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SPICE in brief

The SPICE project (Service Platform for Innovative Communication Environment) was kicked-off in January 2006. SPICE is part of the Wireless World Initiative (WWI) and addresses service platform issues in converged Beyond 3G environments. SPICE complements existing WWI projects to provide Ambient Service Platform enablers. SPICE was accepted during IST-FP6 Call 4 as an Integrated Project and is planned to last 30 months (end: June 2008).

The objective of SPICE is to research, prototype and evaluate an extendable overlay architecture and framework to support easy and quick service creation, test and deployment of intelligent mobile communication and information services. Building on significant advances in IT technologies, the SPICE platform will support multiple heterogeneous execution platforms allowing for new, innovative services to be spread across different operator domains and over different countries realizing a variety of business models.

SPICE is playing a leading role in the Mobile Service Platform cluster of IST-FP6 projects dealing with service platform issues.

Highlights

During 2007, the SPICE project was involved in the refinement of the specification work for SPICE platform mechanisms, algorithms, components and interfaces. First implementations of Work-Package enablers were realized and probes / demonstrations were produced. Inter-WP integration was also started. SPICE contributors were also active in disseminating the results of the project, by participating to various conferences and showcasing demos in events such as Mobile and Wireless IST Summit or WWI Innovation Day. In total, more than 40 publications were produced this year.

From the technical perspective, the main achievements are summarized below:

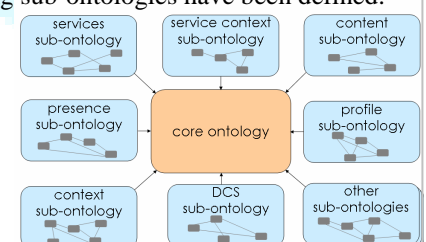
- Production of a Unified Architecture document, synthesizing the global architectural work
- Final version of the platform *Cookbook*, providing guidelines for the development of Generic Middleware Component and Publication and Discovery of Services
- Specification of the SPICE Service Broker and Roaming Manager components
- Definition of the platform SLA framework, allowing to automate the Service Level Agreement process (negotiation, monitoring, interaction with Billing system)
- Final definition of the Access Control Architecture and platform login and session mechanisms
- Final specifications and mature implementations of the SPICE Knowledge Management Layer components
- Implementation of the platform Content Management and Delivery mechanisms
- Full definition of the SPICE Service Execution Environment, made available as open source
- Preparation of a distributed integration test-bed allowing to test inter-platform features (e.g. roaming)
- User studies conducted in 3 countries, trialing SPICE concepts and applications against users
- Foundation of EU-TSOA working group leveraging collaborations with other FP6 and Eureka projects

SPICE Work & Achievements

Mobile Ontology

The SPICE Mobile Ontology is a higher-level ontology for the mobile communications domain. It is structured in a core that describes the main concepts of a service delivery platform and several sub-ontologies for detailed domains. This pluggable environment allows an easy extensibility towards new domains. And, so far, the following sub-ontologies have been defined:

- *Services*: specifies the description of the services for service composition.
- *Service Context*: describes characteristics of services for service discovery.
- *Profile*: specifies a shared user profile structure for situation-related profiles.
- *Content*: describes multimedia content including metadata information.
- *Presence*: maps the presence standard (how to reach the user) into an ontology.
- *Context*: describes context information related to a user or an entity.
- *DCS*: describes proximity resources that can be used to provide services to users.



