

Chapter 2

Framework for Supporting Web-Based Collaborative Applications

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Abstract The article proposes an intelligent framework for supporting Web-based applications. The framework focuses on innovative use of existing resources and technologies in the form of services and takes the leverage of theoretical foundation of services science and the research from services computing. The main focus of the framework is to deliver benefits to users with various roles such as service requesters, service providers, and business owners to maximize their productivity when engaging with each other via the Web. The article opens up with research motivations and questions, analyses the existing state of research in the field, and describes the approach in implementing the proposed framework. Finally, an e-health application is discussed to evaluate the effectiveness of the framework where participants such as general practitioners (GPs), patients, and health-care workers collaborate via the Web.

2.1 Introduction

Services account for large part of the world economy in the developed nations and increasingly large part of developing economies. Services science [1, 13] focuses on theories and methods from many different disciplines at problems that are unique to the service sector.

The dynamic nature of services increases the complexity of service management that attracted various related efforts offering solutions from certain aspects. For example, in an e-health environment, there can be new services arriving from a new primary care provider, while due to the workload some existing services become temporally unavailable. Another example is when a patient goes to a GP with a

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fever, responses (i.e., services) from the GP can range from a simple straightforward solution to a complicated one depending on the information collected on the patient.

Many firms are under increasing pressure from globalization, automation, and self-service, with which service chains can be assembled to form quickly strong competitive threats [14]. Providing services cost-effectively and rapidly especially in today's challenging e-business environment forces companies to interchange documents and information with many different business partners. The new competitors have created network organizational models that increase their innovative capacity and sensitivity to users in defining new products and applications.

2.1.1 Barriers and Obstacles

In a rapidly changing and increasingly complex world, service innovation requires new skills and associated underpinning knowledge to marshal diverse global resources to create value. Frequently, these resources are accessed using advanced information technology. Most academics and government policy makers are still operating in a manufacturing production paradigm rather than in a services paradigm. Change is slow, and this has a negative impact on service innovation rates.

There are many reasons why the shift to a new logic based on services has been slow to happen [26]. Nevertheless, pioneers in service research have reached initial satisfactory results and are calling for a wider range in service research [23].

The research presented here aims to explore the possibility of bringing coherence into the emerging strands of knowledge through a framework supporting Web-based collaborative applications. It builds on the theoretical foundations of service science where services are essential operations within the framework.

2.1.2 Research Motivations

There are several motivations for this research. First, it aims to incorporate knowledge management techniques [2, 22] into the proposed framework to support the automated service management. Second, it proposes mechanisms supporting intelligent use of resources based on context-aware computing [7] within the framework. It will thus enhance the framework's intelligence to process users' request by generating solution plans with the assistance of context-aware computing techniques, and dynamically managing services arrival, departure, and emergency through service management.

2.1.3 Benefits

The framework aims to provide benefits to the participants in the following way. For service providers, knowledge of services can be conveniently and effectively acquired which is going benefit a wider community of users through shared knowledge repositories. For service requestors, a dynamic service management mechanism is to be provided to meet any new requirements through cost-efficient solutions as only the required services are used during the solution process.

2.1.4 Research Questions and Aims

The main objectives therefore will prompt the following questions to be answered:

“How can service systems be understood in terms of a small number of building blocks that get combined via the Web to reflect the application requirements?” How can service systems be optimized to dynamically support services availability and autonomously reacting to changes in the application environments? The research aims to benefit users across different industry sectors and include business owners, providers, and customers who can engage with each other regardless of boundaries and locations. It also aims to make academic contributions toward real-time semantic services research through integration of knowledge management and services computing. The trend of semantic services research in the context of services oriented architecture (SOA) has been comprehensively studied in Martin et al. [17, 18].

2.2 Research Background

2.2.1 Service System

The research attempts to bring together knowledge from different disciplines through a services management framework. Without a clear understanding of service system and its service management infrastructure linking different domains, knowledge will continue to be fragmented. A service system can be defined as a dynamic value co-creating sets of resources including people, technology, organization, and shared information, all connected internally and externally by value propositions, with the aim of meeting customer’s needs better than competing alternatives. For instance, Fuchs [9] may have been the first to define services effectively as coproduction. Service management and service operations were proposed and extensively discussed by Fitzsimmons and Fitzsimmons [8] on service management and by Sampson [24]. Tien and Berg [25] recently demonstrated the need for service systems engineering.

