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Collaborative Business Services Provision

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Abstract: The association of services to manufactured products, leading to service-enhanced products, is an important mechanism for value creation and differentiation. This is particularly relevant in the case of complex, highly customized and long-life products. Suitable servicing in this context typically requires the collaboration among multiple stakeholders. Furthermore, the involvement of the customer is not limited to service consumption but rather includes contributions to new services design and configuration. As such, this paper contributes to the clarification of concepts and definition of a framework for collaborative business services design (co-creation) and delivery. Application examples are illustrated for the solar energy sector.

1 INTRODUCTION

Collaboration and co-innovation in business services open new perspectives of value creation in manufacturing. The notion of service-enhanced product (also known as product-service) and the associated idea of service-enhanced manufacturing represent a growing trend, particularly in the context of complex products. The motivation is that buyers of manufactured products increasingly want more than the physical product itself, they might want finance options to buy it, insurance to protect it, expertise to install it, support to maintain it fully operational during its life cycle, advice on how to maximize returns from it, expertise to manage it, etc. (Shen, 2010). A product-service can be thought of as a market proposition that extends the traditional functionality of a product by incorporating additional business services, especially in global markets.

Service-enhancement of products is closely related to product differentiation. In many industries it is difficult to differentiate manufactured products and thus the profit margins tend to narrow (Bitner, Brown, 2006). By associating services that add value to the products, greater forms of differentiation can be achieved and new business opportunities generated. For instance, in the case of the solar energy plants, which have a long life-cycle, there are interesting opportunities to introduce new services and particularly new forms of service delivery through collaboration. But similar motivation can be found in many other sectors.

The service sector is traditionally defined as whatever is not agriculture or manufacturing. During the last century there has been a large shift of jobs, first from agriculture to manufacture, and in the last decades from manufacturing to services. The most advanced economies are dominated by the services sector, which accounts to more than 70% of the GDP (Ostrom et al., 2010). This is clearly the reality in the case of the USA and most European countries. But this trend can also be observed in countries that have been traditionally more oriented to manufacturing, such as the case of China which is experiencing a rapid growth of the service sector.

Current discussions around the ongoing economic crisis might lead to some level of refocusing on manufacturing and even agriculture, as reflected in some calls for re-industrialization of Europe. Certainly one should draw lessons from the economic downturn and appreciate it as an opportunity for the emergence of new business models towards sustainable value creation. Therefore, the discussion should not be one vs. the other but rather taking advantage of both - combining services with manufactured products (including agribusiness products) to enhance and add value to those products. This calls for collaboration and **involvement of customers and**

local suppliers in target markets. In fact, the notion of *glocal enterprise* represents the idea of thinking and acting globally, while being aware and responding adequately to local specificities.

One of the characteristics of our economy today is that enterprises increasingly need to compete while also collaborate in a global market, using the Internet and other technical means to overcome the traditional barrier of geographical distribution. Internet and cloud computing not only facilitate the development of new collaborative processes, but also allow for new ways of (remotely) delivering services associated to products.

Another characteristic is the continuous and rapid change and innovation, which may be internal or external to individual enterprises (open innovation and **co-innovation**), but anyway affecting how these enterprises can perform in relation to other enterprises and their market environment (Romero, Molina, 2011). The success of an enterprise, therefore, more and more depends on its ability to seamlessly interoperate with other agile enterprises, and be able to adapt to actual or imminent changes and adjust to local specificities, next to other core competence in making some product or providing a service in the most efficient and sustainable way.

In terms of research on services and service-orientation, earlier periods were characterized by intense but separate activity in different communities, such as the *wave* of works on services marketing in the 1970s and 1980s, promoted by the business schools, or the more recent overwhelming developments in the ICT sector around the web services technologies. Nowadays there is a growing consensus on the need to adopt a multi-disciplinary perspective, as advocated by the efforts to establish *services science* as a new scientific field (Chesbrough, Spohrer, 2006).

In this context, this paper aims at contributing to the clarification of concepts associated to service-enhanced products and their technological support, with particular emphasis on composite services collaboratively provided by various stakeholders.

2 GLONET PROJECT

GloNet is a European collaborative project, funded under the ICT-Factories of the Future program, which aims at designing, developing, and deploying an agile virtual enterprise environment for networks of SMEs involved in highly customized and service-enhanced products through end-to-end collaboration with customers and local suppliers (co-creation) (Camarinha-Matos et al., 2011). The notion of *glocal* enterprise is adopted in GloNet through value creation from global networked operations and involving global supply chain management, product-service linkage, and management of distributed production units.

