CUSTOMER / SUPPLIER REQUIREMENTS AND BEHAVIOUR MODELING & SIMULATION IN SERVICE DELIVERY

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ABSTRACT

Service has become over the years a very popular word discussed in the whole world. The economy is dominated by the tertiary sector of activity only one able to create new jobs because the service demand is not yet covered by the private or by the public sector. Citizens see services as a way to have access to basic or complex amenities, authorities as a way to address environmental problems and manufacturers as a way to differentiate them from the competition, to be closer to their customers and to improve the shopper experience. Services are of a huge importance in the national and international economy and are discussed in numerous domains: human service, business service, IT service, manufacturing area, etc. Several concepts related to service have merged as well as new scientific disciplines. Problematic linked to service design, service implementation, service operation management, service quality, service system simulation, product-service system design, service modeling are still under consideration and the multiplicity of the domain concerned failed to come up with unanimous answer. This paper proposes a contribution on service delivery process modeling and simulation that can potentially be used in any area. The proposed model is based on the most relevant concepts coming from a specialized literature review on services. A G-DEVS model of the service delivery process is then proposed.

Keywords: Service study, PSS, G-DEVS M&S

1. INTRODUCTION

Pragmatically, customers are currently looking for individual solutions to meet the challenge of their everyday life. They are torn between their willingness to have the ownership of physical products in a consumer economy and their new enthusiasm for a virtual economy based on use or on functionality. Products are perceived as containers of service corresponding to the product functionality. Two business models can be envisaged to address customers concerns: the first one consists in selling the product together with extra-services. The second one proposes to lease, to rent, to share or to pool the product (Tukker, 2004) and to sell the associated service.

Although the business model is different, one can conclude that from the customer point of view product and service are the two facets of a same object. Economically there exist products oriented service and use oriented services (Manzini, 2001) and besides some pure services. To summarize, everything can be considered as a service and the ability to shift from a product dominant logic to a service dominant logic is of paramount importance in the capital good industry. Service systems are a hallmark of the industrial economy.

Consequently, the management science end economics inputs have been endowed with other concepts proposed by the SSME, the IT industry, the mechanical engineering science together with academics from environmental and social science, etc. All the contributions have in common the willingness to develop models, methods and theories to support the shift. However till now, approaches are service domain centered and it is quite difficult to transpose a contribution from one domain to another one.

Our works rests on the provision of a generic model of Service Delivery allowing simulation. After a first recall on what a service is, we present the most relevant concepts from the disciplines abovementioned regarding our problematic. Then the paper initiates a possible use of modeling & simulation to characterize study and measure the capacity of entity called artifacts to receive or to deliver services. Each artifact can be alternately customer / supplier and it is associated to a service potential definition. M&S can support the understanding of this new paradigm by studying the artifacts behavioral aspects. The potential to supply a service by an artifacts and the need to receive it by another is also discussed to be quantified in order to be used in formal simulation models here G-DEVS models.

2. SERVICE LITERATURE REVIEW REGARDING SERVICE DELIVERY

The presentation of the service literature review is subjected to the limits of our work and mainly concerns the concepts related to service delivery: stakeholders, relation, activities, system dynamic, etc.

2.1. Service basic concepts

Many definition of the term exist having in common the three following elements: i.e the service provider, the service client and the service target (Spohrer, 2007).
The three main characteristics of service are:

- The co-creation of value: idea of the customer as co-producer of the value extracted from the service system and input to the service process
- Relationships: the relationship with the customer is of paramount importance and is a source of innovation and differentiation. Long-term relationships facilitate the ability to tailor the service offerings to the customers' needs
- Service provisioning: there is a provision service capacity to meet fluctuations in demands while retaining quality of service

2.2. Inputs from the SSME

The new scientific approach that merged around 2004 to study, design and implement service is the SSME (IBM, 2004). Defined as the application of science, management, and engineering disciplines, SSME proposes to build service knowledge and basic theories, to manage and optimize the process of creating value with service and to apply theory to solve practical service problems.

Among the highlighted concepts that we recall are the service dominant logic concept, the service system role-holders concept, the service mindset concept and the service system.