Within a service system, interactions among resources take place at the service interface between the provider and the customer. Service science aims to provide a clear and common understanding of service system complexity. Hofmann and Beaumont [11] proposed an architecture to support connecting content services across network. The work focused on a fast personalized content delivery between two Internet endpoints with the architectural support to authorize, invoke, and trace application-level services. The architecture promotes open pluggable services that have compatible concepts in dynamic service management with the proposed research framework. However, it is focused on efficient user-specific content delivery between two Internet endpoints rather to explore the efficient use of existing resources (that are in the form of services) as proposed in this research. The success of modern service system development depends on integrating and delivering high-quality services within budget (i.e., the cost and quality factors). In this environment, there will be a great need to deliver robust and reliable application in less development time. To meet this challenge, software developers will seek using existing resources and methods to automate software design and deployment [16].

2.2.2 Dynamic Re-configurable System

The proposed research adopts the concepts of dynamically re-configurable systems by Hofmeister [12]. These systems use explicit architecture models and map changes into the existing models to the application implementation [20], which showed the limitations on flexibility, e.g., the existing models might not cover all the application requirements. The research on self-adaptation systems made further advancement and improvement on the dynamic aspects of the reconfiguration. Self-adaptation through dynamic reconfiguration is studied in Kon and Campell [15] and Georgiadis et al. [10]. Georgiadis et al. [10] explored the possibility of constructing self-assembling and self-adaptive applications, however, their approach required the adaptation logic written by programmers. To improve the usability of the adaptive technology and reduce development cost, research in software glue code [6] provided insights on the requirements for a complete integration solution through Integration Completion Functions (ICF), which is used as a metric in managing the effectiveness of our adaptive services toward business-oriented problems solving. However, the dynamic aspects of the solution processes in response to external requirements were not addressed. To help close this gap, Dai and Liu [4] proposed a self-adaptive system based on dynamic pluggable services supported by the OSGi framework (url: <http://www.osgi.org>). The OSGi specification defines a service platform that includes a minimal component model, a small framework for managing the components, and a service registry, which opens up the further services computing research as proposed.

2.3 Solution Approach

The outcome of studying service science from information technology (IT) and information systems perspectives [19] leads to a basic configuration of the proposed research framework including its fundamental components, i.e., service requestors, service providers, service registry, and repository.

2.3.1 Dynamic Services Management

The dynamic nature of services (e.g., arriving, departing, and emergency events) increases the complexity of service management, which attracted services from various aspects. Service providers, business owners, and service consumers interact through a service management infrastructure provided by the framework across the Web.

The infrastructure consists of Service Management, Service Bus, Service Registry and Repository, and Business Logic Modules interacting with each other as described in Figure 2.1. In this figure, service providers publish online services information as well as services meta data (such as those leading to services policy) into the Service Registry and Repository through the Service Management module. The Service Requestor receives the composed services via Service Bus after sending request to Service Management. Service Management responds to service request by invoking the relevant business logic modules provided by Business Owners to assist services discovery, composition, and execution before delivering results to Service Requestor.

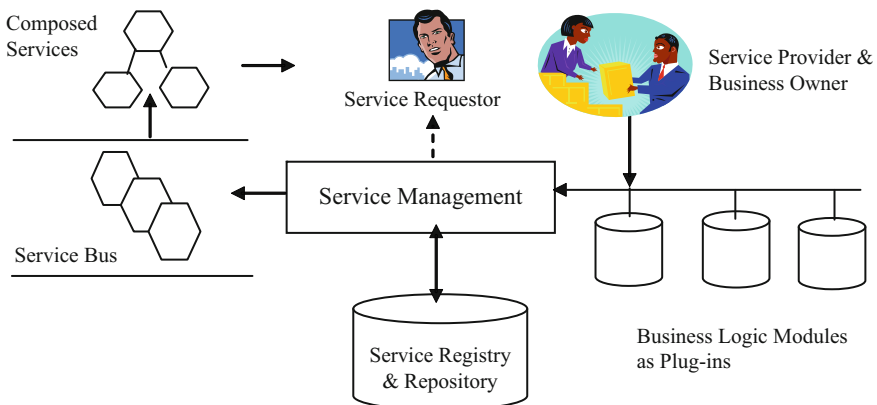


Fig. 2.1 Service framework supporting Web-based collaborations

2.3.2 Service Availability

In order to provide context-aware services management, services discovery, composition, and execution eventually need to be explored. Existing knowledge is limited to serve specific users who are knowledgeable about the services being provided. The new demands from customers may require service providers to frequently change (or modify) their services to fully satisfy the need of the customers. However, existing practice can only offer information solutions by using currently available services with predefined process or procedures [21].

One challenge here is to offer dynamic service availability where services may appear or disappear at anytime according to the sensitivity of task context. Service failures may occur, for example, when a server crashes or when a user simply walks out of wireless network range. These types of occurrences require that applications using the failed services deal with their dynamic departure. Likewise, applications may have to deal with dynamic service arrival when servers or network connections are restored or when completely new services are discovered. An important aspect of service dynamic availability is that it is not under application program control, which requires that applications be ready to respond at any time to services arrival and/or departure.

