THE INTERNET OF SERVICES

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Abstract: The vision of the Internet of Services (IoS) can be seen as a new business model that can radically change the way we discover, select, invoke and interact with services. In the same way that the Internet can be viewed as a Web of Information, it can also be configured to support an Internet of Services. The IoS describes an approach that uses the Internet as a medium for selling and purchasing services. As a result, services become tradable entities. Service marketplaces, a logical location where providers and consumers are brought together to trade services and to engage in business interaction, are enabling the creation of platforms for the IoS vision. Thus, the IoS provides the business and technical base for advanced business models where service providers and consumers form business networks for service provision and consumption.

1 INTRODUCTION

Nowadays, all industrialized countries have become service-based economies in terms of the distribution of the people employed in the service sector. While the first services were certainly delivered by humans to humans, the advances in computer systems over the past sixty years allowed computers to deliver services to humans. Information technologies have significantly contributed to the evolution of services. Over the years, each generation of innovation has created solutions that automatically execute activities that were once done by human beings.

The historical perspective and evolution of services has not only been confined to the use of machines to automate services. The emergence of the Internet, allied with the World Wide Web (WWW) and e-Commerce which exploded into many aspects of businesses and our daily work, has allowed a remote and generalized interaction between humans and computers. The technological developments in the late 90s have pushed the notion of *service* to *Web service* with the objective of supporting interoperable computer-to-computer interactions over a data network. This type of interaction required services to be autonomous and platform-independent, and needed services to be described, published, discovered and orchestrated using standard protocols for the purpose of building distributed solutions. The emphasis was on the definition of interfaces from a technical and programming perspective. The objective was on computerization, since Web services provide a technological solution to enable enterprise transaction systems, resource planning systems and customer management systems to be accessed programmatically through a digital network. The machine-like nature of the activities executed by theses organizational systems made it possible to develop services that no longer required a human in the loop unless there was a problem. The trend was generally to shift the activities and work made by humans to be executed by machines and computers. This practice is consistent with the raise of the service industry.

The term “IoS-based service” is used to identify services provided through the Internet. These services serve a dual purpose since they can be utilized directly by consumers, but they can also be invoked by technical systems to access business functionality which is provided remotely by business providers. The technical goal of the IoS is to provide models, platforms and tools which make services tradable on the Internet and composable into value-added services. Many research questions around the mapping between real world or economic services and IoS-based services are still unresolved. Additionally, only a small fraction of services can be fully digitalized; the vast majority of services rely on physical elements and human resources. An IoS-based service can be technically described using

conceptual models that capture business, operational and technical information to allow the exchange and trade of services among organizations and consumers. Since the models are a specification with clear semantics, IS and IT can be deployed to enable the automatic invocation of a service using Internet protocols. An IoS-based service model defines a view on services that is provision-oriented and service-centric. The most important feature of the model is a separation of characteristics in terms of business, operational and technical. The characteristics of a service model capture the purpose of a service (e.g. painting a house), the required resources (e.g. business processes, goods people, machines, etc.), and used protocols and standards (e.g. WSDL, WS-Security, etc.).

2 THE ECONOMICAL VALUE OF SERVICES

The intense competition of economies and the globalization of worldwide markets in conjunction with the generalization and expansion of IS and IT have opened up significant opportunities for the conception of new specialized services. Services are becoming quickly more productized. Providers are focusing on services for increased differentiation and creation of consumer value as a source of competitive advantage. In the age of information technology, traditional trading processes which involve a close and intense human interaction are inadequate and can become a burden for companies competing in electronic marketplaces.

Recently, the concept of service has acquired a renewed importance since after several years of public debate, the European Parliament has approved the *service directive* (EU, 2006). This directive intends to enhance competition by removing restrictions on cross-border market access for services in Europe. The implications of this measure for businesses and the IT community are enormous since the service sector represents more than 70% of the Gross National Product and the directive can amplify the consumption of services in the European Union by 0.6% (37 billion Euros) (CE, 2005).

Figure 1 illustrates the gross value added of services in Germany in 2005 provided by the *Statistisches Bundesamt*. Service dominance is not restricted to the more traditional notion of services (e.g., hospitality, healthcare or education) but also appears in less traditional industries such as in the information technology services landscape. Indeed, the services divisions of many IT providers are overshadowing their total revenues.

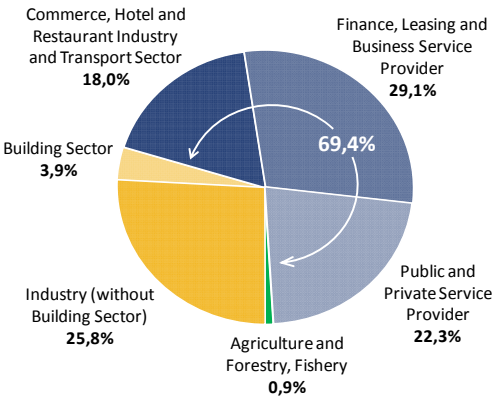

Figure 1: Gross value added of services in Germany.

