Business Modelling of Emerging Service Opportunities in the IoTS Ecosystem

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ABSTRACT
Understanding the business framework in the Internet of Things and Services (IoTS) ecosystem is an essential prerequisite for the successful deployment and exploitation of new services and applications. IoTS infrastructures are often focused on software developers, researchers and technologists, but successful deployment of real-life applications depends on the ability to demonstrate business potential, i.e. realistic and sustainable business cases in selected domains.

The present paper aims at describing a theoretical and practical foundation for performing business modelling of complex, multi-stakeholder oriented eBusiness services based on IoTS enablers, such as Hydra middleware components. The main focus of the paper will be on modelling business performance in IoTS applications involving product companies and on how to derive new and innovative value propositions from emerging service concepts.

Categories and Subject Descriptors
K.6.1 [**Management of computing and information systems**]: Project and People Management – *strategic information systems planning, systems analysis and design, systems development*

General Terms
Your general terms must be any of the following 16 designated terms: Management, Design, Economics.

Keywords
Business models, value models, process models, eBusiness, sustainability.

1. INTRODUCTION
The EU research project Hydra is developing a middleware for creating Networked Embedded Systems, where heterogeneous devices co-operate to achieve a given goal [1]. The Hydra middleware allows developers to incorporate heterogeneous physical devices into their applications by offering easy-to-use web service interfaces for controlling any type of physical device irrespective of its network technology such as Bluetooth, RF, ZigBee, RFID, WiFi, etc.

Hydra incorporates means for Device and Service Discovery, Semantic Model Driven Architecture, P2P communication, and Diagnostics. Hydra enabled devices and services can be secure and trustworthy through distributed security and social trust components of the middleware.

The Hydra SDK (Software Development Kit) will be used by developers to develop innovative Model-Driven applications with embedded IoTS interoperability using the Hydra middleware.

Furthermore a Device Development Kit (DDK) will be provided that enables device manufacturers to produce IoTS-enabled devices.

2. IOTS AND PRODUCT COMPANIES
IoTS technologies will bring huge business opportunities for manufacturers of industrial products. Everything from a pump, a building door, an industrial machine, and an office's thermostat will have the potential to be networked thus creating a huge network of interconnected devices.

Product companies traditionally have expanded their business monolithically from the core manufacturing to various degrees of integrated maintenance concepts. Offerings typically include logistics support for customers, installation and commissioning of products and various degrees of maintenance services. All of these offerings are closely related to the firms' own products and do not substantially increase the business risks; neither do they add significant value to the business processes over and above maintaining a competitive position in the market [2].

Product companies can use device networking technologies to reduce costs, reduce installation time, improve effectiveness, neutralise learning differences, bridge knowledge gaps, gain more customers, and pursue new business opportunities. Product companies can also position their IoTS enabled devices into a customer service relationship that enhances both revenues and customer retention.

In the last couple of decades, product companies have already added numerous new services to their business systems, such as supply chain management, service management and service level management, etc. These services often introduce additional economic benefits into the value creation calculus, such as customer loyalty and customer retention, and lead to yet new models such as customer asset management and customer asset management of services, etc. Common for most of those business models is the increased complexity and hence the risk of loosing the necessary metrics for value computation, validation and evolution. Moreover, the business models tend to be relatively static.

Product companies will soon realise that in the new world of IoTS, device networking is not only possible, it is essential for their future business. In a market where customers continuously ask for more complex and integrated services, it is anticipated that IoTS applications and intelligent services can help reduce the risk that arises when product companies move from well known physical products to global services with increased management responsibility.

Hence, with the introduction of IoTS offerings, completely new business models are needed to identify and explain the much more dynamic value creation and to model the exchange of products, services, information and resulting values among dynamically emerging constellations of multiple stakeholders across the business system. The ability to correctly identify the value creation and the involved actors often means the difference between success and failure of a new IoTS offering.

3. BUSINESS MODELS

The notion of "business models" has increasingly been used in recent years to describe the utterly complex environment in which firms and organisations are operating; having to deal with new disruptive technologies, such as IoTS, and rapidly changing demand patterns. In this environment, firms must constantly move and re-position themselves. In order to do so in a structured way, they use so called "business models" to help them make the right choices.

In Hydra, we prefer to see business models as an artefact, which aggregates the value a firm offers to one or several segments of customers, and the architecture of the firm and its network of partners for creating, marketing and delivering this value, in order to generate profitable and sustainable revenue streams for all actors.

A firm with a strong business model has a much better foundation for understanding the challenges and communicating and sharing the understanding among stakeholders. The process of modelling social ontologies helps identifying the relevant elements in a domain and the relationships between them. Mapping and using business models facilitate change, because designers can easily modify certain elements of an existing model and simulate new businesses. This is a way of doing risk free experiments, without endangering an organisation. A business model is thus an abstraction of a company's entrepreneurial activity.

