Internet of Services

Lecture-11

The Internet of Services (IoS) enables the service vendors to offer their services via the Internet. Internet of Services is considered by many authors as one of the main pillars of Industry 4.0. It refers to the interconnection and interaction of various services through internet. In the Internet of Services envisioned, services and functions are represented as software components and made available by providers via the Internet (cloud). In the Internet of Services, cloud based development and service platforms from a variety of market players provide the simple option of developing and offering web-compatible services.
The IoS's main goal is to present everything on the Internet as a service, including software applications, platforms for developing and delivering these applications, and underlying infrastructures (CPUs, storage, networks, and so on).
An important aspect that characterizes Internet services is availability, measured in terms of average service availability over a given time period. Two factors that affect availability are reliability (the probability that a system fails within a given time period) and resiliency (a system's ability to reach and maintain an acceptable level of service when faced with various faults and challenges to normal operation). Incorporating different techniques to improve the availability, reliability, and resiliency of services deployed in cloud infrastructures is essential to supporting the future IoS. Some existing IaaS cloud platforms have introduced various features to provide high availability and failover functionality at the virtual machine (VM) level (for example, by detecting VM crashes and automatically restarting the VM) and the physical server level (for instance, by detecting server hardware failures and redeploying all the VMs on another server).

Depending on the possible degree of digitalization services can be offered and demanded world-wide. Services are offered and combined into value-added services by various suppliers; they are communicated to users as well as consumers and are accessed by them via various channels. The IoS consists of participants, an infrastructure for services, business models and the services themselves. The idea of the IoS has already been implemented in a project named SMART FACE under the "Autonomics for Industry 4.0" program initiated by the German Federal Ministry for Economic Affairs and Energy. The project has developed a new distributed production control for the automotive industry, based on a service-oriented architecture. This allows the use of modular assembly stations that can be flexibly modified or expanded.
The services can support both functional and technical features. Apart from technical aspects, several business-related questions arise: What are sustainable business models for suppliers of such services? To what extent should interfaces or access to platforms be based upon open standards? Which positions can be taken by suppliers of traditional software or media in such markets? How can billing be organized in an efficient way? To what extent is regulation of service markets necessary from an economic point of view? Another interesting question arises with regard to who actually offers such services. Of course, "traditional" companies like SAP, Oracle, Microsoft or Google are among the suppliers. In addition, an increasing number of services are offered by suppliers that are not supported by one of the traditional companies. This, for example, could recently be observed in form of services for the iPhone or for platforms like Facebook.
There are a growing number of projects in business and information systems engineering dealing with the subject "Internet of Services". The most prominent one is the project THESEUS. It was initiated by the German Federal Ministry of Economics and Technology and deals with technical as well as economic aspects of the issue. In addition, there are several smaller initiatives in different locations which are concerned with particular aspects of the subject, e. g. security. The aim of this issue of Business and Information Systems Engineering is to provide an overview of these activities.
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The term Internet of Services raised from the convergence of other two concepts: Web 2.0 and SOA - Service-oriented architecture. The first concept, Web 2.0 is characterized by four aspects: interactivity, social networks, tagging and web services.
Interactivity: The communication and the dynamic manipulation of data between a server and the Web browser

Social networks: the social networks up come based on common interests and make the information from each network available through different ways

Tagging: users can add a key-word as a tag to a certain Web content, making this tag easily reachable when searched by other users

Web Services: allow that other software make use of the features offered by a Web application, being available not only to people but also to machines.

Service Oriented Architecture (SOA):

The Service Oriented Architecture – SOA - can be explained through two different angles. From a business perspective, it represents a set of services that improve the capability of the company to conduct business with customers and suppliers. From a technology perspective, it is a project philosophy characterized by modularity, separation of concerns, service re-uses, and composition, as well as a new programming method based.

Through the concept of Service-Oriented Architecture, new applications can be assembled from the available components and services, like a LEGO®. In SOA, all applications in an organization can offer and consume services in a unique and integrated communication channel, called Enterprise Service Bus, as a simple way to facilitate integration

SOA is a way of designing and building a set of Information Technology applications where application components and Web Services make their functions available on the same access channel for mutual use. In order to satisfy these requirements services should be
• Technology neutral: they must be invoked through standardized lowest common denominator technologies that are available to almost all IT environments. This implies that the invocation mechanisms (protocols, descriptions and discovery mechanisms) should comply with widely accepted standards.
• Loosely coupled: they must not require knowledge or any internal structures or conventions (context) at the client or service side.
• Support location transparency: services should have their definitions and location information stored in a repository such as UDDI and be accessible by a variety of clients that can invoke the services irrespective of their location.