- Service-dominant logic (S-DL): The service-dominant logic world view, upon which service science is based, advocates that service is value co-creation interactions undertaken when service systems create, propose and realize value propositions, which may include things, actions, information and other resources. Value propositions are built on the notion of asset sharing, information sharing, work sharing (actions), risk sharing, as well as other types of sharing and exchange that can co-create value in customer- provider interactions.
- Stakeholders: also known as role-holders in service systems. Role-holders are people, or other service systems, that fill named roles in service systems. The two main roles in any service system are provider and customer.
- Service mindset: a focus on innovating customer-provider value co-creation interactions (service systems and value propositions, SSME qualified) that is combined with the interactional expertise capabilities of an adaptive innovator to enable team work across academic disciplines and business functional silos.
- Service system: is a dynamic value co-creation configuration of resources. Service systems are a type of system of systems; in which value proposition connect internal and external service systems. The smallest service system is a single person and the largest service system is the global economy.
- Service sourcing: agreed commodity definitions, identifying expected outcomes of customer needs and outcomes, determining cost drivers, defining and communicating requirements, defining supplier evaluation criteria

2.3. Inputs from the PSS community

At the same time other school of thought (mainly academics from environmental and social sciences (Baines, 2007) as well as more recently from engineering technologists) have focused on Product Service System in an environmental awareness perspectives. "Product(s) and service(s) combined in a system to deliver required user functionality in a way that reduces the impact on the environment" (Tukker, 2004). The definition extended through the years acknowledges that the concept of PSS also embraces value in use and sustainability (Goedkoop, 1999). Main contributions concern the principles, strategy, and development in PSS, service design methods and service engineering (Tomiyama, 2001). Concerning these two last point, the main value added is to consider each step of the system life cycle to ensure value delivery. Recent works concerning specifically service simulation are discussed hereafter.

2.4. Inputs from the IT industry

The service industry considers service system under the following definition: a configuration of technology and organizational networks designed to deliver services that satisfy the needs, wants or aspirations of customers. Service system includes: service provider, service customer, service environment and technical support. In the IT industry, software as a service is a widespread PSS (Bohmann, 2008).

The computer science has proposed a service-oriented architecture that rests on the combination of a process innovation with an effective-governance, a technological strategy centred on the definition and on the re-use of services. Here, a functionality is decomposed in a set of functions or of services supplied by components. A business service is a company functionality that seems to be atomic from the service consumer point of view. In this frame, a service is a connection to

3. DECISION SUPPORT TOOL BASED ON SERVICE MODELING AND SIMULATION

Based on the previous literature review, the first assumption we defend in the frame of service delivery is that each system designed and delivered can be seen as a unique complex coupled set composed of products subsets or components and services subsets or components. The second one is that everything is service which means that each product can be described through its functionalities designed to fit service needs. Based on the previous assumptions, we propose to model a service system as a set of services components.

There already exist works on service modeling and simulation (Alix, 2012). The conclusions of the bibliographical analysis are the following:

Regarding service modeling and PSS modeling: Service modeling is a recent domain, which has not yet adopted a unique common standard for developing frameworks to manage services processes. There is a lack of one specific modeling language for PSS. The specification of Service Modeling can involve different process, application and actor components, which are essential to the service execution, but heterogeneous. The specification standards are numerous. Some authors transpose to service the administrative or production workflow process sequence description. Others use the graphical definition of a Service-Oriented Modeling Framework (SOMF). An essential breach concerns the model correctness checking. The W3C proposed an XML representation of Service Modeling Language (SML) accepted as a standard in the Service modeling community but the proposed description is more Computer Science Service Modeling oriented than industrial PSS oriented.

Regarding service simulation and PSS simulation: Most of the projects performed over the previous decade discuss the dynamic behavior of the system and were driven by the goal to provide information to the designers on how to handle the system and to verify desired properties. Others studies focus on Discrete-Event System modeling of PSS. The different researches identify the variables to be followed during simulation including the price, process costs lifetime, sales frequency, lifetime, etc. None research already specifically focus on customer quantifiable level of demand and supplier capacity to answer the need and synergies between products and services or services according to our previous assumptions.

4. SERVICE MODELING METHODOLOGY

4.1. Service definition statement

A service is an interaction between a provider that has a function and a consumer who has a need. A potential difference between both allows an exchange. This potential difference is the trigger of the service.

Touzi in his thesis has considered that the supplier has a potential level higher than the consumer (Touzi, 2011). Based on these service play rules, we will define and study the trigger conditions of service and types of service. The consumer is a service user, in the definition of a service, an object that has a potential negative service is regarded as a consumer and it is called potential need. The provider is the object that renders service to another. Its service potential is positive and will be called a function.