2.3.3 Services Invocation and Execution

The essential tasks, therefore, come down to service discovery to allow service management to pick up potential services, followed up by services composition and execution. The framework uses a plan generator for services-discovery and service-dependency generation as the basis of service composition. Services execution is performed by plan executor as shown in Figure 2.2. The plan generator and plan executor were described in Dai [3], which are tailored in this research with OSGi facilities to support dynamic service management.

Under the proposed approach, the service system is formed by dynamic building blocks, some of them in our terms called core services, others are services provided by third parties. The core services are those managing knowledge, data, tasks, and communications. Depending on the application needs, the services are packaged through orchestration processes.

In order to economically manage software resources, i.e., invocation of minimum level of services, context-aware computing techniques are used to provide goal-driven solutions in a dynamic way. The framework incorporates INDEX knowledge management components that have recently been deployed as services [5] to assist dynamic and intelligent allocation of resources according to each inbound task. The task description module and business logic modules of INDEX are reused and tailored to meet the needs of context-aware processing.

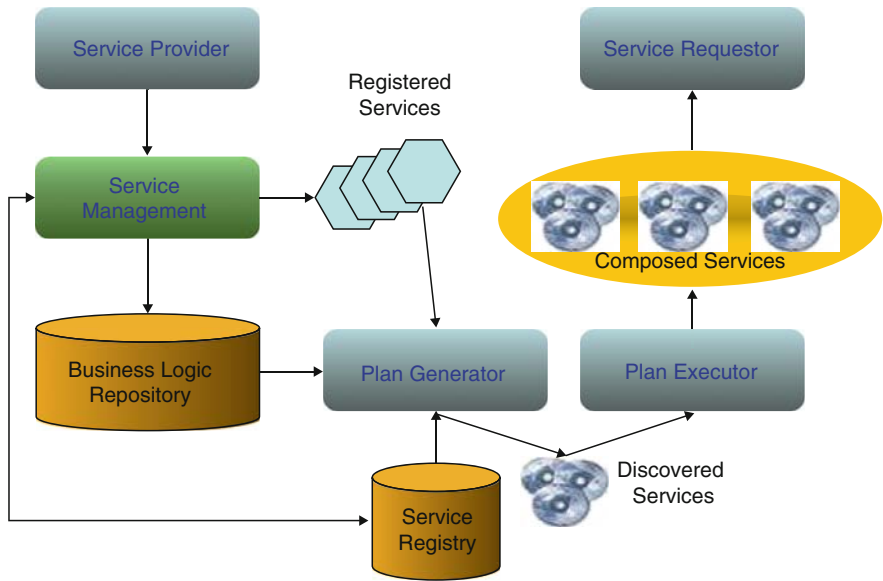


Fig. 2.2 Key process of service management

2.4 Application – Web-based Solution for e-Health

The dynamic collaborative framework as proposed is generic to different sectors. It depends on the sources of the domain knowledge as plug-ins, which will make the model domain dependent. Again, the plug-ins of domain knowledge sources depend on the tasks received. In this section, we use the e-health domain as an application example for the framework.

The main goal of the e-health application is to provide diseases management by assisting GPs generate care plans for patients and monitor the progress of those care plan, in anticipation with a number of health-care providers such as hospitals and third-party care providers. The solution is delivered through the Web where all the operations take the form of services. Services work with each other through a Health Service Bus (HSB) based on a vendor's product. Patients' progress of the disease management is reported and monitored remotely through devices.

In the application environment, as described in Figure 2.3, there are key players and technical entities, specifically, service providers including chronicle diseases management operator (CDMO), hospitals and third-party providers; service requestor including GPs and patients.

Requestors and providers work together through a service registry along the HSB. Service request (e.g., originated by a GP) can be issued at any time. CDMO responses as one of the providers by generating a suitable care plan which is to be progressed along with other service providers (such as hospitals) through care plan monitoring.