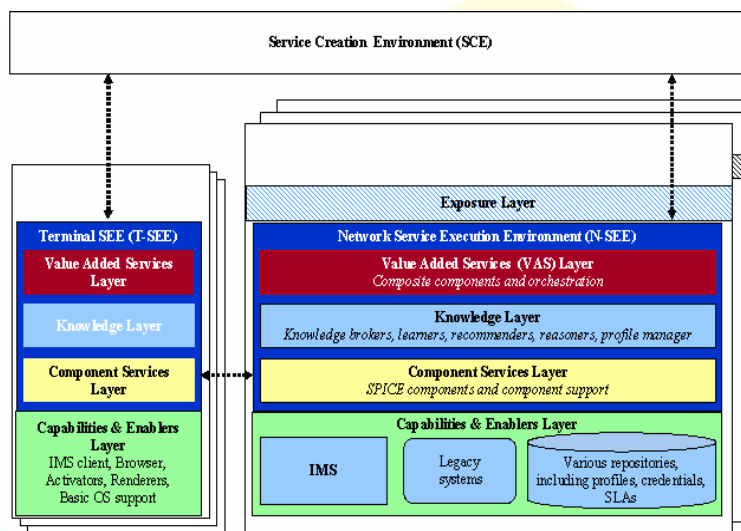
The Mobile Ontology is public and has been shared with other EU projects to extend its usage to the research community.

If you would like to know more about the SPICE Mobile Ontology, please visit <http://ontology.ist-spice.org>.

SPICE Architecture

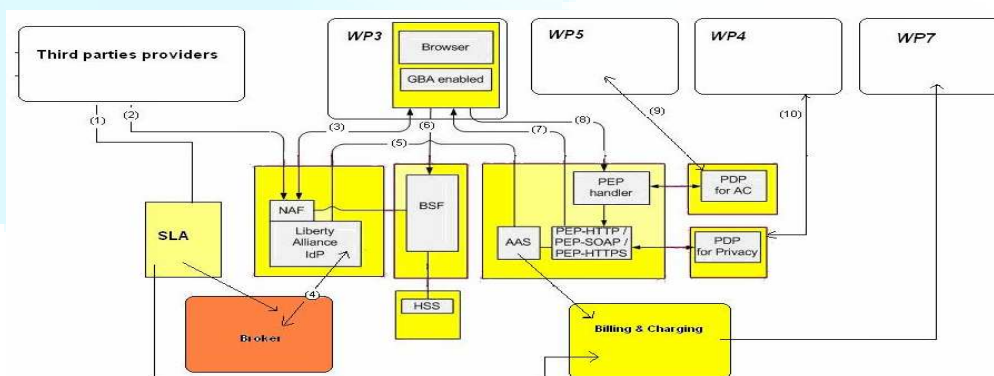
The SPICE architecture is based on a layered design, both on the terminal and on the server platform. It builds on *Capabilities and Enablers Layer*, such as the IMS (IP Multimedia Subsystem), and aims at providing VAS (Value Added Services) in a heterogeneous service execution environment. The SPICE middleware, marked with blue colour on the picture, consists of four well defined layers:

- *Component Services Layer*: provides facilities for deployment and management of basic SPICE components and resource adaptors. Resource adaptors are special components that export Capabilities and Enablers Layer functionality into SPICE platform.
- *Knowledge Layer*: supports the publication, discovery and delivery of information generally referred as *knowledge* in SPICE. Low order knowledge (e.g., user preferences, service profile, location, presence) is inferred to high order knowledge (e.g. recommendations, predictions) via pluggable reasoning algorithms.
- *Value Added Services Layer*: facilitates the orchestration of basic components, using the SOA (Service-Oriented Architecture) principles. The orchestration engines in this layer support design time and run time creation of composed component networks, while also subscribing for relevant knowledge sources at the knowledge layer.
- *Exposure Layer* facilitates communication between SPICE platforms in different organization domains. It also enables 3rd party service providers to publish and advertise their services in the platform.



The platform is completed with a *Service Creation Environment* both for end users and for professional service developers. End users can to create service mashups from existing services, while professional developers can also create new services.

Service Access Control - Identity and Trust Management



SPICE has specified and partially implemented a Service Access Control Framework allowing open but protected and controlled access of SPICE platform features to end-users and Third Party Service Providers.

