Service Patterns in the Process of Service-Oriented Development

Wannessa R. Fonseca, Pedro L. P. Corrêa, and Andreiwid S. Corrêa

***Abstract*—In the process of service-oriented development, the phase of identification of services is a pre-condition for the successful adoption of service-oriented computing. Several methods of service identification have been proposed in order to assist in this activity. This paper presents a literature review on the identification of services and proposes the use of service patterns as a source for the identification and specification of services in e-government applications. The development of a service lifecycle is also proposed to support the use of service patterns. The service identification and conception, coupled with the service patterns, helps software developers to identify recurring functional elements and to reduce redundancy of efforts in the conception of services for the same purposes.**

***Index Terms*—Service, service patterns, service-oriented computing, service lifecycle.**

I. Introduction

The service-oriented computing (SOC) utilizes services as basic constructs to support the rapid development of low cost and easy composition of distributed applications even in heterogeneous computing environments. SOC has the perspective of joint services in a network of loosely coupled services, to create flexible business processes and agile applications that can span different organizations and computing platforms [1].

The lifecycles of traditional software engineering do not include all the activities in the service-oriented development cycle, depending on the architectural features and new development tasks [2]. One of the challenges of the lifecycle of services is the stage that identifies the services that support the business activities of the organization.

Regardless of the paradigm of software development, a good practice is the reuse of solutions already devised and that have worked in the past. Although Gamma *et al.* [3] deals specifically with the object-oriented paradigm, the authors report that the best software designers know that they should not solve a problem based on basic principles or from scratch.

Accordingly, this paper proposes the use of service patterns in the lifecycle of services in order to reduce the redundancy of efforts for the identification and specification of new services for the applications scenario of electronic government (e-government).

This paper presents a discussion of methods of service identification and use of service patterns in the context of e-government. The paper is organized in 5 sections besides this introduction. Section II presents characteristics of the lifecycle of services and approaches for service identification. Section III presents the related work on identifying of services. Section IV describes the use of service patterns in the government setting. Section V presents the service patterns in the cycle of service-oriented development. Finally, Section VI presents conclusions of the paper.

II. Service Lifecycle

The traditional lifecycles for software development, such as waterfall lifecycle, evolutionary development, software development based on components [4], do not include all the activities of the cycle of service-oriented development, in terms of architecture roles and new development tasks contained in the process of service-oriented development [2]. Architecture roles are, for example, service providers and service consumers. Some challenges also need to be considered in the service-oriented paradigm, such as aligning business requirements with Information and Communication Technology (ICT) solutions and managing distributed services beyond organizational boundaries.

The lifecycle of services proposed by Marks and Bell [5] comprises the evolution of services from its conception to maturity going through its execution. The process covers from the identification and discovery of services, service modelling (analysis and design) to its implementation and management. According to Gu and Lago [2], there is no consensus in the literature on a model of the service lifecycle and most of the times those that are available are abstract.

According to Sommerville [4], the engineering of service-oriented software is based on the principle of program building by means of the composition of independent services that contemplate reusable functionality. In the specific case of service engineering, the process has a lot in common with the component engineering, as services should be developed in order to be reused. In the cycle of service-oriented development, one of the major tasks is the identification of services, as mistakes at this stage can propagate throughout the project [6]. The service identification is seen by Kang *et al*. [7], Arsanjani *et al*. [8] and Boerner and Goeken [9], as a prerequisite for the successful implementation of a service-oriented architecture, together with the need for research to develop effective methods for this task.

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A. Service Identification Approaches

Although the identification of services may use different approaches, such as top-down, bottom-up and the combination of both approaches, known as meet-in-the-middle, Inaganti and Behara [10] point out that the top-down approach - targeting the business process - is the most recommended practice to start off the adoption of SOA in enterprises. In order to systematize the task of service identification and conception, some strategies or paths are mentioned in the literature, among which the following are highlighted:

- Business Process Decomposition, Business Functions and Goals - the business process decomposition aims to subdivide the business process into several subprocesses or decompose it into granular tasks and activities. The lower-level tasks may consist of small, cohesive logical units of work that are supported by the functionality offered by different services. Similarly, the functional decomposition of the business and its goals aims to achieve more detailed roles and goals which can be translated into services [11].
- Based on Business Entity - Services based on business entity can be identified as frequently requiring functions such as CRUD (Create, Read, Update, Delete). This approach relies on the use of canonical data models (CDM) that standardize the information exchanged between services [11].
- Component-Based - the essence of components is to split ICT functions into units with maximum internal cohesion and minimum coupling. The benefit of the establishment of service components is that the process of identifying the service is highly simplified. Most of the analytical work is performed as part of the method of component-based development [11].
- Existing Features - identifying services from existing functionality in legacy systems and transforming these features into services for a Service-Oriented Architecture (SOA) platform, presents challenges according to Chen *et al*. [12]: (1) what can be migrated from legacy systems to the SOA platform, (2) how the reusable code of legacy systems can be identified, and (3) how the reusable code can be migrated and integrated into architecture-oriented services.
- Front-Office Applications Usage Analysis - the goal is to select a set of applications that support the business processes and to define a list of operations performed by the set of applications. Then, redundant operations can be eliminated and comparable functions combined into a single service [11].
- Based on Infrastructure - this approach recognizes that services cannot always be identified independently of the technical infrastructure that is being used, in which case the services are linked and dependent on technical resources [11]. Generally, these services are classified as utility services.
- User Interface - in this case, the service identification is performed on the basis of the user interface design [13].

Hubbers *et al.* [11] also emphasize the use of non-functional requirements as input for the identification of services. These requirements may be used together with other strategies. From a set of candidate services, non-functional requirements are checked to verify if they can be met or if the services need to be redefined.

Considering the analysed approaches, several software artefacts can be used as inputs for the identification of services, e.g. business process model, use cases, user interface, business entities, business rules, data flow diagram, legacy systems (documentation and source code) and the organization's goals.

This paper proposes a new approach for service identification and specification. One other artefact will be used as input for the identification of services: the service patterns catalog.

III. Related Work

This section is a discussion of methods and techniques for the services identification and conception.

A method is proposed by Azevedo *et al*. [14] with activities to guide the designer to identify the most suitable set of services to support the business activities of the organization. The method consists of the following steps: (1) Selection of activities subject to automation - this stage is the selection of process activities TO-BE where can be identified candidate services, (2) Process models are represented using the Event-driven Process Chains (EPC) and Function Allocation Diagram (FAD), (3) Candidate services identification and classification - activities identified in the previous step are analyzed within their contexts in process models according to a set of heuristics, and (4) Consolidation of candidate services supported by the use of heuristics.

A guideline is proposed by Shirazi *et al*. [15] for the service identification using two approaches: top-down and bottom-up. The goal is to use the bottom-up approach to identify of applications and entities services, and top-down approach to recognize the business services and services oriented tasks. The method consists of the following steps: identifying business processes, making business use-case model, identifying entity centric services, recognizing application services, identifying task centric services and recognizing process centric services.

A process was proposed by Jamshidi *et al*. [16] to build the Enterprise Service Model (ESM) from the Enterprise Business Model (EBM) according to the following steps: (1) Modelling of business processes - two types of models should be built: a model of business processes and a model of business entities of the enterprise, (2) Identification of service model elements - from the model of business processes and business entities of the enterprise, a first view can be obtained by comparing Elementary Business Processes (EBPs) and Business Entities (BEs) to seek affinity. For the search of affinity between EBPs and BEs, a clustering technique called Elementary Business Process and Business Entity Affinity Analysis Technique (EEAT) is used to identify candidate architectural elements, (3) Categorization of services - the choice is made on which services, identified in the previous step, will be implemented in a Business

Process Management System (BPMS) tool or as external services outside the tool, and (4) Documentation of enterprise service model - the Enterprise Service Model (ESM) is designed in Unified Modeling Language (UML 2.0).

In Dwivedi and Kulkarni [17] the goal is to identify services from UML based hierarchical business process maps. The process map represents a structured modelling of business processes in layers, with the functional processes on top level and flows of tasks on bottom. Based on this modelling are applied heuristics to identify services from highest level process map to the lowest level.

Marks and Bell [5] propose a Service Lifecycle. This cycle includes the service evolution from conception to maturity along its execution. The identification of business services is performed using a top-down and bottom-up approach in iterative cycles. In order to identify new candidate business services, the author proposes an analysis of the following sources: business process, entities (interest and principal), budgeted projects, business experience, preexisting services and existing business applications.

