Service Identification Requirements for Enteprise Information Systems

Olaolu Sofela, Paul de Vrieze and Lai Xu
Faculty of Science & Technology
Bournemouth University
Fern Barrow, Poole, BH12 5BB, UK
{osofela, pdvrieze, lxu}@bournemouth.ac.uk

***Abstract*—Identifying services is one of the most important step in developing service-oriented business systems. Existing service identification methods still have some shortcomings, e.g. *unrepeatable approach, inapplicable to all enterprise information systems and unadaptable to business factor change*. Some approaches focus on fixed cases or certain types of organizations neglecting the change of involvement and operation of the enterprise systems, which have limited value to apply to a broad range of real-life business cases In this paper, we investigate requirements of service identification from different types of information systems, from single systems to collaborative systems, from closed systems to open systems. The research is important for providing a solid foundation for further identifying services for developing different service-oriented systems.**

Keywords—Service identification, service-orientated systems, interoperability, adaptability, reusability.

I. INTRODUCTION

Service identification is the first and most essential phase of SOA development for creating service-oriented solutions which collectively support the business process and existing goals of the organization [1]. In the last decade, several different service identification approaches and methods have been introduced with limited applicability methodology which has informal of definitions.

In current business environment whereby organizations make use of SOA concepts, with series of different enterprise information systems, and involve in different business task, it will be difficult to identify the right services. The usability of current methods of service identification is generally confined to specific organization types, number of data type, neglecting the type of enterprise information system the organization may exist in (*it does fluctuate based on certain business purpose*), and some of the approaches do not adhere to the set of common principles that underpin SOA platforms [2].

In this paper, we classified the various organizational systems based on their involvement and operation. For every involvement and operation, there are certain principles and requirements to follow in identifying the right services. The point is if we study how services of different organizations are used in different enterprise information system, then, we can know how to identify them.

The rest of the paper is organized as follows. In Section II we introduce the framework that will be used throughout the paper. In Section III presents the required principle for the framework. In Section IV and V discusses the classification of single enterprise information systems and open collaboration respectively, and its principle dependencies, and finally in Section VI, we discussed the requirements for identifying services for the various systems.

II. TWO DIMENSIONS OF ENTERPRISE INFORMATION SYSTEMS

Enterprise information systems are used in many application domains for the support and management of human resource, customers, enterprise resources, data and product, and decision etc. Within organizations, with single business domain or multiple information systems are typically using one conventional methodology to identify service for organization with several different classifications and operations.

It is important to distinguish the methodology to be used for every involvement (i.e. single system or collaborative). Same methodology cannot be used to identify services in all systems or organization. Organizations use different enterprises information systems and also have different involvement and operations. An organization with one or many enterprise information systems can be classified into two dimensions, which will support identification of right services for enterprise system.

One dimension shows the representation of organization system, i.e. "*involvement*" dimension (Fig. 1). The organization system dimension denotes that an enterprise system can be used by single system to a collaborative system from different organization. Another dimension represents operation of organizations which can be seen as open or closed for other partners, i.e. "*operation*" dimension.

An enterprise information system can be "*open*", "*closed*" operation, and organization(s) can implement a single or collaborative system which are either openly available to use terms are relatively and dynamically changing its interaction between business partners from open to closed, or in contrast. This in the two axes as shown in Figure 1, describing the four categories of organizations i.e. an organization can exist either

as open single system, closed single system, open collaboration, and closed collaboration.