The basic questions to be answered in the business model are the fundamental questions of any business: What do we offer to the customer, who are they and how do we operate to deliver the product or service so that we can create a profitable and sustainable business? [3]. In other words, we need to identify and analyse the value proposition in the intended IoTS e-Business service, to which customer group the service is targeted and how we organise ourselves to deliver the service in the most efficient way. As we shall argue later, the order of which these three steps are performed have a great impact on the choice of modelling approach to be taken.

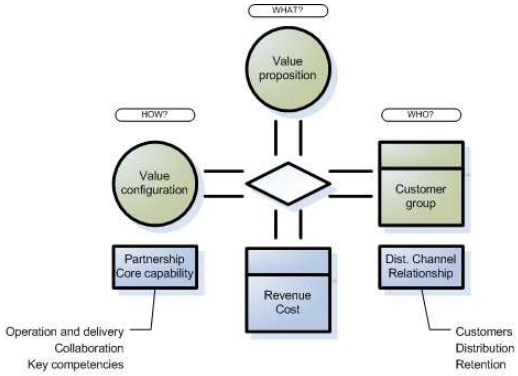

Figure 1 Fundamental elements of a business model [3]

When the three questions have been answered, we can easily instantiate the model into a preferred Business Case, analyse the revenue streams and cost models, derive the financial returns and thus evaluate the sustainability of the proposed IoTS eBusiness.

3.1 Business Modelling Approaches

The business model can take two very different model approaches: The value model and the process model.

As the name indicates, value modelling focuses on value creation; how value is created, by whom and for whom. It is thus foremost a strategic tool with the aim of identifying new business opportunities and how the firm can position itself strategically to derive maximum benefits from new and emerging opportunities, which may or may not require substantial redefinition of the enterprise infrastructure.

Process modelling is in many ways different from value modelling. Process modelling refers to business procedures of the same nature that are classified together into a model. One possible use of a process model is to prescribe how things must/should/could be done in contrast to the process itself, which is really what happens. The process models are thus best suited to provide architectural overview in the implementation of business strategies in established infrastructures.

In this paper we will confine ourselves to working with value modelling as the point of entry to developing business cases for innovative IoTS services such as those which can be developed on the Hydra middleware platform.

3.2 Value Models

It follows from the basic human character that a sustainable business can only be built if its transactions are creating true, lasting values. If there is no added value for the stakeholders, the business will eventually disappear. The purpose of the value model is to describe who exchanges objects of value with whom. The value model predicts to which extent actors are profitable, and whether actors are willing to exchange objects of value with each other. Finally, value modelling uses decomposition of value activities as a way to discover new profitable activities, where decomposition of activities in process modelling serves the goal of clarity or of studying various resource allocations (e.g. operational actors) to activities.

The e^{3}value methodology was chosen in Hydra as the method and tool to create value models. The e^{3}value method was developed by

Jaap Gordijn at the Vrije Universiteit Amsterdam [4]. The methodology is being used successfully in Hydra to demonstrate the actors involved in IoTS scenarios and the objects of economic value created, exchanged, and consumed by these actors. It also shows the objects of value, which actors expect in return for an object of value delivered, or the mechanism of economic reciprocity. Further it shows objects, which are offered or requested in bundles and phenomena that cause exchanges of objects between actors.

Constructing one or more value models, creating profitability sheets and calculating profitability numbers takes too much time if it is to be done manually and limits the number of model iterations one can do in a given time frame. Hence, for the modelling work in Hydra, we are building value models; analysing business cases and presenting them using the graphical e^{3}value software tool developed by the team at VU Amsterdam [5].

The e^{3}value method uses a notion of economic value and illustrates how actors create, exchange, and consume objects of economic value. The method focuses on creation, distribution, and consumption of economic value objects. The e^{3}value ontology is organized in sub viewpoints each discussing related requirement types. The global actor viewpoint shows the actors involved and the objects of economic value created, exchanged, and consumed by these actors. It also shows the objects of value, which actors expect in return for an object of value delivered, or the mechanism of economic reciprocity.

The figure below shows the basic constructs used in the e^{3}value model.

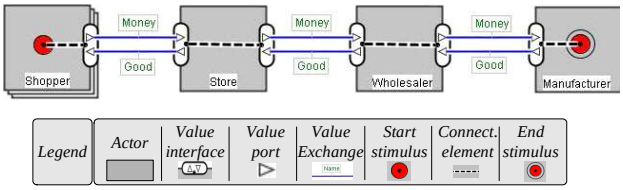

Figure 2 constructs of the e^{3}value model [5]

The value actor "Shopper" exchanges value objects with the value actor "Store". In exchange for goods, the shopper pays money to the store. Both money and goods are value objects, since each of the actors puts a real value on the object. This reasoning can be extended to the entire value chain.

The e^{3}value tool allows for simulation of the economic results from the value exchanges, i.e. calculation in excel sheets of all the impacts arising from the exchange of the value object "Money".

The calculations show the cash flow in and out of actors and can be used for estimating the economic profitability for each actor. The scenario used for the simulation of activities is represented with the dotted line in Figure 2. The start stimulus for the scenario is the shopper's need to buy goods. The stimulus triggers a series of simultaneously value exchanges along the entire value chain.

