Solution Provider (SP)

Theory	Analysis Criteria		Before Mobile Grid	After Mobile Grid
Transaction cost theory	Uncertainty		**[User] Increased** **[GO] Increased** [CP] Low	[User] little decreased [GO] Decreased **[CP] Medium**
	Asset specificity		Increased	**Further increased compared to [User] and [CP]**
	Frequency of transactions		[User] Low [GO] Low [CP] Increased	**[User] Increased** **[GO] Medium** **[CP] Increased**
	Control archetypes	Arm's length control		
		Machine control	[CP] Yes	[GO] Yes
		Exploratory control		**[User] Yes**
		Boundary control	**[User] Yes**	**[CP] Yes**
	Costs	Search and information costs	**[User] Increased** [GO] Low [CP] Increased	[User] Low [GO] Low [CP] Increased
		Bargaining and decision costs	**[User] Increased** [CP] Increased	[User] Low **[CP] More increased**
		Policing and enforcement costs	[User] Low [CP] Increased	**[User] Little increased** [CP] Increased
Principal agent theory	Information asymmetry	Hidden characteristics	[CP] Low **[GO] Increased**	[CP] Low [GO] Low
		Hidden action and information	[CP] Low [GO] Increased	[CP] Low [GO] Increased
		Hidden intention	[User] Increased **[CP] Normal**	**[User] More increased** [CP] Decreased
	Incentives		**[User] Normal** [CP] Low	[User] Low **[CP] Increased**
General criteria	Marginal contribution to the final product		Increased	**More increased**
	Conflict of interests		[GO] ([CP])	

5.3 Serialisation of Generic Mobile Grid Participants

After setting up hypothesises about the most probable future relationships in the mobile grid value network, the analytical criteria introduced in Table 2 are applied to all value network participants in order to confirm or to reject the hypothesises. As none of the hypothesises is rejected it is assumed that the identified relationships set up a process-logical structure that is the basis for further economic analysis (e.g. analysis of supply chain structures or business processes) beyond this contribution.

According to their closely related subjects it is obvious that certain neighbours in the process-logical value network can be grouped. For example in Figure 2 the NEP, NO, and NSP set up network technology provision, the GEP, GRP, and GO establish the grid technology provision, the PIEP, DP, and LRP offer extended mobile device infrastructure services, and the PP and PCP guarantee payment services. A qualitative basis is given for future research towards the cost-minimal entrepreneurial integration degree of mobile grid business. Furthermore, Figure 2 depicts that grid operations base on network services. Grid operations themselves constitute the basis for user-oriented solutions, access, or payment services while all hardware is delivered via conventional business collaboration

infrastructures. Finally, on the one hand solution and access providers combine different services from the value network, on the other hand they are quite customer-oriented and thus should be considered as new intermediaries in mobile grid business.