Further to service-based enhancement, GloNet also considers the growing trend in manufacturing to move towards highly customized products, ultimately one-of-a-kind, which is reflected in the term *mass customization*. In fact, mass customization refers to a customer co-design process of products and services which meet the needs/choices of each individual customer with regard to the variety of different product features. Important challenges in such manufacturing contexts can be elicited from the requirements of complex technical infrastructures, solar energy parks, intelligent buildings, etc.

The guiding use case in GloNet is the life cycle support of photovoltaic **solar energy parks**. The norm of operation in this industry is that of one-of-a-kind production. The involved systems and services are typically delivered through complementary competences shared between different project participants. A particularly important challenge here is the design and delivery of multi-stakeholder complex services along the product life cycle, which typically spans over 20 years.

Focused issues in this context include: (i) Information / knowledge representation (product catalogue, processes descriptions, best practices, company profiles, brochures, etc.); (ii) User-customized interfaces, dynamically adjusted to assist different stakeholders (smart enterprise approach); (iii) Services provision through cloud; (iv) Broker-customer interaction support: from order to (product/service) design (open innovation approach); (v) Negotiation support; (vi) Workflow for negotiated order solution & its monitoring; and (vii) Risks management support.

In addition to the mentioned use case, and in order to achieve further generalization and thus increase the application potential of the proposed solutions, GloNet requirements are also checked against the needs of other relevant use cases with similar abstract characteristics. As such, and taking into account the competencies and interests of the industrial partners in the consortium, the following additional use cases are analysed: Intelligent buildings use case; and Physical incubator facilities use case.

The project started in Sep 2011 with a planned duration of 3 years, and involves the following partners: CAS (Germany), UNINOVA (Portugal), University of Amsterdam (Netherlands), iPLON (Germany), SKILL (Spain), Steinbeis (Germany), KOMIX (Czech Republic), and PROLON (Denmark).

3 BUSINESS SERVICES

In spite of recent efforts, as represented by the Services Science *movement* (Chesbrough, Spohrer, 2006), (Bitner, Brown, 2006), (Spohrer, Maglio, 2009), the notion of *service* remains ambiguous. Two main literature streams - management and computer science - among others, have proposed a number of definitions that often represent a partial perspective of the concept. The ICT developments tend to consider services as some form of "black boxes" that perform some action, being more focused on data, control flow, and interoperability aspects. Other streams look at services from a business perspective, tending to see a service in terms of the added value that is delivered to a customer and the conditions of delivery. Under this perspective, issues such as quality of service (QoS), service level agreement (SLA), terms and conditions, period of availability, interactions with customer, etc., become the focus of attention.

A few recent works have tried to bridge the gap between these two notions of service (Ferrario, Guarino, 2009), (Cardoso, Camarinha-Matos, 2011). Similarly, an ongoing initiative to establish a *Unified Service Description Language* (USDL) (Oberle et al., 2013) makes an attempt to merge various perspectives of service. Although clearly in line with the "*ICT school*", namely regarding the developments in Service-Oriented Architectures, Web Services and Semantic Web Services, USDL tries to also embed aspects of business services, service networks and service provision systems.

In our opinion, it makes sense to separate two concepts - *business service* and *software* or *technical service*. Although they can be interrelated, as discussed below, they basically correspond to different views or perspectives that need to be clarified. In GloNet we are particularly interested in business services that add value to the physical product, i.e. that add value to the power plant during its operation (along its 20-year life cycle). Table 1 illustrates typical business services in the operation and maintenance of solar power plants.

Because a business service typically involves some flows of activities and interactions with the customer, often the terms of business service and business process appear (confusingly) intermixed, although they correspond to different concepts.

What is a **business service**? An earlier definition by Ted Hill (1977) states: *"A (business) service is a change in the condition of a person, or a good belonging to some economic entity, brought about as the result of the activity of some other economic entity, with the approval of the first person or economic entity"*. Also according to Hill, (business) services and goods (or physical products) are of different ontological categories: while goods are both *transactable* and *transferable*, services are transactable, but not transferable. A number of characteristics can be further identified to distinguish between (business) services and (physical) products (Engelmann, 2008), (Chesbrough, Spohrer, 2006), (Sanz et al., 2007):

- Services are intangible;
- Services are interactive, with a high level of customer interaction during the process of service production, delivery and consumption;
- Simultaneity of production (execution) and consumption;
- Services are bound to a particular time (when they are available and delivered) and place (where they are delivered).

It is important to distinguish between service providing, service availability and service delivery. Service providing is about the introduction of a service by its provider within the community of its potential customers. This happens for instance through advertising a service in the market, or in the case of the GloNet environment, through the introduction/registration of the service within the collaborative enterprise network. About the service availability and delivery, consider that a customer may keep paying for a corrective maintenance service (thus guaranteeing the availability of the service), while the service might never be delivered if no malfunctioning is ever detected.