Arsanjani *et al*. [8] present a method for service-oriented solutions developing, called Service-Oriented Modeling and Architecture (SOMA). Specifically for services identification phase, the paper points out that a good practice is to use a set of complementary techniques to identify services and cites three service identification techniques: (1) Goal-Service Modelling (GSM), treats the services aligned to the business goals, (2) Domain decomposition is performed through a top-down analysis of business domains and business processes modelling that are identified services, components and flows. The aim is to consider the static and dynamic view of the business, including information, rules and variations, (3) Analysis of the existing asset, is performed by bottom-up analysis of the existing application portfolio and other assets and patterns that can be used to identify candidate services. After the application of the described techniques, the method also comprises the following step: refactoring and rationalization of the service whose service granularity is determined. Finally, a series of criteria are applied to determine which services is appropriate candidates for publication.

A framework driven by ontology and taking as input a Business Process Architecture (BPA) organization is proposed by Yousef *et al*. [6]. Kang *et al*. [7] proposes a method of service identification to product line. This method utilizes ontology in order to avoid inconsistencies caused by ambiguity.

The methods of services identification analyzed, a general model, using techniques based on heuristics and ontology, some methods provide guidelines to guide the activity and others are algorithms that aims to automate the activity of identifying services from the input documents.

According to Ma *et al*. [18], although most of the SOA design methodologies defend what services are identified from the top-down decomposition of business processes, the quality of the services identified in these methodologies depends largely on the individual experience of the designer.

In the literature review no strategies were observed for service identification that provides mechanisms to support the reuse of expert knowledge.

IV. Service Patterns in e-Government Scenario

A. Service Patterns

A pattern provides a proven solution to a common problem individually documented in a consistent format, usually as part of a larger collection [19]. The solution provided by a particular pattern may not necessarily represent the only suitable solution to the problem. In fact, there may be many patterns that provide alternative solutions to the same problem. Each solution has its own requirements and consequences, and it is up to the professional to choose. Erl [19] also stresses that a pattern is a fundamental part of everyday life; proven solutions are already used to solve common problems. However, when standards are specifically related to these automated systems they are called Design Patterns.

The concept of service patterns used in this study is similar to that defined by Fki *et al*. [20] an abstract service representing a generic and reusable description. Besides this definition, service patterns must contemplate the description of atomic services and compound services, as well as the interactions between services. Thus, the service patterns will be able to meet a government task or business process.

Nazih and Alaa [21] propose generic service patterns for the Egyptian public healthcare system, aiming to integrate several hospitals and to interact with the Government. The work addresses two common types of patterns: architectural patterns, which reflect structural attributes of software architecture and design patterns that provide functional and behavioral representations of software architecture. Table I illustrates some differences in the terms services and service patterns used in this study.

TABLE I: Services and Services Patterns

	SERVICES	SERVICE PATTERNS
GOAL	Be part of an inventory of highly reusable services	Be part of a highly referenced service pattern catalog
RELATED ARTIFACTS	• Service specification • Source • Web Services Description Language (WSDL) • Code of deployment	Service patterns specification
REUSE	Through service composition	Reuse of the concept and logic abstracted from a service

Obtaining reuse depends not only on technical issues; it is strongly related to the issues of management and organizational culture. While creating the service patterns catalog itself does not ensure the reuse, it can support reuse and service conception. The creation of service patterns can support the reuse of the concepts associated with the services.

B. Service Specification in e-Government Scenario

The characteristics of the ICT of the government are presented as a scenario of high potential for the use of

service-oriented solutions, especially due to the large number of existing applications, technological diversity, the need for interaction between these applications and the need for service quality management. The adoption of SOA in the Brazilian Government is recommended by e-PING [22] as a technical guideline for the integration of information systems. But the government scenario is not exempt from the challenges related to the activity of identifying and specifying services

A large number of information systems are created in government, mostly from basic principles without considering the reuse of service-oriented solutions from other public entities. What is observed, thus, is the lack of support to encourage the reuse of service-oriented solutions in the context of e-government.

The Service Specification Method for e-Government (SSMe-Gov) was proposed in order to assist the specification of e-government services. In this method, the service patterns are defined from existing services in the government. The service patterns should be cataloged in a repository to serve as a reference for creating new services. Fig. 1 illustrates an abstract view of SSMe-Gov.

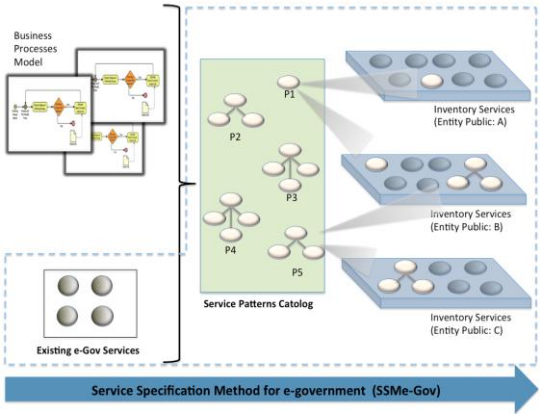

Fig. 1. E-government service specification method based on service pattern.