A particular attribute of this framework is the combined use of Liberty Alliance for 3rd party and roaming identity management and GBA-based authentication. Liberty Alliance protocols enable protection of user's privacy. Also in a context of strong convergence between Internet based SOA technologies and IMS, Generic Bootstrapping Architecture (GBA) was carefully studied and implemented as the preferred authentication method. Several use cases were implemented, among which the **Split-terminal GBA Authentication** allowing users to be authenticated on their PC thanks to their mobile phone connected through Bluetooth. See <http://www.ist-spice.org/demos/demo3.htm> for a video of this demo.

Access Control management was also carefully studied in the context of 3rd party wide access to the SPICE platform and roaming situations.

A cookbook for SPICE components

The SPICE Cookbook presents a methodology for the development of middleware component interfaces, and for publication and discovery of the services provided by those interfaces. An interface is one of the fundamental concepts to offer interoperability. SPICE Components also implement certain interfaces for their maintenance e.g.:

- The Lifecycle Management represents the interface provided by SPICE component that carry out activation and shutdown operations when invoked by Lifecycle Manager.
- The Subscription Manager represents the interface responsible for adding users to or removing them from the registration database that system administrator uses for controlling access to a service component.
- The Performance Measurement represents the interface that monitors high level performance such as QoS. It is capable of comparing negotiated QoS with the measured (or perceived) QoS.

All SPICE Component generic interface and non-generic service capabilities must be exposed using a set of one or more metadata artefacts. Metadata refers to any information about a SPICE component that is encoded in a machine readable format where the encoding is unambiguous. Metadata plays a fundamental role in enabling the capabilities of SPICE components to be accessed, since explicit machine readable metadata enables loose-coupling between the computation a SPICE component implements and the consumers of those capabilities.

Accessing a SPICE platform

Service roaming in SPICE aims to provide the user with seamless service delivery regardless of attached network type, devices and location. The SPICE project will focus mainly on inter Domain issues. The Service Roaming Scope basically defines the most relevant use cases as follows:

- Consuming Home services directly at the Visited Domain without routing back to the Home Domain.
- Consuming Local (Visited Domain) services directly within the Visited Domain.
- Consuming Home services in the Visited Domain where one/or more service components are taken from the Visited Domain for replacing the corresponding component from the Home Domain or to enhance the service.

The overall SPICE architecture makes a distinction about Service Roaming Control and Service Roaming Transport. Service Roaming Transport takes care of routing aspects and Service Roaming Control takes care of access control.

To access a SPICE platform, a user must have a valid IMS subscription, but is not necessarily connected through IMS. For authentication, GBA is used. For identity management Liberty Alliance protocol is an option.

When a user is in a roaming situation, the user authenticates at the home domain, then the roaming platform takes control. Only authorized platforms could be interconnected, the mechanism used is called "Security gateway".

Service creation and delivery

The Service Creation Environment (SCE) within the SPICE architecture is designed to enable fast development of new Telco/IT integrated and convergent services, addressing distribution and heterogeneity of execution platforms at server-side and terminal-side.

The SCE offers dedicated design tools addressing two categories of users. On one hand, the Developer Studio targets professional service designers and developers within telecom operators or within third party service providers. This is based on a domain-specific language named SPATEL, defined in the context of SPICE project, which is a UML-based graphical formalism, exploiting state-machines for expressing arbitrary complex composition of Telecom services. On the other hand, the End-User Studio targets non professional users. It allows expressing in a simple way mashups of pre-existing building blocks.

Apart from the ability to create fixed service compositions, the SCE also provides advanced tools for performing automatic compositions at run-time based on semantic and non-functional annotations that are attached to service description elements (goals of service operations, pre and post conditions on parameters,...).