Another definition of business service (Ferrario, Guarino, 2009) puts the focus on the notions of availability and delivery of the service: "*A (business) service is present at a time T and location L iff, at time T, an agent is explicitly committed to guarantee the execution of some type of action at location L, on the occurrence of a certain triggering event, in the interest of another agent and upon prior agreement, in a certain way*". This definition brings about a number of interesting aspects:

- Then notion of *commitment* through which an entity guarantees the execution of some kind of action(s) in the interest of the customer. This notion comes in line with another definition by O'Sullivan (2006): "*A service instance is essentially a promise by one party (the provider) to perform a function on behalf of another party at some time and place and through some channel*".

- *Commitment* and *availability* are different notions. For instance, in the case of malfunctioning periods (of the service provision system) or working pauses, the commitment still holds but the service is not available (temporarily). Specific constraints regarding availability can be defined in the *agreement* (service level agreement) or contract.
- The commitment by an agent to guarantee a service does not necessarily imply that the service is performed by this agent; it can be delegated on other entities, although the responsibility toward the customer remains with the agent that made the "promise".
- A service delivery implies a delivery *location* where the actions take place or the added value is provided. In the case of the solar plants, the effects of several services take place at the actual location of the power plant, although they might be performed remotely (through an ICT channel).
- The actual delivery of the service, i.e. the execution of the associated action(s), is initiated by a *triggering event*. For instance, in the case of a reactive maintenance service, the triggering event can be the detection of a malfunctioning alarm. In case of a preventive maintenance service, the triggering event can be the scheduled time for the periodic maintenance.
- The expression "*execution of some type of action … in a certain way*" implies a *process*. When the service is quite *standardized*, its execution may well be represented by a **business process**. In some cases, the service might be performed through alternative business processes, depending on the triggering event (Figure 1).

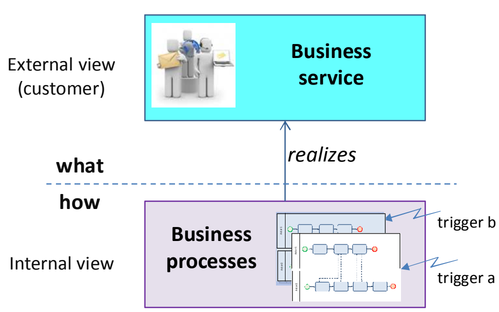

Figure 1: Views of business service

In this sense, we can see the notion of business service as an abstract construct that basically encapsulates the external or customer's view. This "construct" specifies what (value) and under what conditions it would be delivered.

Internal to some "service performance system" we can see the service as materialized by some business sub-processes. In other words, the business (sub)processes (and associated triggering events) represent how the service is performed (its interaction behavioral part).

In the case of less structured services in which the actual set of actions to be performed and their flow strongly depend on the interactions with the customer (during service delivery), it might be difficult to model the interaction behavior of the service through well-defined processes in advance, and thus the processes are dynamically configured "on the fly" during the execution. In this case it is probably more adequate to specify the interaction behavior in terms of a *set of rules*.

The performance of the actions involved in the business service delivery can be done automatically or manually. The automatic solutions can be materialized through the invocation of some *software services*. Manual tasks are human-executed activities ("human tasks").

Service delivery is subject to a number of *conditions* agreed between the provider and the customer which are typically formalized in a *contract* / agreement and govern the responsibilities of all involved parties.

Since a provider might offer more than one service, it might be convenient to introduce the concept of **service entity** – an *encapsulation* of the various services provided by the same entity; in other words, a representation of a service provider (Franco et al., 2009), (Cardoso, Camarinha-Matos, 2011).

Service design. In traditional manufacturing, design has been mainly concerned with the physical product itself, not with services. Given the growing importance of the service sector, a new stream of research emerged mainly in the last decade to provide effective approaches and tools for service design. Given the strong interactions between customer and service providers, service design focuses primarily on: (i) identifying user interactions or "touchpoints"; (ii) designing interfaces and methods to capture the perceived customer experiences; and (iii) service provision management.

Table 1: Examples of business services in the Photovoltaic Plants Operations and Maintenance area