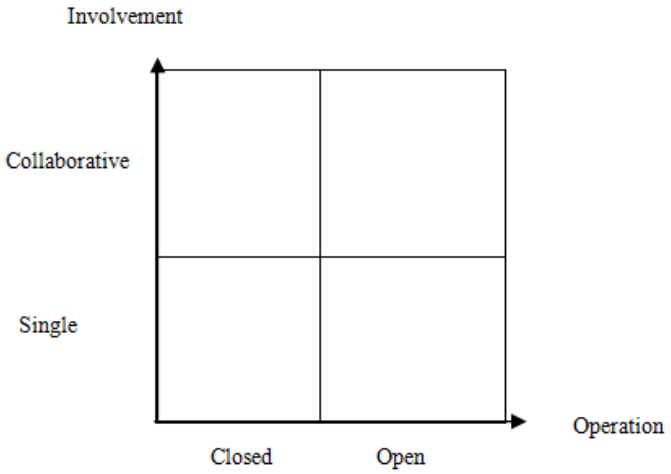

Fig 1. Two-dimensional enterprise information system framework

First, we define the service orientation of the systems as the extent to which services are designed to easily composed, coupled and adapt in order to cope with the business involvement and collaboration. For each axis, certain service orientation for the enterprise information systems are defined in (Section III). Secondly, we propose extended requirements to identify right services for every system in Section VI. These requirements are expected to adapt to the nature of organization involvement and operation.

III. Service Orientation for Enterprise Information Systems

An organization is said to be effective only if they are on-demand and adaptable [14]. To achieve this, many organizations transform themselves from traditional enterprises to SOA supported enterprise information system. A recent survey by Forrester Research shows that the rate of SOA adoption among enterprises is strong and increasing [15], [16], by using architectural style that increases emphasis on flexibility and efficiency. One of the key promises and benefits of SOA is the seamless integration of business services [3], by describing the service orientation.

Service orientation is the service adaptation (or metaphorically it's "DNA") [4], which enables enterprise to react quickly to a frequent business demand [3]. Defining the service orientation in terms of involvements presents the overall tendency to deliver a service excellence depending on operation. Johnston [4] argues that service excellence is about "being easy to do business with". Furthermore, organizations need to have the requisite service orientation measurement that makes it reliably easy for intra or inter-organization integration. Therefore, there are growing needs for valid measurement scales that describe business overall internal service-based competencies. In paper [4], the authors describe service orientation as "the extent to which services are designed in such a way that allows them to be easily coupled, adapted and combined in order to cope with changing environment", and provide service excellence in enterprise information system.

To achieve their goals, enterprise information systems interact between each other depending on certain SOA principle (loose coupling, abstraction, statelessness, autonomy etc.) [5] and quality principle (interoperability, adaptability, reusability etc.). Elvesæter [6] states that interoperability solutions should be driven by first, the business needs, and then the software solutions as the second. We adopt the quality principles of a system (interoperability, adaptability) defined in [5] into this research. Below are the selected quality principles adapted from [5] at system level. These selected principles helps in addressing the type of systems and information dependencies within an organization(s) which further helps to identify services rightly:

System Interoperability. This principle states the extent or level at which two or more systems can exchange information in a meaningful way [5]. Carney lengthened the definition, in [8]; [9] by adding the notion of purpose related to goal of interoperation and the notion of relation in the environment in which the entities exist. Interoperability is defined as the "*ability of collections of communicating entities to (i.) share specified information and (ii.) operate on the that information according to a shared operational semantics (iii.) in order to achieve a specified purpose in given context*". Panetto, in [9]; [10], complements Carney's definition, stating that "*interoperable systems are by necessity compatible, but the converse is not necessarily true*".

A service is said to be interoperable when the level of message exchange between different services interconnected semantically or by agreed upon syntax. Service interoperability depends on level of information exchange between the services through distinct interfaces that specify the usage and behavior of the systems. Interoperability problems may arise due to: organization type, different levels (department) in organization, different kinds of enterprise application as well as due to the varying levels of abstractions of the services. Therefore, the interoperability depends on the type of enterprise system and the level of service standardization (*enables efficient communication amongst services [5], which has to be defined before the implementation of the services.)* (e.g. the use of communication protocol), service abstraction and service loose-coupling. The higher the system level or cost of exchange of information, the higher the interoperability.

System Adaptability. This principle states how a system can accommodate changes within or outside of its environment [5]. Adaptability includes the scalability of evolving software, hardware and operational environment. Service adaptability is the level of service control over its environment and displays efficient request processing [5]. Adaptability also depends on the enterprise system and autonomy.

A. Required SOA principles for service-orientation

Based on SOA design principles, services are expected to be loosely coupled, abstract the underlying logic, reusable, composable, stateless, share a formal contract, autonomous

and discoverable [11], [12], therefore, we refine the quality principles which play key role in service orientation at service level:

Service Loose Coupling. This principle ensures that services can condone changes to application instances without affecting other services.

