A New Platform for Delivery Interoperable Telemedicine Services

Foteini Andriopoulou and Dimitrios Lymberopoulos

Wire Communications Laboratory, Electrical and Computer Engineering Department, University of Patras,
University Campus, 265 04 Rio Patras, Greece
{fandriop,dlympero}@upatras.gr

Abstract. This paper represents a new concept for Telemedicine service delivery. It is based over the existed Service Delivery Platforms (SDPs) with the mentality of SOA and Enterprise Service Bus (ESB) architecture to provide integration and interoperability in telemedicine aspects over the Next Generation Network (NGN). Telemedicine SDP (T-SDP), which is proposed, is a lighter middleware to provide flexibility and integration in emergency cases. Lighter middleware supports the benefits of SDP, real time monitoring and communicating in responses. T-SDP is able to leverage contexts, semantics and events via a service engine and Parlays. In the same platform events from the biomedicine devices, context from user profiles and messages or ontologies and semantics can interoperate with each other and create complex services useful for the healthcare agents.

Keywords: telemedicine, healthcare, interoperability, integration, SDP, ESB, NGN.

1 Introduction

According to recent statistic researches, world's ageing population and average of chronic diseases are increasing rapidly, leading to high demand of healthcare services. Telemedicine involves the delivery of healthcare and related information over long distances, reducing the response time and cost [10].

During the last years many efforts have accomplished to create secure, interoperable, flexible and user-friendly telemedicine systems. Mobile telemedicine has enhanced, smart homes and smart cars have created but the aspect of interoperability, integration and real timing response is always a sensitive and significant issue.

Nowadays, there are different types of service buses that are depending on what a device, a web service, etc use as an output e.g. events, contexts or semantics. It is useless, expensive and doesn't support interoperability to establish different service platforms for all these kinds of ESBs or create a single SDP, which contains all the different types of service buses in order to create an interoperable common service delivery platform that could be standardized and work properly with all enterprises. In this paper we introduce a telemedicine ESB (TSB) in a SDP to solve integrated and

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interoperable problems in large scale enterprises such as hospitals, laboratory institutes, etc and provide flexibility and maintainability. The proposed SDP for telemedicine purposes (T-SDP) is used to delivery, compose, deploy services to create reusability and make different context, event, semantic components to become interoperable with each other.

The innovation of our proposition is, a service delivery platform based on ESB and SOA which provides a *lighter service execution environment*. The lighter the SDP is, the more efficient services are used, reused, created, bund and invoked dynamically in a real world period of time. This aspect is significant in telemedicine field where we have thousand of events only from one sensor and many agents in a common scenario to avoid "spaghetti" communication problems. Not only it is important to have the best architecture but also to be interoperable and flexible in real time responses when the patient is moving, running or when he changes connecting devices and destinations which are not according to his daily program. In our proposition the T-SDP isn't consisted of enablers that are used in classical architectures. This makes T-SDP lighter and flexible, moreover according to the enablers from the network can support properly through APIs and JAINSLEE all different type of output which referred above.

These characteristics make our platform valuable in the telemedicine and enterprise fields and are expected to play an active role in standardizing SDPs.

2 Basic Approach

As a result of the increased life expectancy and chronic diseases, the growing financial costs in healthcare leads to the need of organizing healthcare away from hospitals and clinics and providing a patient- centric, more user-friendly system where patients would have a significant and centric role in their own treatment and care of their illness. Moreover, connects patients with their healthcare professional team and helps them to be socialized without changing their preferences and daily habits.

Figure 1 represents a common telemedicine cooperative working group of subjects, hereafter referred as agents. Each one of the cooperative agents can be simultaneously either a provider or a consumer (such as client - server).