Service Category	Business Service	Brief description	Typical frequency	Form of provision
Operation monitoring *Collecting and processing real-time data on the plant, combined with control operation*	***Energy monitoring services***	*Based on real-time data, allowing to know the energy production in real time, to compare it with expectations, find any issues with equipment, and predict the power generated with increased certainty.*	Continuous	Mostly automated
	Monitoring reports	*Generating a set of relevant reports required for different stakeholders (owner, utility company, insurance company, financial institution, etc.)*	Monthly	Mostly automated
	System performance testing	*To understand plant performance, what drives it, and provide performance testing, benchmarks, power quality analysis, etc.*		Mostly automated
	Site security services	*To detect and to some extent prevent intruders and potential vandalism actions.*	Continuous	Automated and/or manual
	Data analytics services	*Specialized services to analyse historic data (through data mining) and find methods for enhanced diagnostics, troubleshooting and operation.*	As needed	Mostly automated
Preventive Maintenance *Routine inspection and servicing of equipment and plant site to prevent breakdowns and production losses*	***Panel Cleaning***	*It affects panel's performance. However it highly depends on site conditions – amount of dust, pollen and pollution, frequency of rain and snow, etc.*	1-2x Times/Year (depends on local conditions)	Mostly manual, with some automatic checks
	Vegetation Management	*Less critical than panel cleaning, it involves cutting grass, bushes, etc., as they might also affect the operation of the equipment, depending on local conditions such as the amount of rain.*	1-3 Times/Year (depends on local conditions)	Mostly manual, with some automatic checks
	Wildlife Prevention	*The development of colonies of wildlife (rats, rabbits, bird nests, etc.) might destroy some equipment. Preventive actions depend on local conditions.*	Variable (depends on local conditions)	Mostly manual
	Water Drainage	*To ensure proper drainage of water that results from raining or snow melting. It depends on local meteorological conditions and land structure.*	Variable (depends on local conditions)	Mostly manual
	Retro-Commissioning	*A process for identifying less-than-optimal performance in the facility's equipment, and control systems and making the necessary adjustments (replace outdated equipment, or improve efficiency).*	1 Time/Year	Mostly manual, with some automatic checks
	Upkeep of Data Acquisition and Monitoring Systems	*Maintenance of the sensor network / data collection and communication subsystem.*	Undetermined	Mostly manual, with some automatic checks
	Upkeep of Power Generation System	*Periodic maintenance and provision of proofs of any measures taken are needed periodically, not only to ensure proper operation, but also to comply with regulations and requirements from the utility company.* It involves e.g., Inverter Servicing, BOS Inspection, Tracker Maintenance.	1-2x Times/Year	Mostly manual, with some automatic checks
Corrective / Reactive Maintenance *In response to equipment breakdown to mitigate unplanned downtime*	***On-Site Monitoring / Mitigation***	*Implementation of on-site mitigation measures in response to detected weaknesses (e.g. regarding safety and security standards, unforeseen working conditions)*	Variable	Mostly manual, combined with automatic tests
	Critical Reactive Repair	*When a fault / equipment breakdown is detected in a critical component (e.g. inverter, AC sub-systems).*	As Needed (High Priority)	Mostly manual, combined with automatic tests
	Non-Critical Reactive Repair	*When a fault / equipment breakdown is detected in a no-critical component (e.g. weather related sensor).*	As Needed	Mostly manual, combined with automatic tests
	Warranty Enforcement	*Since different components have different warranty coverage conditions, with different penalties associated to the levels of criticality, it is important to properly manage them in association to breakdowns.*	As Needed	Mix automatic - manual
Condition-Based Maintenance *Prioritize and optimize maintenance and resources based on real-time data for increased efficiency*	***Active Monitoring - Remote and On-Site Options***	*Monitoring service allowing to shifts the maintenance process from 'preventive' to 'predictive' model. It involves continuous monitoring and diagnosis of the equipment health / condition, to ensure zero downtime due to equipment failures.*	Continuous	Mostly automatic, with option. manual
	Warranty Enforcement	*Management of warranty contracts enforcement based on collected real-time data.*	As Needed	Mostly automatic, with option. manual
	Equipment Replacement	*Different equipment and components have different life-cycles, requiring replacement along the (long) life cycle of the PV plant.*	As Needed	Mostly manual, with some automatic checks
Other Support *Additional services*	***Training services***	*Average industrial technicians are familiar with AC, but often less acquainted with DC power and other specificities of PV plants. Also personnel involved in other services, e.g. panel cleaning, vegetation management, need to be trained on safety protocols. Thus, several levels of training services are foreseen.*	As needed	In classroom or remotely via e-learning
	Energy audit services	*Establish pattern of energy use and production; identify losses; and suggest appropriate economically viable engineering solutions to enhance energy efficiency.*	As needed	Mix automatic - manual

4 COLLABORATIVE SERVICE PROVISION

Business services can be combined together. A **composite business service** is a collection of related and (to some extent) integrated business services that provide a specific business solution. A lesser definition may consider it as a grouping of related, simpler business services.

Figure 2 illustrates one example of a composite business service. In the case of the solar power plants, a customer might be interested in an integrated *site maintenance service* which is, in fact, a grouping or composition of various simpler services - site security service, wildlife prevention service, vegetation management service, and water drainage service.