Service Abstraction. This principle turns services into "*black box*", publishing only the required information need about the services to the consumer. This information can be changed as service design changes e.g., when a service is composed of other services [5].

Service Statelessness. This principle requires that services in SOA-based system are to avoid the management of state tasks (e.g. keeping trace of interaction-specific) [5].

Service Autonomy. This principle advocates that services have maximum control over underlying runtime execution environment [5].

Service Discoverability. This principle ensures that services have the ability to be effectively discovered and interpreted by supplementing services with communicative metadata [5].

Service Composability. This principle represents the design approach to which services are effective in service compositions to create new services [5].

As shown in table I, there are some required SOA principles for every service orientation, which differs in systems or services.

TABLE I. SERVICE ORIENTATION REQUIREMENTS AT SYSTEM AND SERVICE LEVELS

Service Orientation	**SOA Principles**	
	System Level	***Service Level***
Interoperability	Level of system abstraction	Level of service loose coupling, abstraction
Adaptability	Level of system autonomy	Level of service loose coupling and autonomy
Reusability	Level of system discoverability and statelessness	Level of service loose coupling, genericity, discoverability, composability and statelessness

The next sections discuss only the service orientation for open single system and open collaboration because of page limitation.

IV. SERVICE ORIENTATION OF OPEN SINGLE ENTERPRISE INFORMATION SYSTEMS

Open single systems can be addressed from two perspectives namely, i.) platform-based open single system ii.) application-based open single system.

The service orientation of each of the perspectives is addressed based on its properties, functionalities and operations.

A. Service orientation for platform-based open single system

For an organization using platform single system (e.g. SAP), there is no/less need for standardization, the enterprise service bus can be used in linking the systems which are designed to work together (the platform forms a standard). The system are explicitly required to adopt the specified SAP's standard for application accessibility, system integration, service interconnection, and service management metadata. By using the enterprise service bus, the systems can interoperate which has to conform to the following SOA principles namely:

Less abstraction: less concern on service abstraction which relates to the platform logic. In some cases, the organization can compose their activities (*generating abstract services*) based on the platform (*e.g. SAP*) standard. Therefore, the systems aid the effective utilization of the service needed giving out the required information to consumer.

Level of loose coupling: *A g*iven service A is directly coupled via the information exchange to another service B *iff* there exists information used in A that is defined in B, change in service A is likely to affect B. Thus, to achieve loose coupling between the services, there must be a level of isolation.

The adaptability of two services is depended on the level of the standard which is easy to determine if they belong in the same system e.g. platform-based open single system.

B. Service orientation for application-based open single system

In an organization with several bundles of sub-systems, each sub-system can have different applications which may interoperate depending on the business requirement, generating different services for unified business goal. This is known as application-based open single system. In this system, system adaptable and service interoperability are the major concerns. With established standard, systems are compatible (i.e. *increase service interoperability*), connected seamlessly, providing an *efficient and simplified* application, regulated for the amount of information exposed (*i.e. increase service abstraction),* clearly documented and accessible (*service discoverability*) and exposed for services functionality for reuse (*service genericity*). For improved interoperable services, well-established standards must be defined for easy communication and ensuring less/no negotiation power between the applications in the platform, creating a standardized level of abstraction and loosely-coupled, autonomous and generic services.

For the services to interoperate, the systems have to be adaptable. The level of system adaptability and interoperability depends on the following SOA principles:

a. *Service abstraction:* the services are required to be connected seamlessly, providing an efficient and simplified application regulated for the amount of information exposed.

b. *Service autonomy*: the services are required to have reasonable level of control over its own execution environment or their underlying logic, thereby

reducing the dependencies it may require on shared resources within the execution environment.

c. *Service statelessness*: the services are required to minimize of state information they manage and reduce the duration for which they are stateful.

d. *Service discoverability:* the services are required to clearly documented and accessible.

e. *Service composability and genericity*: In organization (e.g. insurance company), services are composed to deliver new services and services are required to display its functionality to reuse from the existing services.

f. Loose coupling of service: For instance, when a department depends less on another department in an organization to execute its business process or application; it might not be coupling on technical level, but bit more operational level. An organization running open single system defines the level of standardization that they incorporate into their business process or application, which ensures low impact of individual failure between the systems.