4.2. Service potential

The service is implemented through the existence of a potential difference expressed as follows:

Pot.service(A)>Pot.service(B) // Service A/B

The particular case of a hybrid object can be distinguished as it can be both provider (in French *Fournisseur*) and consumer (in French: *Bénéficière*) (see figure 1). This leads to:

Pot.service (A)>Pot.service (B)>Pot.service(C)

Figure 1: The hybrid object, both supplier and consumer

The nature of supplier or provider is an absolute value that is not relative to other objects. This allows telling from the above equation that A is considered as a supplier because its potential is the greater one; C is lower potential which defines it as a consumer while B is a consumer or supplier under the sign of its potential.

4.3. Notion of artifact

An artifact is an object which has undergone a transformation, however simple, by human and which is distinguished from another only created by natural phenomenon. On the other hand in management and process management, the artifact is any document (rule, graphic, procedure, etc.) identified within a process.

Thus it can be defined that an artifact has a capacity to provide a service. Moreover, this ability has an only interest regarding the need to consume of another object. From this postulate, we can understand that the concept of service can be considered only as part of a couple service provider/consumer.

According to the definitions so far, a subject is able to serve or consume. Yet an artifact capable of making several services of different nature, an object can also use several different types of services. In general we consider that an object can be a consumer or supplier of a range of services.

From the analysis of the complexity of the relationship between provider and consumer, it results multiple possible relationships between objects. The diagram figure 2 below can illustrates this concept.

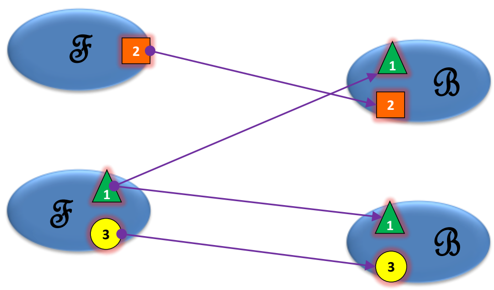

Figure 2: Multi relationships between objects

Given the complexity mentioned above we will define the functions and needs of an object from the following notations. *Fn (A)* (*provider*) means the ability of the object A to supply a service *n* when the notation *Bn (A)* (*Consumer*) will describe a need *n*.

4.4. Service delivery process

Service Delivery (SD) process is a service production process. For realizing the SD, a coupling between a consumer and a provider is required. The steps of the coupling are illustrated in figure 3.

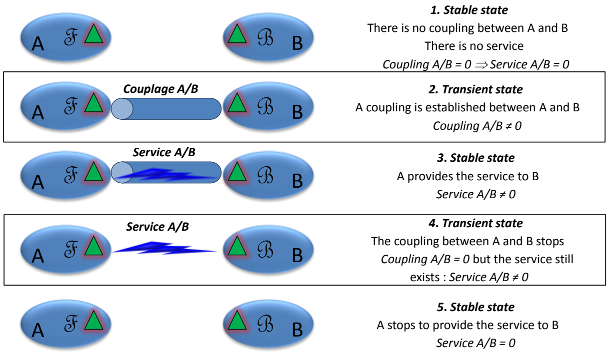

Figure 3: Service consumer / provider coupling steps

However, additional situations pre and post-coupling are required for each object. These situations are initialization phases; contextualization, de-contextualization and disconnection they are detailed below.

4.4.1. Trigger conditions of a service

A service can be triggered according to the figure 5 three cases:

- Case 1: The consumer requests the service, it is a pull service.
- Case 2: The vendor initiates and provides a service to consumers; it is a push service.
- Case 3: It is a third actor action that sends information to both supplier and consumer for a SD. This is called service-driven.

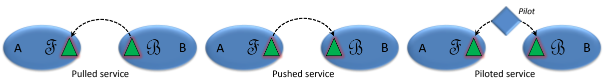

Figure 5: Triggering the Services

4.4.2. Notion of capacity and load

An object has a function that is a capacity to serve another object that has a need load. Hence the notion of capacity and load requires to be quantified. $CF_n(A)$ is the capacity function of the object A to make n service(s) belonging to a size interval [0, MaxCF]. The capacity can be Boolean, expressed on a continuous or discrete scale. Similarly we can define a load $CB_n(A)$.

4.4.3. Parameters of a SD process

Assuming two objects A and B, respectively provider and consumer, the possible situations that can initiate a SD procress are:

- $CF_n(A) = 0$: the service can't be made, regardless of the evolutionary stage of the SD process,
- $CB_n(B) = 0$: the service can't be made, whatever the stage evolutionary SD process,
- $CF_n(A) = CB_n(B)$: the function capacity perfectly matches the intensity of need of B, a is fully occupied and the need of b is filled,
- $CF_n(A) < CB_n(B)$: the service needed by b can't be offered by a,
- $CF_n(a) > CB_n(b)$: b can receive entirely the service needed, a is partially occupied to deliver.