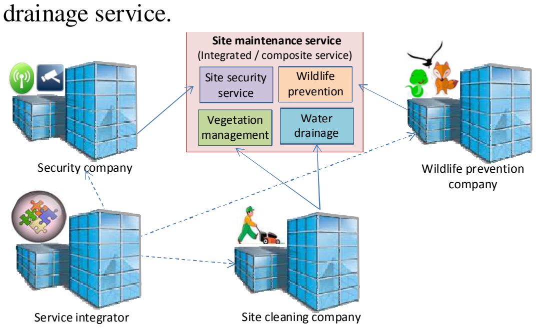

Figure 2: Example of composite, multi-stakeholder service

The various simpler services that compose an integrated service might be provided by different companies, as also illustrated in Figure 2.

Besides the stakeholders directly involved in the provision of the simpler services, this example also shows the role of a new stakeholder - the ***service integrator*** - that coordinates the other ones and possibly offers a unique contact point to the customer. The customer would typically establish a single contract with the service integrator and not separate contracts with the other providers.

This group of entities together forms a ***virtual organization*** (VO) for the provision of this composite service, where the service integrator plays the role of virtual organization coordinator. This organizational structure and the role of business service integrator open new business opportunities for SMEs.

In the case of PV energy sector, although a few large companies are able to offer a large number of the services shown in Table 1 (EPRI, 2010), most SMEs active in this domain are focused on the provision of just a small subset. This situation limits their capabilities, namely their participation in other geographical markets. Also from the customer perspective, the resulting fragmentation of services is not a desirable situation. A single contract / single interface for a package of services would be preferable.

However, it is also necessary to avoid typical problems with extensive *sub-contracting / outsourcing* practices. Some large corporations have extensively outsourced the provision of their services. However, there is no real collaboration among the involved sub-contracted entities, and whenever there is a need that spans across two or more areas the lack of seamless integration becomes obvious. The customer then clearly notices the "walls" between providers and a situation where there is no clear responsibility, with each one transferring the responsibilities to the others. Furthermore, the lack of proper platforms often leads to problems of synchronization among the various providers, which again reflects in a bad quality of the service provided to the customer.

To avoid such risks, rather than a sub-contracting model, it is necessary to implement a real collaborative network, supported by an environment such as GloNet. Further to the need of mere workflow coordination, typically performed by the service integrator, it is necessary to have a collaboration space where the various entities can share information and resources, and thus contributing to the building of a sense of co-responsibility. Complementarily, proper involvement of local suppliers, close to the customer location, can increase the sense of proximity.

Often the customer is a ***co-creator*** of its needed services, closely involved in defining, shaping, and packaging the service. It is important to notice that in the case of products with a long life cycle, these interactions are built around long-term relationships.

Furthermore, although ICT facilitates remote delivery of some services or service components, other parts require local intervention.

For instance, in the case of the PV energy plants, a service like "Energy production monitoring" can be delivered remotely. Through a network of sensors and data loggers installed in the plant and some communication channels, it is possible to collect real-time data on Internet (a kind of Internet of Things). However, a service like "Water drainage" will require local (manual) intervention. Other services might combine remote and local operation. For instance, a "Panel cleaning" service might involve some remote actions (e.g. detection of a production performance level lower than expected), a local (manual) activity (the actual cleaning) and possibly another remote action to verify the end result.

In order to give the customer a feeling of *proximity*, and thus a better service *experience*, it is important to involve local suppliers in some components of the service delivery. The services science community uses the term *service experience* "*to encompass all aspects of the production, delivery, and creation of value from the customer's perspective*" (Ostrom et al., 2010).

To address the questions above and improve collaboration and proximity, GloNet contributes with a number of elements:

- Mix of collaborative networks. GloNet assumes two base *communities* out of which members will be selected to compose the VO in charge of the service provisioning: The long-term manufacturers' network and the informal community of local stakeholders around the customer (Figure 3). The service integrator will typically be selected from the manufacturers' network.

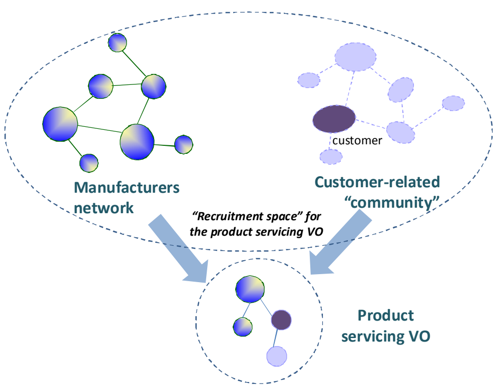

Figure 3: Recruitment of members for the product servicing VO

- Co-creation business scenario. One of the relevant business scenarios identified in GloNet is aimed at providing an environment that supports and promotes the collaborative design of new business services. It foresees a collaboration environment that helps providing business services based on innovation, knowledge and customer orientation, as well as identifying future needs, through collaboration between manufacturers and the customer and members of the customer's community (open innovation approach). Figure 4 shows the i* Strategic Rational model for this scenario.