4. EXAMPLES OF BUSINESS MODELLING OF IOTS OPPORTUNITIES

To demonstrate the value modelling method used in Hydra, the following case has been developed from the Building Automation domain; one of three domains in Hydra.

Industrial services have traditionally been considered as "necessary add-ons" to the physical product: they have been centred on custom-design only in an initial phase, and around the simple provision of spare parts in a second phase. This has changed significantly in the last decades: as Monitor [6] underlines, there is a dramatic shift from "engineering and manufacturing companies" to "performance providers". Services have become powerful instruments to retain customers and to generate new revenues for product companies.

Ajax Manufacturing Ltd.[1] is a manufacturer of components for building automation such as coolers, compressors, valves, etc. Their traditional customers are building construction firms, design firms, and engineering firms. Ajax enjoys a solid market position with a very high market penetration in many countries. Ajax is considering introducing IoTS technology and concepts in their product base, and a business model has been developed comprising customers, owners, and users of Ajax components for cooling and HVAC applications.

The first extension to the present Ajax service business case involves the introduction of a new remote monitoring service: the "Remote Access" value object. Customers, Facility Managers, and building owners with service contracts will be able to access the installation remotely and perform asset monitoring and control. They will be able to monitor early indications of breakdowns and thus reduce risk of down-time. They can also perform compliance monitoring and store the information for documentation to public authorities. The value object is closely related to the service contract itself and enhances customer loyalty and retention.

By using decomposition, one can derive two new value activities. One value activity is concerned with the offering of service contracts. Another value activity is concerned with internal support for the field service technicians. Due to increased complexity of the installations, there is a strong need for service staff training. Not only the cost of education, but also the costs of supporting the service technicians during installation and commissioning and during actual service work are high. Having established remote accessibility to all installations, "Remote Access" can now be used for improving the value activity of "Installation and service support" leading to a substantial saving on service support costs.

Finally, since the "Remote Access" value object is already being requested by all of the present actors, the possibility of introducing new actors with a similar value proposition is considered. The "Remote Access" object can be used for transmission of high accuracy temporal data about energy supply and consumption. Hence, the Ajax installation can become a component in the "Smart Grid" information network for energy distribution. Information becomes a commodity and Ajax has a new value object, which is of interest to a completely new actor in the scenario: A utility company.

Having developed the business scenario described above, the e^{3}value tool provides the flexibility and it is easy to perform several iterations and present the results, both in terms of economic value and in terms of visualisation of the business ecosystem. The value objects are clearly described and the

[1] At the request of the company, the real name has been disguised.

interactions among actors are defined, and the Ajax business case is now finished as shown in Figure 3 below.

By having remote access to their products, Ajax can begin to change the nature of their business. They will increasingly engage as information brokers and service providers based on their IoTS enabled products. They can start offering a range of new services such as assisted installation and commissioning, remote diagnostics, repair and maintenance, energy management, asset optimisation, and information management. In this hypothetical market, Ajax Manufacturing undertakes three profitable value activities: Contract service, installation and service support, and remote metering.

The number of new installations and replacements annually amounts to 6,000, of which 1,200 customers have opted for a service agreement with annual service calls and free spare parts [7]. In this hypothetical market, all actors are profitable and the IoTS eBusiness concept is thus sustainable.

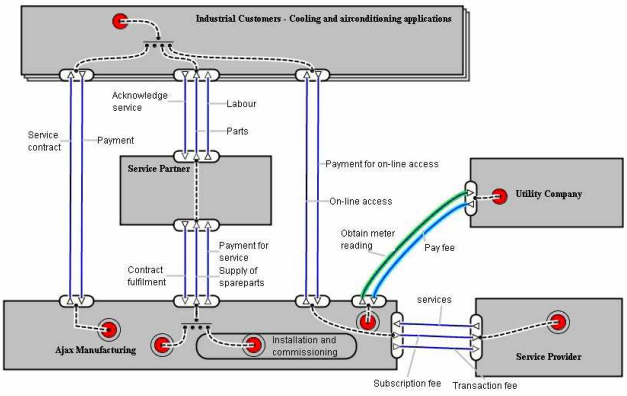

Figure 3 Ajax extended business case (Hydra, 2008)

5. CONCLUSION

Our work has shown the importance of applying a value based approach to business modelling of emerging IoTS services. We have demonstrated that a formal value modelling ontology, such as the e^{3}value method, is useful and that it provides an excellent understanding of the IoTS ecosystem in itself, the value creation process, and the exchange of value objects between actors. It also provides a tool for de-composing and re-composing value activities in order to develop a new, innovative business model.

In our work, we have focused on industrial services in product companies and we have demonstrated how a sustainable business model can be developed and how the value analysis can be used to identify new value objects to be considered by the existing actors (such as cost savings).

We have also shown how the emergence of new value objects can bring entirely new actors into the business system for improved performance and sustainability of the business model.

The models we have investigated in this paper have been of moderate complexity, but we have been using the same methodology of value analysis in the agricultural sector and the more complex healthcare sector, which is characterised by many more actors, including actors that operate on a non-profit basis.

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