5. G-DEVS MODELLING AND SIMULATION OF SERVICES

Indeed, the service modeling requires also the modeling of the interactions between multiple services; this process can lead very quickly in a significant level of complexity. We therefore focus in this paper on the establishing operations for a single service coupling in the G-DEVS formalism (Giambiasi, 2000). This discrete formalism is selected for its formal property and its time management. We propose to model each service component through a G-DEVS model based on attributes. The model attributes are described from a qualitative and quantitative point of view and all elements (actors and material) that interact within its environment are required. Once the description is complete, the described component can integrate a G-DEVS based library of service components: service repository. The prospect of a break in service into four subsets then seemed obvious. These four subsets are:

- The object requesting the service (here object B) is the consumer, the one who feels a need.
- The service provider (here object A) is the supplier, the one who has the ability to satisfy a need.
- The coupling is the association between two objects that will achieve the SD process.
- The SD process is the service producing.

5.1. The service requester: Object B

The atomic model corresponding to the object B is an applicant for a service. The G-DEVS model (Figure 6) and its operations are detailed. This model describes its behavior during the process of SD coupling.

The G-DEVS model (figure 8) follows the coupling steps described in the § 5.3. It communicates with the service delivery model. To assume the simulation dynamical execution, the states, event and temporal information have been added. These data are not related to any information coming from a real system.

1. Every 5 time units (arbitrary chosen), the model B launches the comparison of its P/S potential intensity over a threshold value. This comparison is expressed as a condition on the internal transition.
2. The model function sends a request (DFb1) to the object service provider (the object A).
3. Positive response is received when the object A is able to achieve this service.
4. Negative response is received when A is not available or not competent for this service achievement, a request will be send to another object.
5. Sending an acknowledgment to the object A to tell them that the service can be achieved and to lock between them a SD process.
6. Sending "ok_couplage" to external produce model.
7. Pending the external event "fin_SD" meaning that the production of the service is completed.
8. Back to the waiting phase, the service was rendered, the intensity of the object B to decrease the capacitance value function of the object A demand. We note that some strategy can keep the value of the object B since some service potential is infinite.

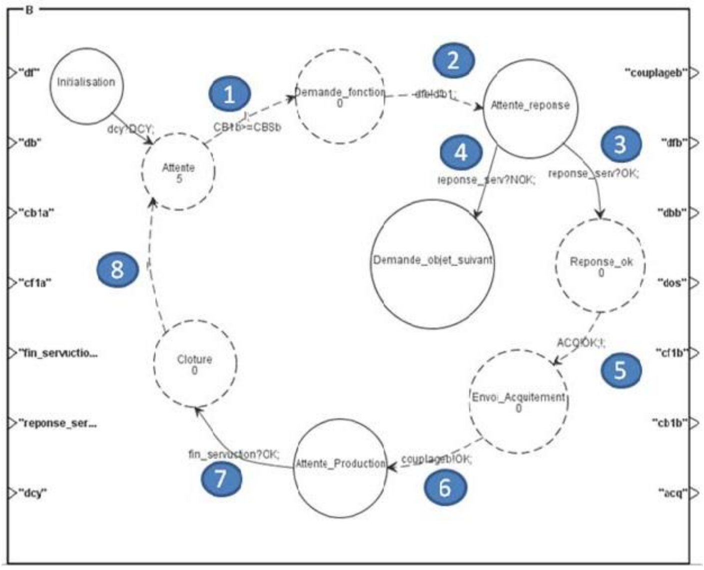

Figure 6: Service Requester Object B

5.2. The service provider: Object A

This section is introducing the G-DEVS atomic model of the service provider object A. An explanation of the model and its operations is detailed here.

1. The model A is expecting a request from object B.
2. A tests the ability to get the function (CF1a) and the load required by the object B (CB1b). If the ability and capacity of A is greater than or equal to the need and load of B then the service is feasible.
3. Same as step 2; if the capacity is lower than the load of B then the service will not be feasible.
4. The service is not feasible, the supplier is informed the consumer via a message object “NOK”.
5. The service can be done, A sends to B “OK”.
6. The model is waiting for the acquittal of the object B to produce the service.
7. The model is awaiting a response from an external “process” models and indicating that the service is in progress.
8. The model is pending an external event “fin_SD_OK” from the “process” model.
9. The process is over and the ability to provide the function of the particular service A can be reduced (consumption) or increased (experience).