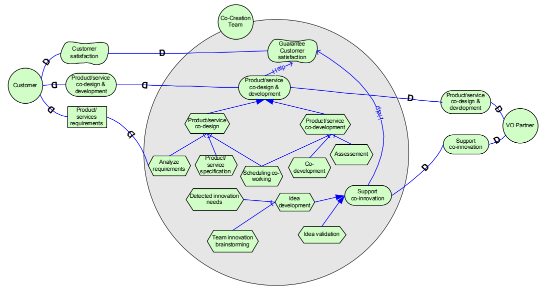

Figure 4: Strategic Rationale i* Model for Co-creation

- Collaboration spaces. The notion of "collaboration space", introduces a sharing space where effective collaboration among the multiple stakeholders involved in the service creation and provision can take place (details in section 6).

Clearly the approach adopted in GloNet does not follow the traditional company-centric CRM model, but rather a collaborative network/ecosystem model, which is more promising in terms of sustainability and better contributes to the quality of service (in comparison with outsourcing), namely in what concerns the responsibility each entity has within the service that is provided to the customer as a whole.

Naturally technology is not enough to achieve an effective collaborative approach to business services; a new culture is needed. This requires other tools such as: Better communication strategy; Team building; Training; Etc.; which are not in the core of a technology-oriented project such as GloNet. But technology is an enabler, facilitating sharing, visibility and transparency among the involved stakeholders.

5 SERVICE PACKAGING

Customers are often interested in a grouping of services, rather than an isolated service. Typically a bundle or package of services is offered for a more competitive price. Two approaches can be considered for this grouping:

- *Free grouping*. In this case the customer freely selects, from the portfolio of available services, the ones he wants to subscribe. The specific delivery conditions, service level agreement, etc., are negotiated on a case by case basis. Sometimes there are dependencies between services and then the selection of one specific service might mandatorily imply the selection of another one from which this service depends on. For instance, in the solar energy case, the subscription of the service "Monitoring reports" will probably require the service "Energy monitoring" as well, as the latter case provides the base sensorial network that is needed for real-time data acquisition.

Table 4: Illustrative example of pre-prepared business service packages in the solar energy case

Service Category	Business Service	Basic	Comfort	Premium
Operation monitoring	***Energy monitoring services***	X	X	X
	Monitoring reports	X	X	X
	System performance testing		X	X
	Site security services			X
	Data analytics services		X	X
Preventive Maintenance	***Panel Cleaning***		X	X
	Vegetation Management			X
	Wildlife Prevention			
	Water Drainage			
	Retro-Commissioning			
	Upkeep of Data Acquisition and Monitoring Systems	X	X	X
	Upkeep of Power Generation System	X	X	X
Corrective / Reactive Maintenance	***On-Site Monitoring / Mitigation***		X	X
	Critical Reactive Repair		X	X
	Non-Critical Reactive Repair			X
	Warranty Enforcement			X
Condition-Based Maintenance	***Active Monitoring - Remote and On-Site Options***			X
	Warranty Enforcement (Planned and Unplanned)			X
	Equipment Replacement (Planned and Unplanned)			X
Other Support	***Training services***			
	Energy audit services			

- *Pre-packaged options*. Under this approach, the service provider (service integrator) organizes some pre-configured packages of services, which already take into account all interdependencies and are offered under pre-defined conditions. Often these packages correspond to different levels of coverage, e.g. basic, comfort, and premium. Table 4 shows an example of packages in the solar energy case. Additional services, not included in a specific package level, would have to be negotiated with the service provider.

6 IMPLEMENTATION ISSUES

Taking into account the characteristics mentioned above, Figure 5 introduces the proposed model for business services. The UML diagram also represents the iterative definition of composed business services, through their individual or atomic services.

Table 5 gives a brief description of the elements of the business services that constitute their profiles.

Figure 6 shows a simplified diagram of the GloNet system architecture, which follows a SOA approach (MacKenzie et al, 2006) and is developed using standard blocks of a Java based technology stack, Eclipse, MySQL, Apache Tomcat, etc. The base platform, developed by CAS Software AG, uses an OSGi run-time based on the Spring framework. The system runs on top of a cloud-based IaaS.

