SPICE: Evolving IMS to Next Generation Service Platforms

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Abstract

Today's wireless and mobile services are typically monolithic and often centralized in nature, which limits heterogeneous service access and shared service usage. New sources of revenue for providers are expected to include tailored, personalized, and dynamically composed services that are fast to market, cost efficient, and provide compelling user experience. To meet these market needs, the SPICE service platform extends the IP Multimedia Subsystem (IMS) by supporting added-value services that are composed of more basic services. The platform is presented through the architecture and through scenarios showing the interactions between the platform and its service components. We describe the IMS role and functions in SPICE, and the use of ontology and Semantic Web technologies for integrated knowledge management in such mobile service platforms.

Keywords
IMS, service provision, mobile computing, semantic web

1 Introduction

Today's wireless and mobile services are typically monolithic and often centralized in nature, which limits heterogeneous service access and shared service usage. Meanwhile, new sources of revenue for the telecommunication area are expected from tailored, personalized, and dynamically composed services that are fast to market, cost efficient, and provide compelling user experience [3, 6, 7]. The EU IST SPICE (Service Platform for Innovative Communication Environment) project addresses these issues by developing a framework for the rapid development of new mobile services [1, 2]. The aim of the framework is to hide the complexities of the converged communications environment, and to allow commercial services to be developed and deployed efficiently and economically. The project integrates the competence and knowledge of more than 20 leading European telecom operators, service providers, and key IT and telecommunications suppliers.

The SPICE project researches, prototypes, and evaluates an extendable overlay architecture and framework for the rapid creation and deployment of intelligent and personalized mobile communications and information services. The project provides a novel service platform architecture that enables cross-domain service access with service roaming support. In addition, SPICE works on several key technologies such as a middleware for enabling components, service brokering and mediation mechanisms, semantic enhancement and discovery of services, life-cycle management, context-awareness and multi-modality.

The work is driven by several innovative scenarios and a derived set of requirements, which guide the development of the architecture and technologies. They reflect the technological and business aspects of the different value chain players. Also new technologies and emerging standards such as IMS, OSA/Parlay, and Web services have been taken into account.

The IP-Multimedia Subsystem (IMS) defines the functional architecture for a managed IP-based network. The IMS architecture has been designed to clearly separate the transport, control and service layer. The SIP protocol is used for basic signaling and mobility support for the terminal [4]. The IMS architecture is widely acknowledged to be the network architecture of the future. However, it is also evident that significant cost and effort reduction is needed to achieve the OMA/IMS vision of a broad service eco system [5].

A service platform is required that reduces the effort of creating and delivering services by several orders of magnitude in terms of capital expenditure and shrinks the time-to-market compared to traditional approaches. Efficiency gains on this scale can only be reached by

- re-using existing service enablers in a fast and easy way;
- opening the networks for 3rd parties which can faster adapt to markets need when creating new services, business models, and value chains;
- unifying charging and billing, allowing users to easily pay for connectivity, services and other goods while allowing the operators to take a small premium from each service;
- simplified service provisioning and service discovery, thus making the life of the end-user easier;
- personalization and situation adaptation, which makes mobile and converged services easier to use and allowing new revenue models e.g. targeted advertisement;
- mediation providers supporting creation of service bundles from different players in the market.

This paper first presents an overview of the SPICE architecture and one of the scenarios; it discusses the role of IMS and of the knowledge layer and documents the research challenges stemming from this.