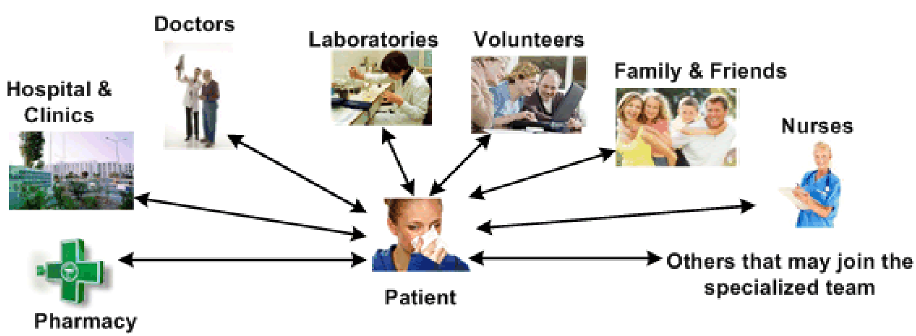

Fig. 1. Cooperative agents in healthcare based on patient-centric philosophy

Due to the fact that healthcare is transferred in the environment of patients (home, car, office, etc) it is important to support patient mobility (monitoring of remote vital signs, mobile medical records etc). S.Van Hoecke, K.Steurbaut, et al, have designed and implemented a secure and user-friendly broker platform supporting the end to end provisioning of e-homecare services to solve the problem of patient mobility and provide interoperability via an open ESB [1]. Although, the solution for healthcare interoperability provides many advantages for the use of ESB and eliminates the startup time since it is required only a login to be authenticated and accessed to the e-environment services, it is premised all the e-environment services to be integrated in a single client application and doesn't support different type of contexts, events etc. This paper proposes not only a middleware architecture like ESB, but a SDP middleware based on the benefits of ESB. To achieve authentication with only one sign in and save time we have lighten the SDP platform removing the service components, so that e-environment services can be anywhere, integrated and transferred via APIs, Parlay, OSA etc in the SDP via the JAINSLEE and ESB (Fig. 2). The authentication will take place in SDP and since the validation is controlled and guaranteed is the first and last time the system requires the electronic health pass card. Moreover, due to the fact that the application, services are integrated and connected to TSB can support different contexts.

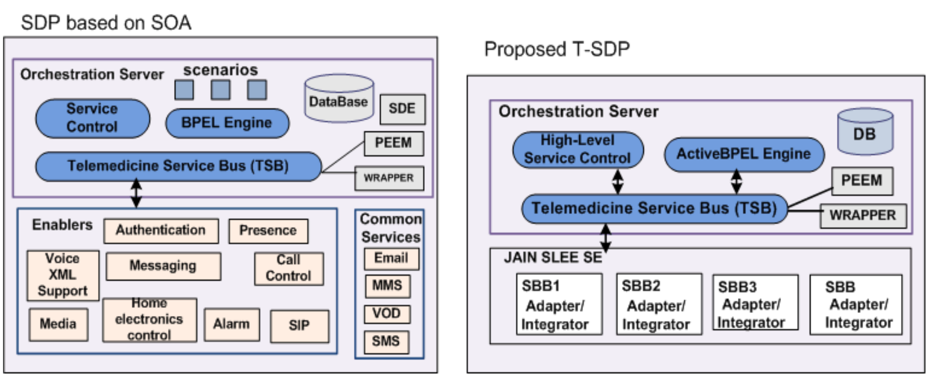

Fig. 2. Traditional architecture of SDP based on SOA and the proposed T-SDP

Jaime Martin, Mario Ibanez et al have published an e-Health system for a complete home assistance [2]. E-health system tried to adjust integration and openness to telemedicine services and leave for future work a manner to generate medical alerts based on the patient health data and usability of applications. In our approach ESBs are established in the environment of patient and biomedicine vital signals are sent in SDP. The ESB provides management mechanisms for troubling states on the NGN, that's the reason ESB is expanded in the business support system of NGN as shown in figure 3. Moreover, according to a survey on web services in Telecommunications [3], JAINSLEE's framework contains Alarms, Timers, profile information and emergency states which are mediated via ESB to inform agents. The reusability of all the services and applications is guaranteed in SOA and ESB architecture.

3 Architecture of the Proposed T-SDP

T-SDP is a middleware software architecture which is established between the service stratum of NGN and the applications provided by 3rd party providers. T-SDP communicates through Telemedicine Service Bus with NGN Business Support System (BSS) for the purpose of management in the service stratum and Operation Support System (OSS) in transport stratum. Figure 3 depicts the proposed T-SDP structure, which is aligned with the majority of SDP architectures.