Interoperable services are by necessity adaptable in open single system, but the converse is not necessarily true. To realize the power of service interoperability through robust data exchange, one must look beyond adaptability.

V. SERVICE ORIENTATION OF OPEN COLLABORATION

In fast growing business world, collaboration does not only exist with similar businesses, for instance, software companies (Microsoft and Apple), Universities (MIT and Harvard) but more of unrelated businesses, for instance, the collaboration of Microsoft and Toyota for intelligent energy consumption [13], Mercedes-Benz and Facebook for new frontier social driving [13], Puma, Adidas and Innovalley for intelligent sportswear and accessories [13], NHS and Facebook for enormous potential of health's socializing, Evernote and Moleskine for information overload management and many more. Therefore, the two different collaborative perspectives described above i.e. the related and unrelated open collaborations, which cannot be treated the same way. Each of the perspective is described and the collaborations are achieved based on the level of service orientation which conforms to SOA principles. Technically, the level of service orientation for open collaboration is different for every case. For instance, organization A and B have to specify the level of collaboration for their systems to interoperate, adapt and reusable.

A. Service Orientation of related open collaboration

At system level, organization A and B in similar business drive can easily define the level of interoperability and adaptability of their systems based on the agreed upon standard. In doing so, the following quality principles have to conform the following SOA principles with namely:

The level of adaptability of the system: For an organization A and B to adapt, agreed-upon standards have approved by both organizations giving rise to the development of an interface which will be the collaborating environment for the organizations. In defining adaptability, organization A and B specifies the portion of its business processes to collaborate with, which is accessible by both organizations using defined interface. Inside of the interface, the related open collaboration defines the *level of service autonomy* when its services exercises control logic over their underlying and execution environment or interface which has to be loosely coupled.

The level of adaptability of services: After the adaptability of the systems, service adaptability is dealt with. Service adaptability in related collaboration or network is far more achievable as long as the levels of standardized service contract, loose coupling, statelessness and autonomy are all defined, creating interoperable services. For instance, MIT and Harvard universities are collaborating to provide free online courses, known as Massively Open Online Courses (MOOCs) [12]. With established standards and interface, the two universities can collaborate using the standardized bridge between the specified services (data and resources). The next step is the interoperability of the services of the two universities. To safe cost and time, instead of creating new suitable services, the adaptability of their existing services is considered. Each organization defines its level of abstraction, coupling and service contract duration with each other as shown in Figure 2.

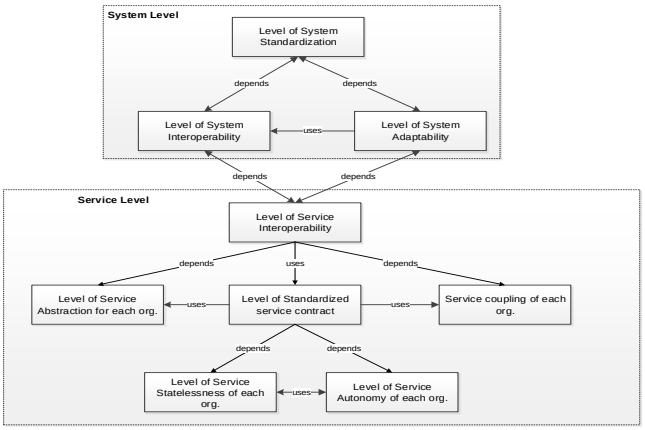

Figure 2. Service Orientation of related open collaboration

B. Service Orientation of unrelated open collaboration

In recent collaborations, more of unrelated organizations are partnering to improve or establish new services, e.g. health sector and social media (i.e. *NHS and Facebook*) collaborate to create sociable health care to raise awareness about the need for donations [13]. This collaboration entails more detailed work which involves the looking at the service orientation of each collaboration processes which conforms to SOA principles at system and service levels. The following quality and SOA principles have to be conformed to namely:

The level of system adaptability: depends on what they are working on and the d level of relation of organization A and B. An interface is created for collaborating organization A and B by agreed-upon standard which uses on each organization's service autonomy and statelessness.

The level of system interoperability: With the interface created, the next step is establishing standardized service contract which depends on each organization's level of service abstraction and coupling.