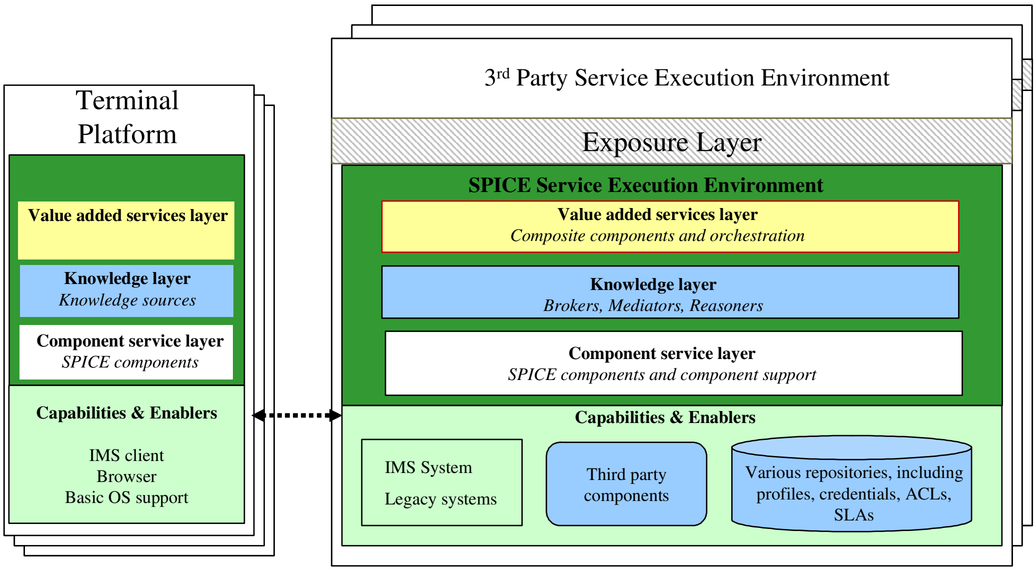

Figure 1: SPICE Architecture

2 SPICE Architecture Overview

The architecture developed within the SPICE project is based on components, which are discovered, federated, combined, and executed in a distributed environment. The SPICE project platform consists of four different kinds of components. The "basic components" are generic building blocks that take advantage of the SPICE project platform features. Special basic components are *resource adapters*, which act as proxies to components in legacy systems. Components with interfaces from the knowledge framework will be called "intelligent components". Both may further be used to create "Value Added Service (VAS) components" and "Composite VAS components". The composite components may be created at runtime by using real-time information provided by various sources and processed by the knowledge layer components.

Figure 1 presents an overview of the SPICE architecture. The terminal platform is presented on the left of the figure and the server-side distributed platform on the right. Both the terminal and the server-side system have a layered structure. The SPICE architecture has the following four layers:

- The *capability & enabler layer* consists of external services and enablers that are used by the SPICE platform.
- The *component service layer* provides facilities for component-based development and deployment. This layer includes services such as the message router, various managers, controllers, and the resource adapters. Resource adapters are used to integrate legacy components with the SPICE-project architecture components.
- The *knowledge layer* supports the discovery, delivery, and transformation of information, such as context and presence variables. This layer introduces several fundamental building blocks for intelligent components, e.g. *knowledge brokers*, *reasoner* and *recommender*.
- The final SPICE platform layer is the VAS layer which hosts the value-added components. Typically, these services contain the service logic of a new service. They are typically composite components built of a number of more basic components. Run-time discovery and *orchestration* support the creation of ad hoc consumer services.

Components are accessible by the outside world using the *exposure layer*. A third party service execution environment can use the publishing capability of the SPICE platform to publish and advertise services or components in the overlay systems of different SPICE platforms.

Several support functions are needed, such as the IMS system or a Web Service runtime, which are not part of the core SPICE platform.

3 SPICE Scenarios and Architecture Mapping

This section presents a service usage scenario in order to illustrate the scenario-driven approach used in the SPICE-project. The SPICE I-Portal scenario presents Philippe's family traveling from Paris to Berlin, and focuses on different interactions using a SPICE-based portal service. The scenario is structured into several scenes, which feature personalized and customized services. Service usage is illustrated using a "Video on Demand (VoD)" service that is adapted for use in different environments, as shown in the table below. This scenario involves the SPICE functions related to subscription activation, service access, content search, media adaptation, and media delivery end-point relocation (user mobility) [4].

Assuming that there is an existing service subscription associated with Philippe's digital identity. In order for Philippe to execute the subscription, he first needs to be authenticated and authorized by the system; then the subscription is activated by the video on demand subsystem.

Table 1. High-level view of the I-Portal VoD scene

1. Service consumer activates an existing subscription.
2. Service consumer executes the VoD service.
3. Service consumer sends a movie request to the VoD service. The VoD service searches for a local content provider that has the item. The VoD service consults user and device profile and responds with a list of movies and prices.
4. Service consumer sends buy request to VoD service. The VoD service creates a user interface with various billing options. Service consumer buys movie for next 24 hours. Transaction pertains to consumer, VoD service, and the SPICE billing system.
5. Service consumer has access to movie. Service consumer may watch the movie at a suitable host device. The playback of the content adapts to the current environment and new output device.

Figure 2 presents a summary of the different interactions during the scene; it shows an example of service-driven change of the streaming end-point. The sequence diagram highlights four interactions, namely client access request, request for movies and billing options, buying a movie, and playing a movie. The VoD service is responsible for providing necessary interfaces for locating, buying, and playing movies. The service is a VAS component but uses also other components, such as the profile manager for attribute queries and knowledge brokers for finding content.

In addition to these SPICE components an existing IMS billing and accounting interface is used through a resource adapter, which exposes the billing interface. The client-side VoD is also a SPICE-project VAS component; it coordinates the interactions and controls video playback. The actual video playback subsystem is separate from the VoD client [1].

4 Knowledge Layer

The use of IMS technology ensures a solid basis for signalling; however, the development of added-value services on top of the system is crucial to facilitate adaptability. Due to its success the WWW is host to vast amounts of distributed, machine-processable data covering all aspects of human life. Reuse, common interpretation, combination, and shared understanding of these data are necessary for the mobile services to be context-aware.