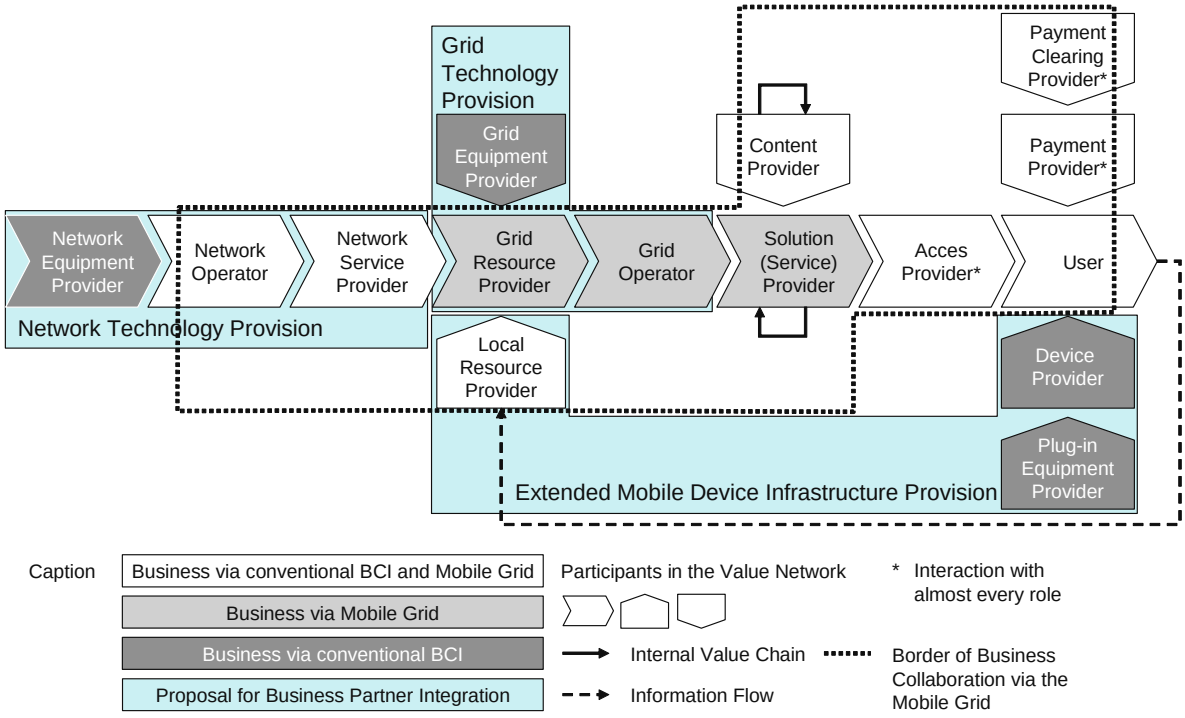

Figure 2: Proposed Value Network with Process Logic

6. Results

In our approach we suppose that the new institution economy is an adequate instrument to forecast the structure of future value networks. Indeed, we identified an analytical framework based on transaction cost and principal agent theory that we applied to the mobile grid case. During a workshop with mobile communication and grid technologists we identified potential participants assuring different tasks in providing end user oriented mobile grid services. As a second result all of them were described in detail regarding their input needed, output provided, and value added as well as analysed by means of a theory-based analysis framework in order to understand their respective economic relationships. As our third result we provided a value network for the use of mobile grid technology comprising several classification aspects: types of value network participants based on their attitude towards the services provided by the value network (e.g. exclusive service provider, shared service provider, service integrator, distribution channel, or business infrastructure), means of business activity (e.g. conventional business collaboration infrastructure and mobile grid infrastructure), and levels covered of the process-logical value network.

7. Business Benefits

Starting from current changes in the telecommunication market mobile grid technology offers certain opportunities for telecommunication companies. However, they can hardly manage in getting more detailed insight in such a highly innovative technology as their planning horizons are too short. This is why we offer a framework based on two partial theories of the new institutional economy. It can be used by practitioners (e.g. enterprise executives, business developers, and product managers) as well as by scientific staff in order to discuss by means of workshops how the dyadic relationships between the ex ante identified value network participants will evolve. Based on these discussions the intensity

of the respective dyadic relationships between the different value network participants can be identified and used to confirm a hypothetical process-logical value network. In the case of mobile grid technology it has already been applied in the e-learning and rescue services domain and accepted by big European telecommunication companies and has been approved by project reviewers. Finally, the mobile grid value network and the analytical framework can continuously be used by practitioners for planning the design of their transactions and control mechanisms within the mobile grid value network.

8. Conclusions

Our approach of identifying structures in future value networks by means of economic theories is strongly deductive. In addition, it is sufficiently generic so that it can be used with low effort in further research projects regarding economic implications of innovative information technologies (e.g. wearable computing, software sensors, multi-agent systems, etc.), as far as they concern transaction costs or principal agent relationships. Expensive market studies that can hardly be performed several years before a potential technology rollout are not obligatory for our approach. Thus, it is not only effective (as demonstrated in the mobile grid case) but also efficient if users are experienced with economic theory.

Regarding the value network, further examinations have still to be performed in order to get more sophisticated knowledge about the effectiveness and efficiency of the approach and its results as soon as the overall considerations about mobile grid technology are more precise and completed. Nevertheless, the generic value network has already been evaluated regarding its direct benefits as it was used for the identification of joint exploitation issues for mobile grid technology as it offers the possibility to assign potential exploitation partners to the respective complementary generic participant roles [16].

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