The service is completed. The ability of A can stay decreased or can recover its initial value with a gain of experience that increases its ability (the hypothesis can be to gain 10% capacity acquired for each SD).

5.3. Coupled model

The coupled model (figure 7) is presenting the G-DEVS component required for the global simulation of the process. The component 1 & 2 are the A and B models. The component 3 is a coupling model used to connect the models that will be paired for the service. The component 4 is used to orchestrate the process steps defined in § 5.3.

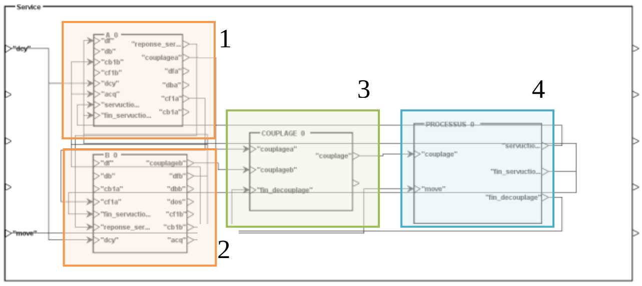

Figure 7: Coupled Model of SD

5.3.1. Coupling (and decoupling)

This atomic model is permitting the coupling orchestration of two objects before the SD process; managing the notion of decoupling, which is at the end of the service. This model is labeled 3 in figure 6. Its main operations are the followings.

It starts by waiting an event from the object A informing that is ready and looking for a SD coupling. Then it is waiting for an event from the object B answering that it is available and capable regarding the load and competence required by A. Then the coupling can be realized. Gathering the information, the model is informing both participants. Then it is waiting for an event informing of the end of the SD to return to the standby state. This is producing the end of the coupling.

5.3.2. The SD process

A last G-DEVS atomic model is required to defines SD the characteristics and simulate the SD process behavior (SD model number 4 in figure 6).

This model starts by waiting an event to be informed that a coupling is ok. At this time, it computes the characteristics of this SD including coupling, duration, quantity of load and experience acquired at the end. It informs by output sending the “SD” settings to the model participants and set them in progress. When the service is ended, it informs the participants by sending to output “fin_SD”.

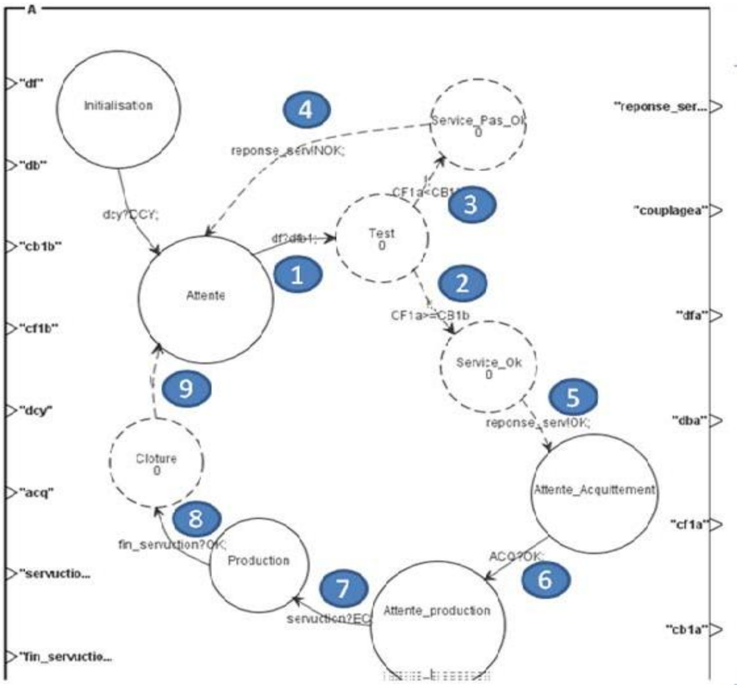

Figure 8: Service Provider Object A

6. CONCLUSION

The paper has provided a preliminary work to define the base of what can be modeled and simulated about the concept of PSS. It has focused on decomposing the SD steps used to couple a service supplier and a receiver. It opens the research in this domain where few works considering dynamic are done. The simulation is considered under the idea of defining a space of objects moving autonomously. When an object needs a service, it will try to connect to a service supplier in its neighborhood. The construction of this space is still under the consideration of the authors at the moment.

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