The SSMe-Gov consists of two steps:

1) **Defining Service Patterns**: in order to define service patterns the concept linked to a service should be abstracted and represented as a service pattern.
   - document the service pattern using the Service Pattern Description template
   - catalog the service patterns in the service patterns repository
2) **Create new services**: in order to create new services cataloged service patterns should be used as reference.

There is no established rule on the format used to describe a service pattern, therefore this work defined a template named Service Pattern Description, as shown in Table II. This template was defined from the analysis of the works, such as Tchuta and Chunhua [23], Li *et al*. [24] and Fki *et al*. [20].

V. Service Patterns in the Service-Oriented Development Lifecycle

Considering the government scenario, where there is redundancy of functional characteristics in several government levels and sectors, in most cases, efforts are redundant in the tasks of service identification and conception. As a result, service concepts already devised by an expert in the government area can be reused by other government levels and sectors.

TABLE II: Service Pattern Description Template

Service Pattern Name	Name that identifies the service pattern.
Service Pattern Description	Meaningful description of the service pattern.
Keywords	One or more keywords related to the business area that offers the service capabilities.
Version	Version number.
Contact	Contact information of the institution that has documented the service pattern.
Problem	Describes the recurring problem for which the solution was defined.
Solution	Describes the fundamental principle of the solution proposed by the service pattern.
Participating elements	Presents which parts are involved in the services, for example, the systems and service layers.
Pattern Type	Specifies the type of service rendered by the pattern, whether it is atomic or compound.
Related patterns	Name of the patterns related to the pattern described.
Service Composition Model	Graphical representation of the composition model used in the service pattern.
Catalog	Describes the name of the catalog the pattern belongs to.
Service Interface	Representation of the service pattern interface.
Operation Name	Service operation name.
Operation Description	Service operation description.
Diagram	Graphical representation of the service pattern operation.
....	....

A. Proposed Service Lifecycle

In general, all of the service lifecycles include the following activities: business process analysis, identification, modelling (analysis and design), development and service management, e.g., those defined by Marks and Bell [5], Arsanjani *et al*. [8], and Gu and Lago [2].

Thus, the proposed use of service patterns presented in this paper aims to add an activity in the life cycle of services, called "Location of Candidate Service Patterns", as illustrated in Fig. 2.

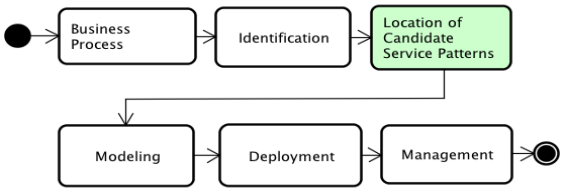

Fig. 2. Proposed service lifecycle.

The activity "Location of Candidate Service Patterns" must be performed by consulting the catalog of e-government service patterns. The aim is to find patterns of services that meet the business process in question. The service patterns will be used as reference to create new services.

B. Services Patterns to Support Services Specification

The analysis is performed by means of the top-down and bottom-up modes in iterative cycles. The top-down analysis is used to conceptually identify candidate services and analyze before proceeding to the analysis activity itself. The design of the services is performed from a bottom-up perspective, when the candidate services, identified in the analysis phase, are translated into physical services.

The process steps of services identification and analysis proposed by Marks and Bell [5] are illustrated in Fig. 3.

After candidate services are identified, the services must be analysed and designed for implementation. The main focus of the analysis is to transform candidate services in final business services. First, they evaluate the functionality of each candidate business service to determine the granularity of the service, then apply logical operations on

the candidate business services according to their functions or levels of granularity. Logical operations (union, intersection, decomposition, subset, etc.) are applied in order to aggregate and fragment candidate business services, reorganize its operations and services giving rise to the final business services. The activity of analysis of services focuses on controlling the granularity and the potential for reuse of services.