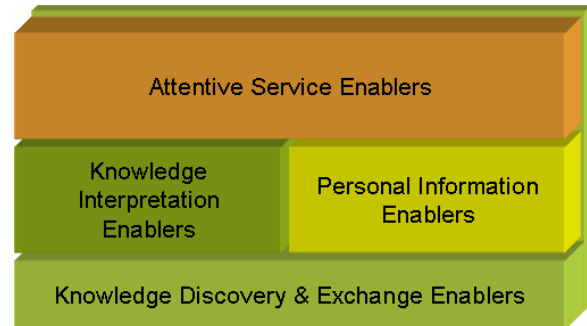
The components developed using the SCE execute in an extendable framework aggregating heterogeneous execution technologies: the SPICE Service Execution Environment (SEE). The supported technologies include an IMS system with its list of basic enablers (like an Instant Messaging wrapper), the JainSLEE event-driven server, JBOSS application server, a BPEL engine as well as other execution engines more dedicated to the design formalisms used in the SCE like a state-machine based execution engine and a RuleML engine. The SPICE SEE is packaged in the form of two VMWARE images, one containing pure open source software, the other including non open source extensions.

Fast delivery of developed components use model-driven technologies and exploits a well-defined deployment process to guarantee appropriate management of the installed software in compliance with SPICE component cookbook rules.

Intelligent Service Enablers

The knowledge layer of the SPICE architecture enables the creation of intelligent services by bringing knowledge into the service platform. Advances have been made in the specification and implementation of four types of service enablers, interrelated as depicted in the figure below.

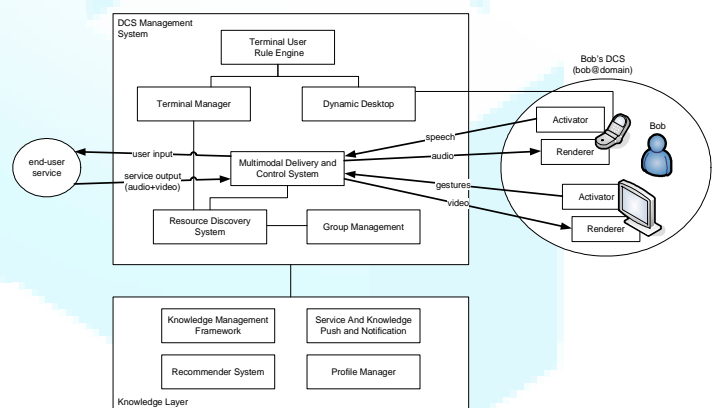
- Knowledge Discovery and Exchange Enablers* constitute the basis of knowledge provisioning in the SPICE platform. These enablers facilitate the discovery, gathering and exchange of knowledge throughout the knowledge layer in the form of middleware frameworks. Two implementations have been realized; the Knowledge Management Framework (KMF) and IMS Context Enabler (ICE), each targeting a distinct deployment environment. In addition, exchange enablers allow for interfacing with other platforms, such as Presence Servers, by using the gateway paradigm.
- Personal Information Enablers* manage miscellaneous user information, such as name and address data, as well as service and situation-specific user preferences. This knowledge is made available to SPICE services by the Profile Manager (PM), which thereby enables personalization of services tailored to the user's current situation.
- Knowledge Interpretation Enablers* provide means to derive higher order knowledge out of lower order knowledge. By facilitating this interpretation process with specialized components in the knowledge layer, SPICE developers can easily create services that adapt to the user's needs and wishes. This functionality is implemented by learners, recommenders, reasoners and knowledge bases, grouped in the Knowledge Acquisition and Provisioning System (KAPS).
- Attentive Service Enablers* allow services to be pro-actively notified of upcoming changes in the user's environment. To realize this functionality, future knowledge values are estimated by knowledge predictors. Current and predicted knowledge is used by the Service and Knowledge Push Notification System (SKPN) to push content to the user, utilizing a SIP push mechanism.