The next section discusses the requirements for open single system and open collaboration because of page limitation.

VI. Service Identification Requirements of Enterprise Information Systems

As the current methods exist, there are over twenty methods for identifying services which are not adaptable to changes and less applicable to every business case. Also, the approaches are too simple to satisfy the common principles that are supported by SOA platforms. In order to realize or create a new method, the following requirements are to be satisfied for each enterprise information systems.

Identification of services in enterprise information systems has some requirements leading to modification of the service design. Likewise, identification of service orientation for a specific enterprise information system will improve the service design, and services can be identified as business requirements change.

A. Service Identification requirement for open single system

Services in open enterprise systems operate in a highly dynamic manner; independently subject to have less boundaries (*depending to the level of standard*) running different business processes or applications. There might be variations due to changes in business goal and environment in one department, making the services to slightly change or loose-coupled. The effect of the slight change in the business goal or environment plays a risk on the right identification of services.

In recent business world, organizations are subject to changes in requirements and goals, therefore, does it mean the services have to be subject to change as it switches dimension?

For example, an organization 'A' running an open systematic structure has different resulting values of the service design description depending on the task parameters. The organization 'A' can become closed systematic structure as a result of a merge with low centrality system. Therefore, to make the services in open enterprise system to have the right service design description for every changing business case, the following requirements have to be satisfied:

The service identification requirements are as a result of the reviewing and classification of the open single system. In Section 4, the open single system is classified into platform-based and application-based, which have different functionality and principles.

The requirements for identifying services in open single systems are as follows:

a. Analyze the type of services they provide, what means (platform or application-based)
b. If it is platform-based:
    i. The dynamic relationship of the services is defined by analyzing the service orientation of the services identified (*level of loose coupling and abstraction*) in the enterprise system as it changes round the dimensions. In platform-based single system, standardization is not a major concern for the organization; it conforms to the platforms standard. The only concern is the level of coupling, which involves less abstraction.

Else if it is application-based:

    ii. The requirement for application-based is more difficult because it is tailor-made to the business specification. Creating a specific level of interoperable services within an organization using different applications, the following condition has to be met namely: Agreed-up standard, the level of service abstraction, autonomy, statelessness, discoverability, composability and genericity, and loose-coupling of the services.

c. Then, dynamic candidate services from the integrated business processes (*top-down approach*) can be identified depending on the type of system and service orientation.

B. Service Identification requirement for open collaboration

As discussed in Section 2.1, collaboration is a broad topic to dive into. In this paper, collaboration has been dealt with in the area of interaction of partnering organizations, people and machines. Therefore, defining the requirements to identify services in open collaborating organizations,

The service identification requirements are as a result of the reviewing and classification of the open collaboration in Section 4.

a. Analyze the type of services they provide, what means (related or unrelated)
b. If it is related collaboration:
    i. Standardization has to be agreed upon for services to interoperate or adapt on a defined interface.
    ii. Each organization defines its level of abstraction, coupling and service contract duration), as it may changes.

Else if it is unrelated collaboration:

    i. Standardization for unrelated collaboration is more difficult as it needs more consideration on the service orientation. The standard has to be highly agreed-upon, creating a connecting medium for collaboration.
    ii. Each organization have to well-define the standard for collaboration, high level of abstraction, coupling and service contract duration), as it may changes.
    iii. For instance, 'Toyota' and 'Microsoft' can collaborate in one business aspect of their business process or they jointly create new

business processes in the standardized interface.

c. It is required that separate service can keep track of collaborative services' transactions or sessions in the collaborating organization for monitoring accuracy, appropriateness, time behavior, co-existence, user error, authenticity (*service statelessness)*.
d. Therefore, collaborating tasks and entities are defined from the interface. Analyze the level of service orientation of collaborating organizations and its entities.
e. Then, the dynamic services can be identified from the integrated business processes model using the quality and service orientation principles as shown in figure 3.