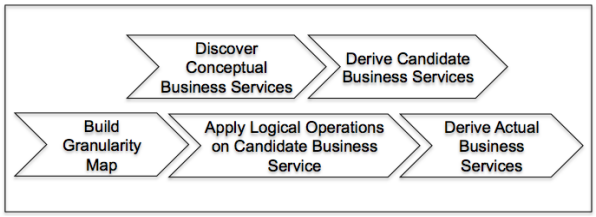

Fig. 3. Service analysis and identification process [5].

Potential services must be identified to support the organization business model. The candidate business services can be identified from the business process analysis, entities analysis, business experience, pre-existing services and existing applications, as illustrated in Fig. 4.

This paper proposes an evolution to the service lifecycle model proposed by Marks and Bell [5]. The objective is that the Government's service patterns catalog be also used as a source of consultation to identify potential services to meet a business model of a governmental organization, as illustrated in Fig. 4. The e-government service patterns catalog should be used in addition to the analysis of business processes, business entities, budgeted projects, business experience, preexisting services and existing applications.

It is noteworthy that the analysis of pre-existing services is made in order to optimize existing investments through reuse, composition or even redesign of services according to business requirements. On the other hand, the analysis of the government service patterns catalog will allow supporting the reuse of a concept already idealized in another organization or even in the same organization but in another business area.

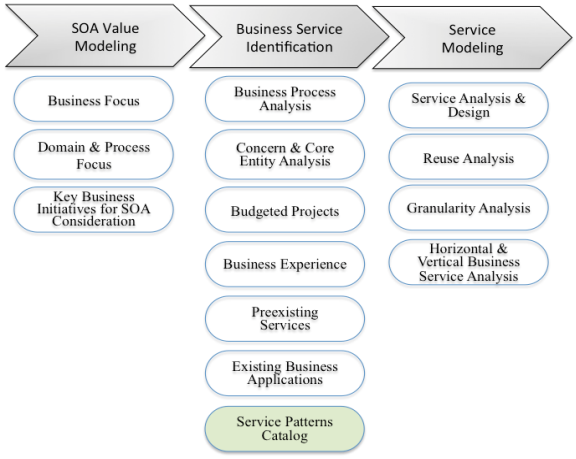

Fig. 4. Identifying candidate business services - adapted from Marks and Bell [5].

According to Marks and Bell [5], the experience of a business domain expert can help identify candidate business services in a company. Similarly, service patterns are also related to the experts experience, as patterns represent concepts of services already conceived by other experts. Therefore, the analysis of service patterns can serve as a basis for reusing the experience of the experts.

C. Discussion

The use of the design principles of service orientation (e.g. Standardized Service Contract, Low Coupling, Service Capability Reuse) assists in defining how the logic should be decomposed and modeled into services. These principles support or contribute to the interoperability of services. The goal is to produce inventories of highly reusable services to meet new business demands. In this sense, the organization must adopt methods that help identifying services to build their inventories.

In the process of service-oriented development goal is to create services as a unit of software to be reused. When inserting the concept of service patterns in the process of service-oriented development, the goal is to reuse the service concept and service logic represented by the service pattern.

VI. Conclusion

This work presents a literature review on service identification inherent to the service-oriented development lifecycle. The activity of services identification is a complex activity and requires methods to do it with the necessary rigor, as mistakes at this stage can propagate throughout the project. Several research efforts have been made in order to assist the activity of service identification and specification.

Aiming to evaluate the definition of service patterns based on the analysis of existing services, two case studies were conducted in the government area. The first was carried out for the Daily Allowance Management business process and the second one was for the Electronic Invoices. These case studies show that it is possible to define service patterns from the analysis of existing services in the government and take advantage of the experience of these experts.

This work proposes the progress of a service lifecycle taking into consideration a set of new activities to be included in a lifecycle of services proposed by Marks and Bell [5]. The proposal to identify and design services combined with the concept of service patterns aims to reduce redundancy of efforts in the conception of new services for similar purposes.

Future studies may consider examining other service lifecycles and the establishment of other sources to define service patterns, e.g., business processes models.

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References

[1] M. P. Papazoglou, P. Traverso, S. Dustdar, and F. Leymann, "Service-oriented computing: A research roadmap," *Int. J. Coop. Inf. Syst.*, vol. 17, no. 2, pp. 223–255, 2008.