The SPICE Distributed Communication Sphere

SPICE defines the concept of the user's Distributed Communication Sphere (DCS), i.e. all the devices, networks and services available to the user at a given moment, forming a 'sphere' around him. The SPICE platform provides the means of managing the user's DCS through a set of components distributed over the end-user terminal and the platform, forming the DCS Management System. The different components of the DCS Management System are:

- Dynamic Desktop:** the main user interface of the SPICE platform, it proposes the user with means to search and access services on his mobile device.
- Multi-modal Decision and Control System:** it is responsible for taking and enforcing decisions regarding service rendering in terms of modalities and session transfer between devices.
- Terminal Manager:** it provides means to perform data synchronization between the user terminal and the platform.
- Resource Discovery System:** it is responsible for probing a user's DCS by discovering resources such as devices, networks and services. The resulting information is made available as Knowledge in the platform.
- Group Management System :** provides the platform and the user with group related support and functionalities.
- Terminal User Rules Engine :** light-weight, terminal-side rule engine to fine-tune the DCS Management System behaviour based on user rules.



The DCS Management System and the associated DCS sub-ontology are documented in the public deliverable D3.2 available on the project web-site. The different components are under development, and some of them have already been demonstrated in multiple occasion. The MDCS is planned to be released as open-source – check the website !

Media/Content Management and Delivery in SPICE

Media/Content Management and Delivery in SPICE is in charge of enriching the SPICE Service Platform with content-related functions: to this purpose an easy and simple way to deliver content in the SPICE service environment and a variety of networks and devices to support preparation, aggregation, and delivery functionalities for multimedia content has been designed. The system manages directly supplementary data as content metadata and relies on other data such as user-related and context-related information to let the end user experience the SPICE multi-modality and pro-activeness features.

Advances in the implementation of Content Management System are summarized in the following points:

- The DB implementation fully supports the CGDM data model and is considerably more complex and flexible: getting all the information necessary to be aggregated in the content guide (requested from and to be displayed in the various Content Guide Client Panes) implies more complex communications.
- Flash Content Guide Client implementation: through this component the end user is able to access the multimedia content that is stored on the Platform using different approaches (simple search, supported content navigation, tag cloud or personalized access). The end user has the possibility of rating a content he has accessed.
- Integration of Content Guide with the Charging System.
- The enabler to allow the Content Providers to upload their content on the SPICE platform has been developed. This component, gives the content providers an open, flexible tool that is not tied to any web navigator, to any operating system, application server or any specific data base.
- The DRM Platform supporting OMA 1.0 and 2.0 and Windows DRM is available through a WSDL interface.
- The watermarking component has been implemented. This component includes a method to embed digital watermarks directly within images to provide copyright information, track, monitor distribution and include information about bundle and licensing opportunities of content database elements, across multiple devices within the end user's DCS.

As to Content Delivery, the first version of the Multimedia Distributed Control System is being implemented: the goal is to provide a set of components for dynamic adaptation of multimedia services. The decision on how to distribute multimedia services to the user is based on the characteristics of the devices that surround the end-user (current sphere) and his current contextual situation. Moreover, the system is capable of re-evaluating dynamically the delivery of running services based on contextual changes.

User Experience and Integration for future demos in SPICE

Most of validation activities in SPICE are focused on end-user aspects. The platform complexity is hidden behind a common SPICE (demonstration) scenario which has been developed in several steps. After defining initial scenarios, an evaluation by end-users and professionals took place (Task 8.1). Results of this evaluation and analysis of available paper mock-ups were used for improvement of previously prepared scenarios (Task 8.2). On that basis and analysis of available prototypes of SPICE components, one demonstration scenario was created - Common SPICE scenario. This scenario illustrates the most significant features of the SPICE platform.

At the end of Year 2, demos from each work package were evaluated by end-users and professionals by Task 8.4. Methodology was similar to focus groups interviews used for evaluation of scenarios but this time supported by expert workshops. All demos were tested based on movie presentations in three countries (Italy, Poland, and Spain). The collected feedback is intended to be used to improve components and final demo.

Task 8.3 is responsible for the development and configuration of the Distributed Testbed. Its activities concentrate on software integration aspects of all components that will be developed in the SPICE project. The aim is to represent a model of interconnected service platforms deployed at various operators. The goal of integration activities is to deliver demonstrators that will be installed on top of the Distributed Testbed and in this way will show a broader range of possible applications of software components delivered in the SPICE project. In particular, it will enable to show roaming aspects and service delivery in a distributed architecture that resembles the future landscape of the IT infrastructure of modern Telecom operators.