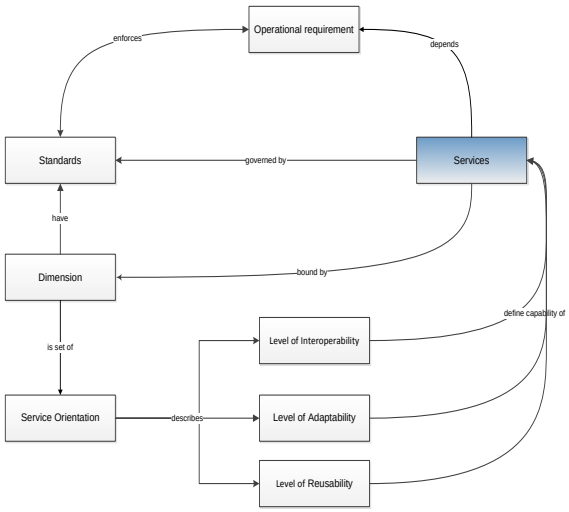

Figure 3.Service Identification Requirement Map

VII. CONCLUSION AND FUTURE WORK

With the changing factors like economy, market competition, security and location, enterprises are subject to changes or improvement in services or systems. We stated that organization agility is achieved when loosely coupled services are identified by knowing the level of service orientation for enterprise system. From these service orientations of the enterprise systems, the requirements for designing new method for identify services are generated.

The next phase of work is modelling service-oriented goals and requirement for enterprise information system and development of an authoring framework requirement for identifying services which facilitates availability of knowing the level of service-orientation of the enterprise system and adapt to changes which conforms to ISO 25010 and SOA principles.

REFERENCES

1. D. Bianchini, C. Cappiello, V. Antonellis, and B. Pernici, "Service Identification in Interorganizational Process Design." IEEE Transactions on Services Computing, 7(2):265{278, April 2014
2. T. Erl, 2008. *SOA design patterns*. Pearson Education.
3. N. Komoda, "Service oriented architecture (SOA) in industrial systems. 4th IEEE International Conference on Industrial Informatics. pp. 1-5 IEEE, 2006.
4. R. Johnston. Towards a better understanding of service excellence. *Manaqinq Service Quality: An International Journal*, *14*(2/3), 2004 pp.129-133.
5. A. Aldris, A. Nugroho, P. Lago, and J. Visser. Measuring the degree of service orientation in proprietary SOA systems. *7th IEEE International Symposium on Service Oriented System Engineering (SOSE), 2013* pp. 233-244.
6. B. Elvesæter, A. Hahn, A.J. Berre, and T. Neple. "Towards an interoperability framework for model-driven development of software systems." In Interoperability of enterprise software and applications. 2006, pp. 409-420
7. E. Yahia, A. Aubry, and H. Panetto. Formal measures for semantic interoperability assessment in cooperative enterprise information systems. *Computers in Industry*, *63*(5), 2012, pp.443-457.
8. D. Carney, D. Fisher, and P.R. Place. Topics in interoperability: System-of-systems evolution. 2005.
9. H. Panetto. Towards a classification framework for interoperability of enterprise applications. *International Journal of Computer Integrated Manufacturing*, *20*(8), 2007, pp.727-740.
10. M. P. Papazoglou,, P. Traverso, S. Dustdar, and F. Leymann,. Service-oriented computing: State of the art and research challenges.*Computer*, (11), 2007, pp.38-45.
11. M. Stal, "Using architectural patterns and blueprints for service-oriented architecture," Software, IEEE, vol. 23, 2006, pp. 54-61.
12. L. Pappano, The Year of the MOOC. *The New York Times*, *2*(12). 2012,pp.20-12.
13. T. Turiera, and S. Cros. 50 examples of business collaboration. Online http://www.co-society.com/wp-content/uploads/CO_business_2013.pdf. Accessed 7th of May, 2016
14. Afsarmanesh, H., Camarinha-Matos, L.M.: Towards a semi-typology for virtual organization breeding environments. In: COA 2007 – 8th IFAC Symposium on Cost-Oriented Automation, Habana, Cuba, vol. 8, part 1, pp. 22(1–12) (2007)
15. Camarinha-Matos, L.M., Afsarmanesh, H.: A comprehensive modeling framework for collaborative networked organizations. The Journal of Intelligent Manufacturing 18(5), 527–615 (2007)
16. L. Cherbakov, G. Galambos, R. Harishankar, S. Kalyana, and G. Rackha. "*Impact of service orientation at the business level*". *IBM Systems Journal*, *44*(4), 2005, pp.653-668