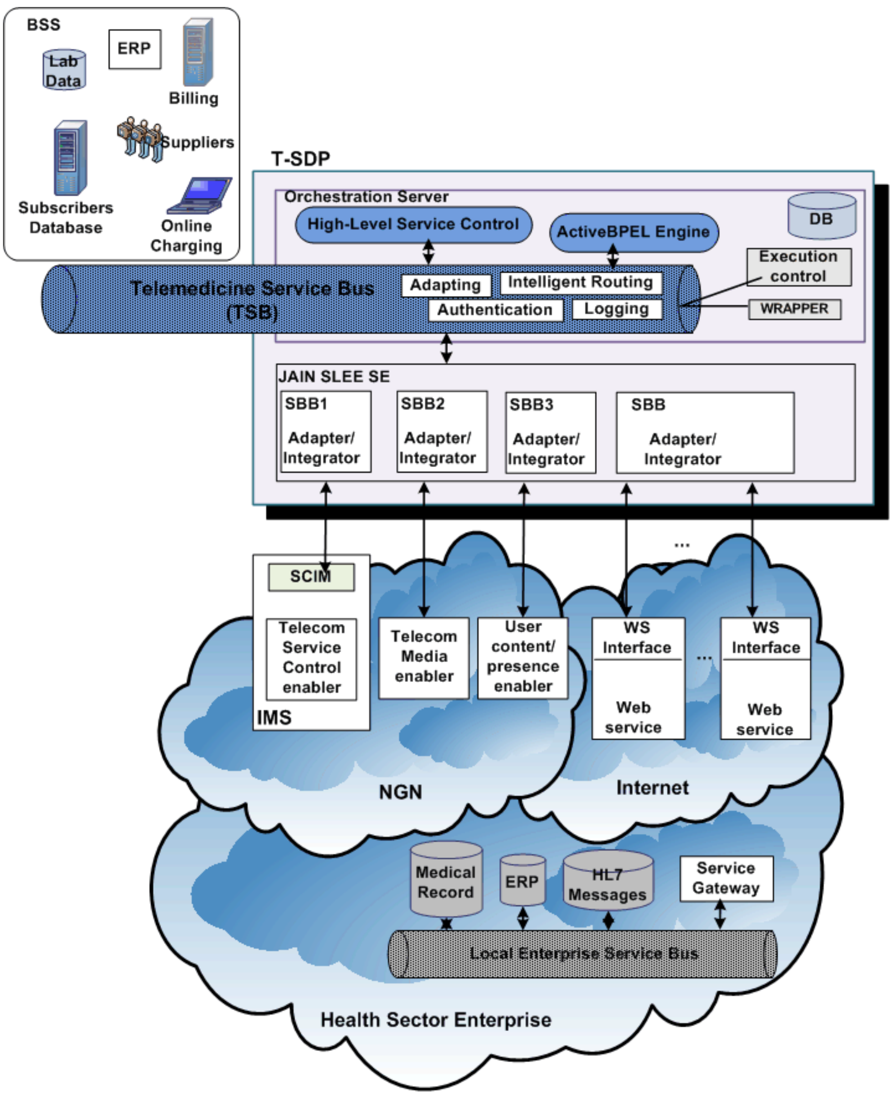

Fig. 3. Proposed architecture of T-SDP

In our approach, enablers are provided from the network, internet and health sector enterprises. By the term health sector enterprises we depict smart e-homes, smart cars, e-ambulance, hospitals, etc. T-SDP leverages adopters and integrators of telecom Media enablers (voice, video, audio etc), Service Control enablers (signaling, calling, controlling etc), User content enablers of networks like GSM, 3G, NGN, web services, and applications and services from the health sector enterprises. The Service Capability Interaction Manager (SCIM) function block is necessary to control SIP messages between the network and enablers. The SCIM distributes messages to appropriate destinations based on customer profiles or SIP parameters, blocks inconsistent messages, relays messages between Application Servers (ASs) and enablers, and controls service contention [5]. Then, T-SDP authenticates patients via the PEEM, mediates intelligent route requests and composes more complex services and application from these fine- grained components to create a new required service for a healthcare agent or patient.