Business and payment models

Various business modelling related tasks have been performed within the project. Firstly, the value proposition of a next-generation service delivery platform has been mapped, both for end users and service developers. Secondly, business roles have been defined, and four specific actor role models have been identified based on real life cases, each offering different views on the introduction of a next-generation service delivery platform.

There was special attention for the development of specific mobile payments models, also based on real-life examples like Pay Pal Mobile, Ogone, Bibit, i-Mode etc. Six different models were constructed, namely the Walled Garden Model, High value Garden, Buy Direct Model, Combination of Buy Direct and Walled Garden Model, Mediated Model and the Mediated Model with Payment Aggregator. Out of these six, it was established that the last two models would be the most beneficiary for the industry, although they do require several strategic modifications from carriers.

The results of the business modelling effort so far can be found in public deliverable 1.4, available on the project website.

Charging and Mediation

SPICE identifies the need to have a component providing the means to charge SPICE services and also services provided by third parties. This component takes up several challenges induced by the SPICE overall context : charging in a context where business models and roles evolved, charging in several administrative domains and charging of any types of services (i.e. simple and composite).

Functionally, this component has two facets :

- a mediation facet : it controls the exchanges between entities generating accounting data and the billing systems. C&M could be considered as mediator or a central point where all the accounting data are collected, aggregated and also correlated.
- a charging facet : it provides interfaces toward services, allowing them to be charged.

Thus a Charging & Mediation enabler has been designed taking into account these two facets and openness, re-usability requirements.

Charging concepts and C&M enabler are documented in the public deliverable D6.7 available on the project web-site. The C&M enabler is under development and will be released early 2008. Demonstrations are planned during first quarter of 2008 and in particular one enabling to purchase multi-media contents through a content guide.

2007 Dissemination

Mobile IST Summit 2007 (July 2-5th 2007, Budapest)

- 3h tutorial entitled "Service platform challenges for B3G converged environments"
- SPICE exhibition booth: 6 demos, WWI Validation Cross-Issue poster
- 3 SPICE during the technical sessions and one chaired session
- Co-organisation of the Workshop "User centricity – state of the art" (H. Van Kranenburg, TELIN)

WWI Innovation Day (November 13th 2007, Brussels)

- 3h session of technical presentations
- Demo booth with 5 demos
- Participation to panel "From individual projects towards a common approach: benefits and challenges"

1st International Telecom SOA workshop (as part of ICSSOC conference), Vienna, September 17th

- Workshop organised by 2 SPICE members (Mariano Belaunde, FT and Paolo Falcarin, Polito)
- 11 papers presented, 2 of them coming from SPICE

Other events

- Workshop with OPUCE, MAGNET, LOMS and SMS projects (Vienna, September 18th)
- IEEE VTC'07 Spring (Dublin, April 2007)
- WWRF#18 (Helsinki, 13-15 June 2007) / WWRF#19 (Chennai, November 5th – 7th)
- Workshop on Context Aware Applications and Services (CAPS'07)
- IEEE SAINT 2007 Workshop on Next Generation Service Platforms for Future Mobile Systems (January 2007)
- MAGNET workshop (Enhancing Quality of Life)
- Workshop on "Communication in Distributed Systems" symposium (KIVS 2007)

White papers: SPICE contributions in Mobile Service Platform Cluster Achievements paper and WWRF Service Architecture white paper (published by Wiley in "Technologies for the Wireless Future, Volume 3")

Coming Events

S4All testfest, Feb. 6th, 2008, Berlin
AmbiSys 2008, Quebec City, Feb. 11-14
ICT Mobile Summit 2008 Stockholm, Sweden, June 2008

Available Demos (can be downloaded from the Web site)

- Content guide
- End-user service creation studio
- Split-terminal authentication
- Intelligent service enablers probe

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