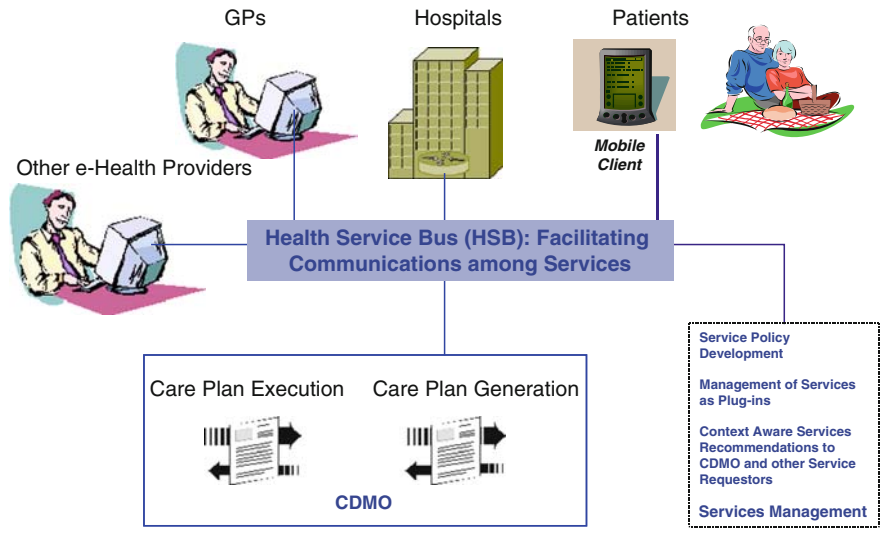


Fig. 2.3 Web-based e-health application

Service management is based on service policy in conjunction with service registry. Services can arrive and leave and can become unavailable. The dynamic services management is supported by plug-and-run paradigm. The application supports the HSB as a service provider specializing in plug-ins management for anticipating services. Therefore it is beneficial to the users to gain transparency in terms of the relevance and availability of other services.

A unique feature of the application is its context-aware capability to dynamically identify the relevant services according to the current focus of attention within the e-health framework. The service management functionality of the framework provides feedback to CDMO via the HSB to facilitate various providers (or members including new members) utilizing the services provided by the health network via the Web.

There are several contributions of this application to the e-health framework, which are: (1) providing Web-based context-aware solutions to CDMO to make effective use of available resources; (2) providing technical support in service policy development and management of dynamic services as plug-ins; (3) knowledge sharing from services providers to consumers.

Figure 2.4 gives a snapshot of a Web-based client receiving medical recommendations through relevant services working behind the scene.

The application is implemented on the OSGi platform ([url: www.osgi.org](http://www.osgi.org)) where the dynamically required services are invoked as plug-ins. Currently, the implementation state of the framework is a research prototype. To demonstrate the generic aspects of the proposed research, the prototype of the framework was also applied in the supply-chain sector [5].

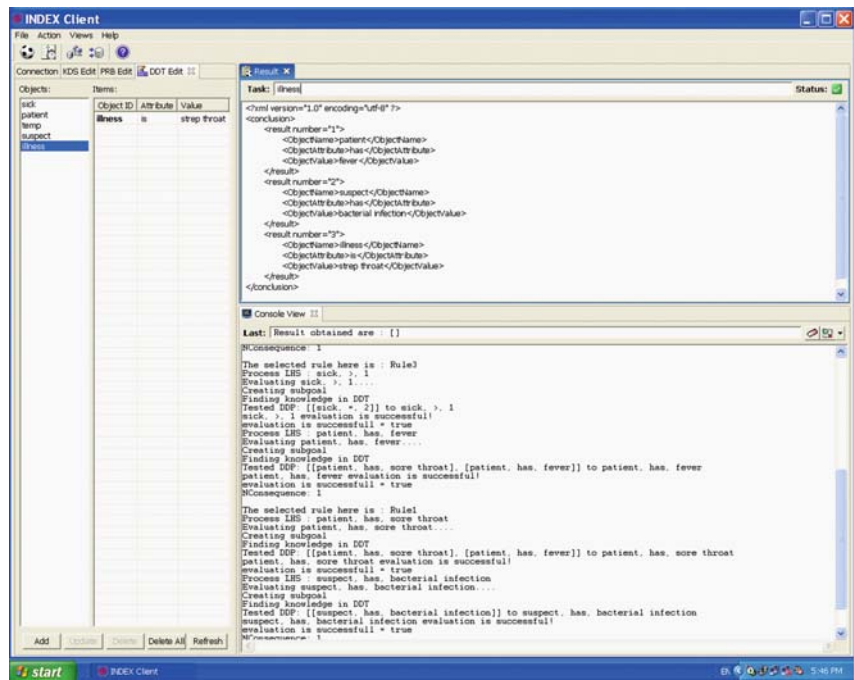


Fig. 2.4 A Web-based client program receiving medical advice

2.5 Conclusion

The article discussed the current state and emerging trend of service science and proposed an innovative approach of integrating and utilizing information resources in the form of service through the Web. It opens up an opportunity for service consumers and service providers in general to collaborate across the Web. Users of various needs including owners of business logic can make economical and flexible use of the services provided by the proposed solutions, therefore significantly increased the use of Internet to support each individual’s need.

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