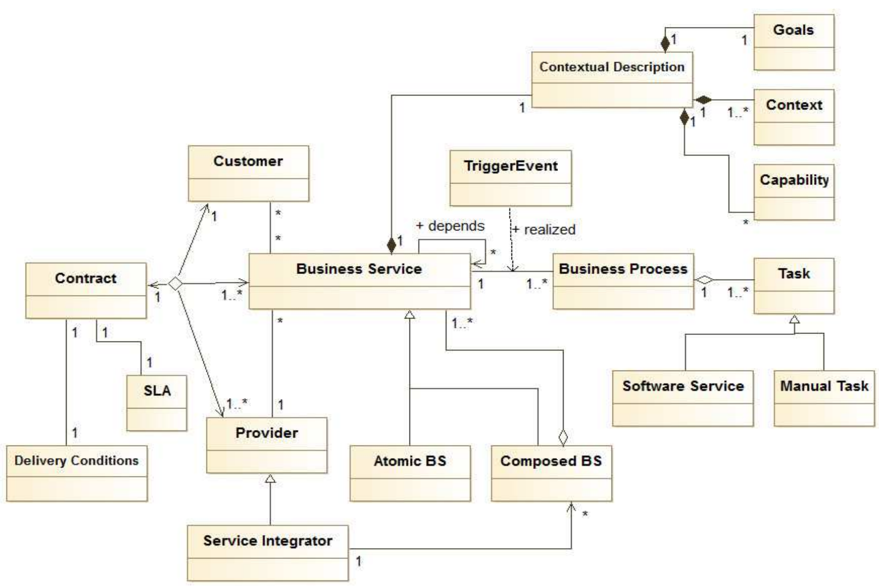

Figure 5: Simplified business service model in UML

Table 5: Brief description of the elements of business service profiles

Element	Description
Business Service	The core element in this diagram for the definition of business service profile. If the BS is composed, then its individual BSs are also properly defined. Also the 1..* depends-on relationship which is defined for business services, models the potential inter-relation between one business service and a set of other services, e.g. a dependency may exist between an Energy management business service and certain other specific Lighting and heating management business services, due to the specific input that needs to be exchanged among them.
BS Id	A unique number which identifies the business service (BS) in the registry.
BS Name	The name of the BS.
Execution duration	The duration of time to execute the BS.
Price range	The min and max price for the BS that should be paid by the customer.
Certification	Documents certifying the quality of the BS, according a particular set of standards.
Notes	Provides some essential recommendations or advises about deploying the business service.
Provider	The company that provide the BS.
Customer	Past and present customers of the BS.
Composed BS	The kind of business services which consists of several individual business services.
Atomic BS	A single business service (a service which is not registered as a composed BS).
Business Process	A process description for the business service, represented by a BPMN Diagram.
Trigger Event	Events that launch the execution of business processes implementing the business service.
Service integrator	The entity that offers an integrated or composed business service, coordinates the other involved providers, and possibly offers a unique contact point to the customer.
Contextual Descriptions	Contextual information about the business services.
Goal	Addresses the technical or strategic goals of the business service.
Strategic Goal	Specifies the business targets and benefits of the business service.
Technical Goal	Specifies the operational targets of the business service, which aim at satisfying strategic goals of the business service.
Context	Describes the business or industrial context of the business service.
Capabilities	Addresses the capabilities and capacities of the business service.
Contract	Establishes an agreement between a supplier and a customer, for the provision of one or more business services.
SL Delivery Conditions	Describes the specific conditions during the business service delivery. This element includes facets such pre-conditions, post-conditions, privacy policy, etc.
SLA	Specifies the service level agreement associated to the contracted service(s) provision.

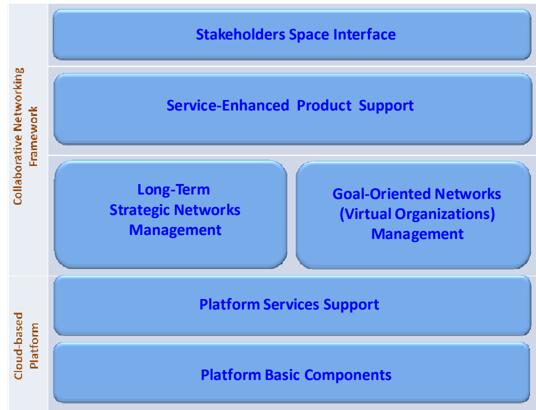

Figure 6: Main blocks of the GloNet system architecture

7 COLLABORATION SPACES

GloNet adopts the notion of collaboration space as a construct to facilitate the interaction among stakeholders involved in the achievement of some common goal. Nowadays this notion is used in both the physical and virtual worlds. In the physical world, besides the traditional characteristics of a meeting room, it means an environment that supports a group of people in working collaboratively, such as doing brainstorming or performing some tasks. It can involve novel design ideas and furniture to inspire creative thinking and provide different sensations according to the objectives of the collaborative activity. In the virtual world we try to mimic some of these aspects allowing a group of geographically disperse participants to work together, mediated by technology. In terms of the virtual collaboration spaces, various other terms are often found in the literature to represent similar notions. Examples include virtual room and virtual co-working space. There are also hybrid versions, which combine physical spaces with advanced technologies to allow both local and remote participation.