Services seem to be the new hub for most economies. Infrastructure services such as transportation and communication are fundamental blocks which link to all other sectors. In most countries, one of the largest and most important providers of services is the government which operates in sectors such as water management, public safety and basic healthcare system.

Based on the economic value and importance of services, one question that immediately arises is *how can the Internet provide a solution to create and enable a genuine market for the trade of cross-border IoS-based services?* Since the Internet is now an integral ingredient of the fabric of worldwide societies, economies and commerce, it can intuitively provide a fundamental infrastructure to enable the realization of the Internet of Services. On the one hand, the Internet can host electronic marketplaces to enable the trading of services. On the other hand, new Internet standards and models can be developed to digitally describe services and industries. In turn, these descriptions will be consumed by marketplaces.

3 CHALLENGES FOR THE IoS

Compared to previous approaches to support services -- which were mainly implemented as pieces of software (e.g. Web services) -- developing solutions for the IoS is more elaborate since real world services have very specific characteristics. While e-services and Web services are usually seen mainly as technological entities, the Internet of

Services will take the representation of services one step further. IoS-based services will combine and correlate business, operational and IT aspects into service descriptions.

The support of the IoS requires identifying and understanding the challenges to address to provide solutions to realize this vision. IoS requirements need to have a strong emphasis on the business and IT sides underlying a service. Therefore, the several topics need to be analyzed, studied and framed within IoS. The implications of IoS need to be studied from a legal perspective. The combination and integration of world-wide regulations is fundamental. A special emphasis has to be given to the generation of new business models for all stakeholders (i.e., service providers, brokers, and consumers) and corresponding incentive mechanisms. Community aspects encourage cooperation, innovation and boost innovations through the extensive exchange of knowledge.

Efficient approaches for fostering innovation are required. Innovation suggestions can be derived from successful and unsuccessful discovery efforts made by service users, from service communities or from information sources in the Internet.

An infrastructure for service delivery has to be provided for technically enabling businesses to participate in IoS. This infrastructure has to be scalable with respect to complexity, i.e., its users must be able to counter the intricacies of distributed systems. Furthermore, the platform should support brokering, mediation, billing, security and trust services. Trust and trustworthiness of service offerings must be facilitated by the platform, balancing individual requirements, policies, and must be capable of adapting to the given business context.

Service engineering methodologies need to be proposed to involve and integrate software and service providers by giving methods and tools for constructing and deploying services. The support of governance is indispensable to addresses the strategic alignment between business services and business requirements thereby reducing risks and assurance compliance with rules and regulations. The ability to freely compose and orchestrate business functions which are available as services on a diversity of market places bears overwhelming opportunities.

Before proposing and architecting solutions for the IoS and for IoS-based services, it will also be fundamental to understand the nature of real world services since it is this type of services that will be digitalized and represented with proper models to enable their trading over the Internet. Services are often known to have one or more of the following characteristics: intangible, inseparable, immersive, bipolar, variable, ostensible, long-running, decoupled, perishable and qualitative.

4 TEXO PROJECT

TEXO (Texo, 2008) project main goal is to develop a new generation of marketplaces for IoS-based services. The TEXO comprises an overall research vision which attempts to identify business models and technologies to support an Internet of Services. It targets the development of an (open) platform for the development, distribution and provision of (business) services by supporting IoS-based services.

TEXO project is part of a broader program: the THESEUS (Theseus, 2008) initiative. THESEUS program is funded by the Federal Ministry of Education and Research in Germany and targets the development of prototypes based on new emerging technologies and test them in six application scenarios. The purpose of the tests is to find short-term ways of converting new technologies into innovative tools and commercially-viable services for Internet-based networks. As stated, the development of concepts and prototypical implementations are organized around six application scenarios: ALEXANDRIA (Consumer oriented knowledge database), CONTENTUS (Safeguarding cultural heritage), MEDICO (Towards scalable semantic image search in medicine), ORDO (Organizing digital information), PROCESSUS (Optimization of business processes), and TEXO.

The outcomes of early prototypes will be fundamental to test the applicability of new technologies and business models. The positive validation of innovative models will be the first gateway for their adoption by the industry.

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BRIEF BIOGRAPHY

Prof. Dr. Jorge Cardoso joined SAP Research, Germany, in 2007. He previously gave lectures at the University of Madeira (Portugal), the University of Georgia (USA) and at the Instituto Politécnico de Leiria (Portugal). He has worked at the Boeing Company (USA) on enterprise application integration and at CCG, Zentrum für Graphische Datenverarbeitung on Computer Supported Cooperative Work Systems. He has published over 90 refereed papers in the areas of workflow management systems, semantic web, and related fields. He edited several books, and organized several international conferences on Semantics and Information Systems.