Since T-SDP is a light middleware software architecture, it doesn't contain enablers but points of integrations supported by JAINSLEE service engine. Integration of service components and APIs takes place away from T-SDP, and in the database of T-SDP there are only copies of required services and not all the information of applications servers. These reasons provide flexibility in the T-SDP and reusability in real time action, so make T-SDP platform challenging for emergency occasions.

The T-SDP is composed of:

The *Orchestration server* is provided by a service bus in the role of service broker which connects and controls all workflows and manages processes and components such as enablers and BPEL engines. Orchestration server controls the business process, implements the SOA paradigm (find, publish, bind and invoke) and involves the intelligent routing and capabilities of Service Bus. Orchestration server is composed of:

Active BPEL (Business Process Execution Language) engine. BPEL is a process - oriented language which is used in web services for describing workflow composition of services, invoking purposes, handling asynchronous communication and event subscription. BPEL engines are stateful and able to interpret the BPEL language. Moreover support different context awareness scenarios for service coordination depending on patient's or agent's needs and preferences. Active BPEL is an open source BPEL engine written in Java which can read BPEL code and related standards, and create its own representation of BPEL processes. When a client invokes a BPEL process, the engine creates a new instance of it by translating patient's or agent's request in each scenario. The appropriate services are found according to policy, bound and invoked dynamically. Because Active BPEL is an open source is the appropriate BPEL engine for our approach and open environment.

Service Database (DB) is where the data are stored, manages registration, advertisement and discovery in electronic health records - EHR, agent's profiles and preferences, laboratories tests etc.

Execution control provides Policy Evaluation, Enforcement and Management (PEEM) capabilities. It provides Single Sing-On SSO authentication and guarantees the SLA by observing the response time.

Telemedicine Service Bus is a middleware software architecture and a standard-based messaging engine, actually a message broker, which is driven by events and provides fundamental services for more complex software systems. TSB is used in medical care environment and provides connection and integration to distributed health services and agents with a secure and reliable way, regardless of the type of software or hardware which they use. Usually service buses are realized as distributed service containers and connected to the services via endpoints such as routers, application adapters, message-oriented middleware bridges and other communication facilities. The TSB is also used to provide mechanisms to bind the federated required services in the composed service solution and provides infrastructure services such as mediation services, security, logging, service discovery, service description transformation services.

Wrapper is a program that sets the rules for other applications and services which are more complex and are composed of services and interfaces. Leverages application interfaces to web services format that can be used for further composition and reusability of other services to make services more reliable.

The *JAIN SLEE SE* is a high throughput, low latency event processing application environment Java standard for a Service Logic Execution Environment (SLEE). The JAIN SLEE SE is used to make sure that SLEE ruins in the TSB environment as a service engine. Is composed of messaging processing, lifecycle, deployment unit, registration management module and is designed to achieve scalability, interoperability and availability through federating services and service oriented architectures. Finally, JAIN SLEE is the point of integration for multiple network resources and protocols. The integration between the enablers, web services and other health sectors is achieved through adapter/ integrator service building blocks. [3], [8]

4 Creation of High Level Telemedicine Service

In this section, we use T-SDP in order to represent the creation of a complex high level telemedicine service, which is composed of fine grained services such as multimedia conferencing, media records, vital examination and user content services (Fig. 4). Moreover we represent the implementation of a multimedia conference scenario between a patient and an agent (Fig. 5).