[2] Q. Gu and P. Lago, "A stakeholder-driven service life cycle model for SOA," in *Proc. 2nd international workshop on Service oriented*

software engineering: in conjunction with the 6th ESEC/FSE joint meeting, Dubrovnik, Croatia, 2007, pp. 1–7.
[3] E. Gamma, R. Helm, R. Johnson, and J. Vlissides, *Padrões de Projeto*, Bookman, 2000.
[4] I. Sommerville, *Engenharia de Software*, Addison Wesley, 2007.
[5] E. A. Marks and M. Bell, *Service-Oriented Architecture (SOA): A Planning and Implementation Guide for Business and Technology*, 1st ed. Wiley, 2006.
[6] R. Yousef, M. Odeh, D. Coward, and A. Sharieh, "BPAOntoSOA: A generic framework to derive software service oriented models from business process architectures," in *Proc. Applications of Digital Information and Web Technologies, ICADIWT '09*, 2009, pp. 50–55.
[7] D. Kang, C. Song, and D.-K. Baik, "A method of service identification for product line", in *Proc. 3rd International Conference on Convergence and Hybrid Information Technology, ICCIT 2008*, 2008, vol. 2, pp. 1040–1045.
[8] A. Arsanjani, S. Ghosh, A. Allam, T. Abdollah, S. Ganapathy, and K. Holley, "SOMA: A method for developing service-oriented solutions," *IBM Systems Journal*, 2008.
[9] R. Boerner and M. Goeken, "Service identification in SOA governance literature review and implications for a new method," in *Proc. 2009 3rd IEEE International Conference on Digital Ecosystems and Technologies, DEST '09*, 2009, pp. 588–593.
[10] S. Inaganti and G. K. Behara, "Service identification-BPM and SOA Handshak," *BPTrends*, 2007.
[11] J. Hubbers, A. Ligthart, and L. Terlouw, "Ten ways to identify services," *The SOA Magazine*, 2007.
[12] F. Chen, Z. Zhang, J. Li, J. Kang, and H. Yang, "Service identification via ontology mapping," in *Proc. International Computer Software and Applications Conference*, 2009, vol. 1, pp. 486–491.
[13] S. Mani, V. S. Sinha, N. Sukaviriya, and T. Ramachandra, "Using user interface design to enhance service identification," in *Proc. the IEEE International Conference on Web Services, ICWS 2008*, 2008, pp. 78–87.
[14] L. G. Azevedo, F. Santoro, F. Baião, J. Souza, K. Revoredo, V. Pereira, and I. Herlain, "A method for service identification from business process models in a SOA approach," *Enterp. Bus.-Process Inf. Syst. Model.*, pp. 99–112, Jan. 2009.
[15] H. M. Shirazi, N. Fareghzadeh, and A. Seyyedi, "A combinational approach to service identification in SOA," *J. Appl. Sci. Res.*, vol. 5, no. 10, pp. 1390–1397, 2009.
[16] P. Jamshidi, M. Sharifi, and S. Mansour, "To establish enterprise service model from enterprise business model," in *Proc. Services Computing, 2008. SCC 08. IEEE International Conference on*, 2008, vol. 1, pp. 93–100.
[17] V. Dwivedi and N. Kulkarni, "A Model driven service identification approach for process centric systems," in *Proc. Congress on Services Part II, 2008. SERVICES-2. IEEE*, 2008, pp. 65–72.
[18] Q. Ma, N. Zhou, Y. Zhu, and H. Wang, "Evaluating service identification with design metrics on business process decomposition," in *Proc. SCC 2009-2009 IEEE International Conference on Services Computing*, 2009, pp. 160–167.
[19] T. Erl, *SOA Design Patterns*, 1ed. Prentice Hall PTR, 2009.
[20] E. Fki, S. Tazi, and C. S. Dupuy, "Towards a user intention aware service composition," in *Proc. 2010 10th Annual International Conference on New Technologies of Distributed Systems (NOTERE)*, 2010, pp. 113 –120.
[21] M. Nazih and G. Alaa, "Generic service patterns for web enabled public healthcare systems," in *Proc. 2011 7th International Conference on Next Generation Web Services Practices (NWeSP)*, 2011, pp. 274–279.
[22] BRASIL, "Padrões de Interoperabilidade de Governo Eletrônico - E-PING," Brasília: Comitê Executivo de Governo Eletrônico, Documento de Referência Versão 2012, 2012.
[23] L. Tchuta and G. Chunhua, "Atomic New Service Pattern," *International Journal of Software Engineering and Its Applications*, 2011.
[24] P. Li, M. Xiangxu, S. Zhiqi, and Y. Han, "A reputation pattern for service oriented computing," in *Proc. 7th International Conference on Information, Communications and Signal Processing*, 2009, pp. 1 –5.

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