The following section describes the compatibility aspects of the IMS-based environments with knowledge-

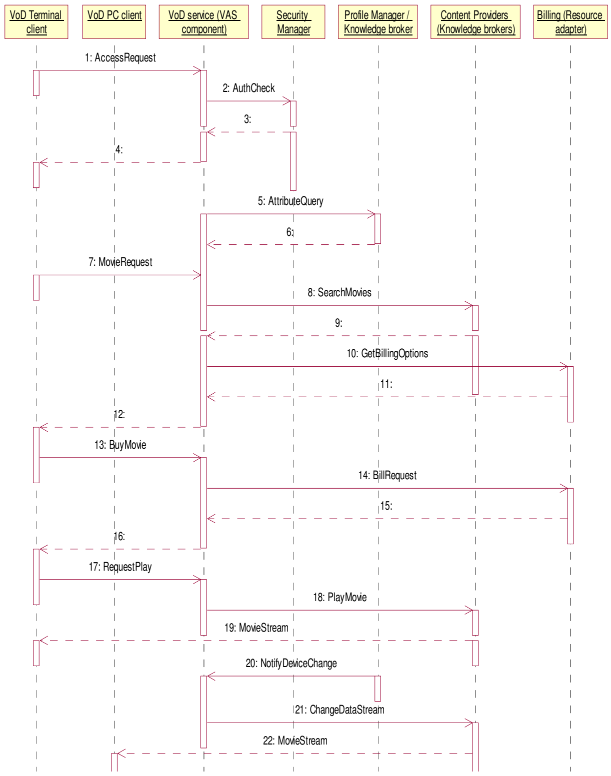

Figure 2: Example Sequence Diagram

based systems and the Semantic Web. This includes a description of how the specific mobile communications ontologies are created and evolved in the SPICE platform. Second, the mapping of IMS-related data models into ontologies is explained, and finally the SPICE knowledge-based service enablers are outlined.

4.1 Ontologies for Mobile Communications

To address the interoperation challenge of the Web and mobile service environment, a wide ranging Mobile ontology is being developed. This comprehensive Mobile ontology covers the mobile communications domain, specifically, addressing persons, terminals, services, and networks.

The Mobile ontology is a machine-readable schema specified in RDF/S [9] and OWL [8] formats, these technologies have been chosen due to their relative maturity. The ontology enables sharing of knowledge and exchanging of information both between people and across services/applications in mobile environments within any domains. The added values of the Mobile ontology are:

- It offers an easy and formal way to reference objects from the mobile communications domain (in particular, to serve as data exchange format between mobile service enablers);
- It provides the basis for ontology-based reasoning;

Initially, an ontology dedicated to Distributed Communication Sphere (DCS) - an environment supporting users and their equipment in a distributed setting - has been the starting point for development of the Mobile ontology [10]. The next areas covered within this ontology include recommendation and profiles, location awareness, quality of content, representation of services, privacy and security, and content and multimedia. Reuse of existing data models such as employed in IMS is an additional important activity associated with the Mobile ontology, as discussed below.

4.2 IMS Data Models as Ontologies

IMS-related standardization bodies such as OMA [6] have been working on a set of specifications for data models, in particular Presence information (Presence), Device characteristics (UAProf), Device Management (DM), Resource lists (XDM), and Presence authorization rules (XDM). Relating and mapping these schemata to Mobile ontology is beneficial for interoperation of communities standing behind the schemata and ontologies [10]. Following observations have been made:

- Mobile ontology developers and users benefit by acquiring additional knowledge in the mobile communications domain captured in the existing OWL, RDF, XML schemas (i.e., reusing the present knowledge);
- users of the related ontologies and schemata benefit from a straightforward mapping of their schemata to the Mobile ontology that enables a simpler involvement or extension of the Semantic technologies for these communities.

Two different approaches to combine the Mobile ontology with existing common ontologies and schemata have been identified; their use depends on whether the data is encoded via an ontology language (such as PDF/S and OWL) or only via XML.

4.3 Towards Knowledge-based Service Enablers

The SPICE Knowledge Management Framework (KMF) consists of a network of distributed knowledge sources, sinks, and brokers. The main objective of the KMF is to enable the generic discovery and exchange of information, such as context information, preferences, recommendations, and rules. This objective will be achieved by providing a common set of interfaces for knowledge discovery and knowledge exchange within the knowledge layer of the SPICE platform.

In order to create services addressing the users' needs, SPICE has built a set of enablers for attentive services. One of them is the *goal deriver* that predicts the intention of a user. Another enabler aims to pro-actively determine which context information is needed for future decisions, to gather that information, process it, and push the knowledge towards relevant knowledge sinks.

5 Conclusions

The SPICE project aims at designing, developing, and testing an innovative mobile service creation and execution environment for networks beyond 3G. The SPICE project architecture consists of four well-defined layers, and is based on components, which are discovered, federated, combined and executed in a distributed environment.

This paper briefly discussed IMS systems and identified the requirements for a simple creation of value-added services. By interoperation with ontology-based knowledge layer, the current IMS systems become more compliant to requirements of personalization, compositionality, and context-awareness.

The paper outlined the SPICE architecture and discussed how existing IMS systems can be extended, to support knowledge-based distributed service provision. An of example service usage, based on a scenario with a video-on-demand service was used to illustrate component interactions. The knowledge layer of the SPICE architecture was discussed in more detail. This layer will help to reduce the fragmentation of information and support knowledge sharing. The proposed Mobile ontology also supports this by unifying several existing information models.

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