As depicted in fig.4, each one of the granularity services is created from a set of reusable service building blocks (SBBs), which are usually wrapped around a set of applications and services in interaction with databases, relying on a system infrastructure and delivered to the customer via an access network, NGN enablers, IMS (IP Multimedia Subsystem) in coordination with Service Capability Interaction Manager (SCIM) and health sector enterprises networks. For example, multimedia conferencing service is composed of voice, video, audio and data SBBs (Fig.5). SBBs from NGN, Internet and Health sector enterprises are integrated and driven in JAIN SLEE service engine. JAINSLEE service engine can be easily connected to different application platforms or enablers (network elements) and store temporary the appropriate enablers and services for each purpose. Then JAINSLEE service engine and Active BPEL engine are integrated to TSB which transforms, routes, mediates, etc, the SBBs and common services and creates the required application. The created service is registered in the service repository and is ready for the next time someone will need it. With the same way and according to the preferences of the consumer (Active BPEL engine), the policy enforcement, QoS, SLA agreement etc, the user content, medical records and vital examinations are created from all the other fine grained components and services. Moreover, Active BPEL engine provides the capability to manage the conference process by orchestrating conference services. [7]

The high level Telemedicine service is controlled by the service control engine and is provided to the consumer.

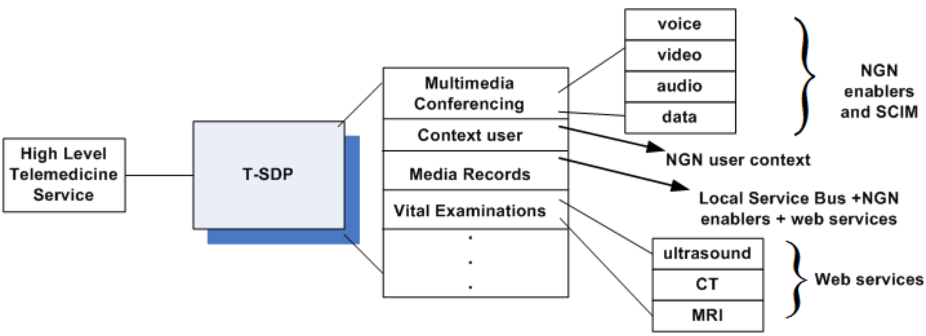

Fig. 4. Creation of a High level Telemedicine service

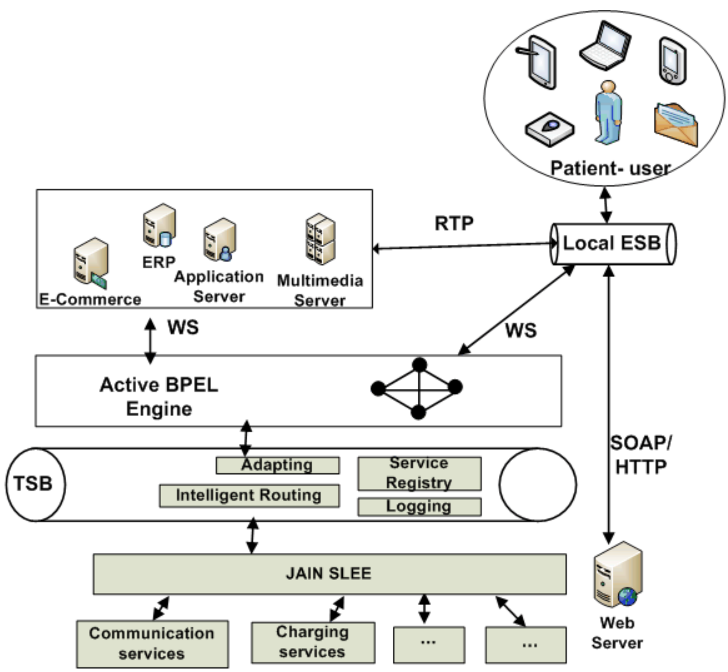

Fig. 5. Implementation of Multimedia Conferencing service

5 Conclusion

This paper has presented an advanced T-SDP and TSB approach in telemedicine field based on agent and patient oriented demands. The proposed system would provide a flexible, interoperable and integrated way of delivering and composing healthcare services in patient's and cooperative's agents than is currently available in a number of healthcare scenarios in remote, emergency, rural cases.

Lighter middleware of T-SDP could be significant in ubiquitous telemedicine environments because it has the ability to provide secure services based on private policies, preferences, profiles and integrates agents and patients dynamically in a short period of time so that is efficient in emergency events. Moreover, a standardized TSB appropriate for events, semantics, and contexts is expected to solve interoperable problems and establish more flexible and efficient telemedicine systems.

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