GloNet is particularly concerned with the virtual world version in order to support the members of a collaborative network, mostly composed of SMEs. Two main collaboration spaces were initially identified: Collaborative solution space and Services provision space. In terms of basic characteristics, the two spaces are quite similar, but their purpose and thus the support tools are distinct.

Collaborative solution space. This case is envisaged to support a group of stakeholders in the design and development of a new solution, e.g. initial design and development of the product, or co-creation of a new business service. Table 6 shows its main characteristics.

Table 6: Characteristics of the collaborative solution space

Meeting place	A specific user interface provides a common web access point to the participants.
- Purpose	Joint development of a product or business service.
- Participant group	The members of the VO involved in the development of a specific solution. For instance, it can be the “product development network” (the VO involved in the development of the physical product and design of initial associated business services), or the “service co-creation network” (the dynamic (temporary) VO involved in the design and development of new business services associated to the (physical) product.
Sharing space	A specific information sharing space to allow sharing specific information and knowledge assets that the participants decide to bring in, as well as those assets (e.g. product model, business process models) that they jointly create.
Support tools	Besides generic collaboration tools, the various functionalities provided in the GloNet system for Product Configuration, Service-Enhanced Product Ordering, Service Registering, etc., will be accessible through the user interface.
Privacy and security	The generic protection mechanisms of the platform are used to guarantee protection and access rights to the VO participants. Depending on the access rights of each participant, they might have access to other assets besides the ones included in the shared space.
Occupancy period	The “life” of this space is typically tied to the life cycle of the VO that uses it. Since the aim is to support the creation of a new product or service, the space is created by the starter of the corresponding VO and destroyed when the VO dissolves. Naturally, the objects created by the VO and that need to be kept will be maintained in other information spaces (e.g. product portfolio, or the private spaces of each tenant), depending on the specific asset.

One special instance of this collaboration space corresponds to the business service co-creation scenario. Creation of a new business service can be typically done through a co-creation process carried out by a temporary consortium involving a number of participants selected from the Manufacturers network and Customer “network” or Product Servicing network.

Business services provision space. This class of collaboration spaces is typically aimed at supporting the virtual organizations that will provide services to enhance the product during its life cycle. Table 7 shows its main characteristics.

Table 7: Characteristics of the services provision space

Meeting place	A specific user interface provides a common web access point to the participants.
- Purpose	To support collaboration during the delivery of (multi-stakeholder) business services along the life cycle of the product.
-Participant group	The members of the VO involved in the delivery of business services associated to a product. Typically a long-term VO organized to provide integrated (multi-stakeholder) business services along the product life-cycle.
Sharing space	A specific information sharing space is created to allow sharing specific information and knowledge assets that the participants decide to bring in (related to the service provision), and specially the product model, registry of services, and all data related to the business services provision.
Support tools	Besides generic collaboration tools, various functionalities provided in the GloNet system for Product Portfolio Support, Service Monitoring, etc., will be accessible through the user interface.
Privacy and security	The generic protection mechanisms of the platform are used to guarantee protection and access rights to the VO participants. Depending on the access rights, each participant might have access to other assets besides the ones in the shared space.
Occupancy period	This collaboration space is supposed to be available during the operation phase of the life cycle of the product, typically a long duration. It will typically be connected to the duration of the services provision contract. Similar to other collaboration spaces, this one is also created in association to the VO that uses it, i.e. the “product servicing network”.

In terms of the GloNet system, these spaces are accessible through the Stakeholders Space Interface layer (Figure 6). These spaces are naturally supported by the collaborative networks management functionalities. Other important elements include common ontologies, an essential element to facilitate collaboration (Afsarmanesh, Ermilova, 2010), (Unal, Afsarmanesh, 2009), and management of common knowledge and information assets.

To assess the validity of the proposed solution, a demonstrator is being built around the use case of solar energy parks. A solar park represents a clear example of a complex and highly customized product, which is expected to have a long life cycle of around 20~25 years. During its operation phase, the power plant needs to be supported by a number of business services. In the case of our demonstrator these services are provided by a network of stakeholders located in different continents (Europe and India), which requires bot a collaboration platform and proper organizational structures. Additional validation, but at a smaller scale, is done for the case of intelligent buildings.

8 CONCLUSIONS

The development and provision of business services to enhance products is an important business opportunity for SMEs in various economic sectors. Of special relevance is the possibility of developing composite business services that involve the collaboration of a network of stakeholders and provide integrated solutions to the customer.

In this line, the GloNet project addresses the development of a cloud-based environment aimed at supporting collaborative business services design and delivery to enhance complex and highly customized products. These processes involve the interplay of various strategic and goal-oriented collaborative networks.

Proposed models and tools are validated in the solar energy plants and intelligent buildings sectors. For this purpose, a large scale demonstrator is being implemented.

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