Classification of IoS:
The IoS can be classified as business service, e-service and web service

Business Service: In business and economics, a service is the non-material equivalent of a good. In these domains, a service is considered to be an activity which is intangible by nature. Services are offered by a provider to its consumers. It is defined as business activities provided by a service provider to a service consumer to create a value for the consumer. Therefore, business services may be performed by humans. Examples include cutting hair, painting a house, typing a letter, or filling a form. If a service is executed by means of automated mechanisms then processing an insurance claim is also considered a service. Services are considerably different from products primarily due to their intangible nature. Most products can be described physically based on observable properties, such as size, color, and weight. On the other hand, services lack of concrete characteristics. Thus, services must be defined indirectly in terms of the effects they have on consumers. Products have usually a well-defined set of possible variants for customization. For example, if a consumer requires a faster laptop, a more powerful CPU can be designed, built and attached to the motherboard. If an important consumer (e.g. Yellow Cab Co.) desires yellow cars, a manufacturer only needs to notify the production chain to select a new color. The same cannot be easily achieved for services. This makes the description of services one of the most important undertakings for the IoS.

Web Services: Web Service is defined as "a software system designed to support interoperable machine-to-machine interaction over a network". It has an interface described in a machine-process format that informs what the service does and how to call its functions. Basically, Web Services on-line delivery functionalities (called services) offer simple input and output interfaces – hiding its internal structure and programming language – that can be used by other Web Service, software application or machine, as well as humans
Web Service. Web services are e-services that are made available for consumers using Web-based protocols or Web-based programs. Separating the logical and technical layers specifications of a service leaves open the possibility for alternative concrete technologies for e-services. Nowadays, we can identify three types of Web services: RPC Web Services, SOA Web Services, and RESTful Web services. RPC Web Services bring distributed programming functions and methods from the RPC world. Some researchers view RPC Web services as a reincarnation of CORBA into Web services. SOA Web Services implement an architecture according to SOA, where the basic unit of communication is a message, rather than an operation. This is often referred to as "message-oriented" services. Unlike RPC Web services, loose coupling is achieved more easily since the focus is on the "contract" that WSDL provides, rather than the underlying implementation details. RESTful Web Services are based on HTTP and use a set of well-known operations, such as GET, PUT, and DELETE. The main focus is on interacting with stateful resources, rather than messages or operations (as it is with WSDL and SOAP). [4] describes REST objectives in the following way: "The name 'Representational State Transfer' (REST) is intended to evoke an image of how a well-designed Web application behaves: a network of web pages (a virtual state-machine), where the user progresses through an application by selecting links (state transitions), resulting in the next page (representing the next state of the application) being transferred to the user and rendered for their use." We also consider that any e-service that can be invoked using Web standards, such as HTTP, is also a Web service.

E-Service: "e-service is a collection of network-resident software services accessible via standardized protocols, whose functionality can be automatically discovered and integrated into applications or composed to form more complex services." E-services are services for which the Internet (or any other equivalent network such as mobile and interactive TV platforms) is used as a channel to interact with consumers. With the advances made by the Internet, companies started to use electronic information technologies for supplying services that were to some extend processed with the mean of automated applications. At this stage, the concept of e-service, electronic- or e-commerce was introduced to describe transactions conducted. over the Internet. The main technology that made e-commerce a reality was computer networks. Initial developments included on-line transactions of buying and selling where business was done via Electronic Data Interchange (EDI). Examples of such transactions include an EDI request for bank transfer or a money transfer via a private network. Virtually any service can be transformed into an e-service if it can be invoked via a data network. It should be pointed out that this definition implies that the ability to withdraw money from an ATM machine is supplied trough an e-service. E-services are independent of the specification language used to define its functionality, non-functional properties or interface. The term Internet Services will be used be used to refer to the discovery and invocation of e-services using the Internet as a channel.

Examples of Internet of Services:

Tesla is delivering vehicles with hardware and software which can be upgraded, their cars are sensor ready and software upgrades will provide extra intelligence, delivered via the internet. The customer could pay for the upgrades which then generates extra revenue for Tesla.
Otis is supplying elevators/lifts with sensors which send data into their cloud. The data is analyzed and Otis sells a predictive maintenance services package, again adding a long-term revenue stream.
A catering company in The Netherlands is supplying custom meals to hospitals. Each meal is prepared for the patient based upon data received from the hospital about the patient's needs. The meals are prepared in an automated plant.
Electronic marketplaces for products have gained much attention over the last years enabling business interaction between providers and consumers of physical goods. Examples of such marketplaces include eBay and Amazon. In the IoS vision, services are seen as tradable goods that can be offered on service marketplaces by their providers to make them available for potential consumers.

Challenges of Internet of Services:
Scalability of services: Although there are many services that are static in nature from the view pint of their size but still the services experiences fluctuations due to workload.

Monitoring of Services: Most of the mechanism of billing including payment as offered by providers are based on resources of individual users as per their consumption time based on unit.

Context awareness of applications: One of the key challenges of the future of IoS is to address the increase in the information relevancy within a given context. Of becoming more aware in specific application and services such as social networking, computational environment and various other mobile applications. This context awareness adapts certain behaviors related to the environment such as activity of users, accessing of devices, location or people who are nearby.