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1. Final publishable summary

1.1 The Challenge

SOA4All aims at realizing a world where billions of parties are exposing and consuming services via advanced Web technology. We develop the theoretical foundations and technological building blocks required to make the Service Web of tomorrow as accessible, ubiquitous, and successful as the information-centric Web we know today. Just as for the Web, we envisage software and applications targeted at a global network of users with various technical skills, which will make the provision and usage of Web services equally easy and comfortable as the publication or consumption of Web pages on today's Web. This focus on usability and scale is reflected in the core principles and technologies applied in the project (Web 2.0, semantics) and in the choice of the use-case scenarios. We will create service delivery platforms for audiences from different domains (telecommunication, eCommerce, and public sector), with different business interests (business users and consumers), with different abilities (developers, business experts, advanced and casual users), and with different roles (service consumers and providers).

1.2 Addressing the Challenge: SOA4All's proposition

More precisely, the outcome of the SOA4All project is a comprehensive framework and infrastructure that integrates four complimentary and revolutionary technical advances into a coherent and domain-independent service delivery platform:

- Web principles and technology as the underlying infrastructure for the integration of services at a worldwide scale.
- Web 2.0 as a means to structure human-machine cooperation in an efficient and cost-effective manner.
- Semantic Web technology as a means to abstract from syntax to semantics as required for meaningful service discovery.
- Context management as a way to process in a machine understandable way user needs that facilitates the customization of existing services for the needs of users.

The components that compose SOA4All (following figures) can be grouped in the following categories.

- **SOA4All Studio:** A rich Web platform that provides users with a unified view that covers the whole lifecycle of services; including the design-time, run-time and post-mortem analysis. As shown in Figure 1 that includes the Service Provisioning Platform, Service Consumption Platform, Analysis Platform, and a set of user-oriented components
- **SOA4All Runtime:** The work carried out explores the combination of Semantic Spaces and ESBs to support what we refer to as the SOA4All Services Cloud. It acts as the infrastructural backbone around which all the SOA4All components effectively communicate and collaborate.
- **SOA4All Infrastructure Services:** These services provide the basic SOA4All functionality in terms of Service Ranking and Selection, Service Discovery, Service Adaptation, Service Composition, Service Execution Semantic Reasoning Engine, and other components developed in the context of the project
- **Third-Party Services.** This category contains the actual services provided by final users. The SOA4All delivery platform is designed to be as technology-agnostic and less intrusive as possible, for a mixed economy of services implemented using different technologies and following different paradigms.

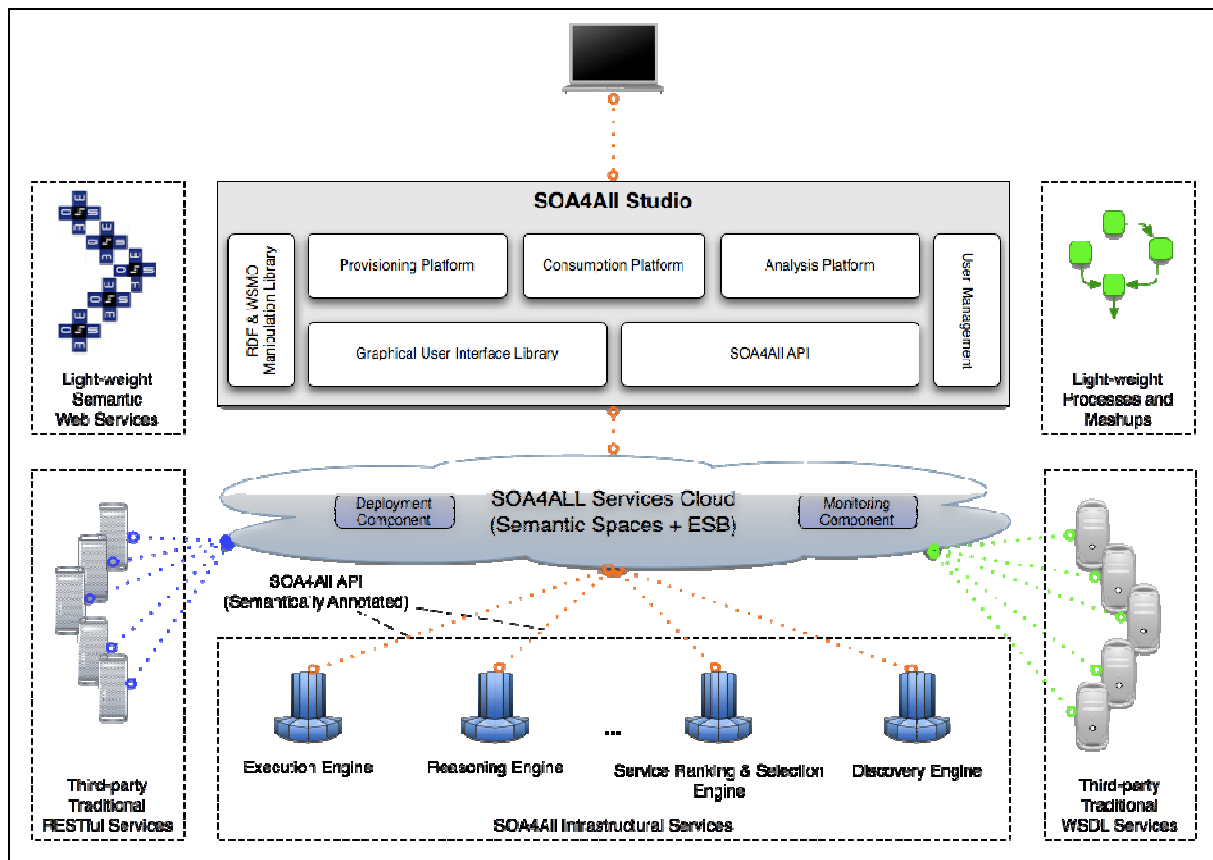


Figure 1. SOA4All at a glance

Our technology has been applied in three real-world use cases. Further details on each case are provided in the Results section:

- Service Platform for the Public Sector.** In the Public Sector use case, we target public administrations like municipalities. Public administrations nowadays have to deal with hundreds of different procedures (e.g., for handling a parking permit request) that are typically implemented in one or more legacy systems or are even executed manually. At the same time, the increasing number of regulatory changes and new regulations, including an increasing number of international, bilateral agreements, asks public administrations to constantly adapt their procedures in a flexible and cost-efficient way. As a consequence, public administrations now need to adapt their service offerings flexibly to the needs of their constituents. Based on SOA4All technologies, we have developed a flexible service delivery platform for public administrations that supports civil servants in handling typical administrative processes. Civil servants can model and execute administrative processes containing SAP Enterprise Services, which provide rich business functionality, public Web services, and human tasks.
- Web21c Futures.** BT has identified that Internet based communication is important in the vision of a 21st century Telco business and therefore released a web based API for accessing a variety of telephony services over the web, named Web21C SDK. Following that, BT acquired the Ribbit open platform which also exposes telecommunications functionality via web technology. BT's Case Study was concerned with the creation of novel applications based on these exposed functionalities and looked into a number of scenarios that would be of interest to

different user groups. Two prototypes were created, the first was focussed on supporting consumers or 'prosumers' in building service mashups while the second was focussed on supporting businesses in rapidly building and monetising business propositions to address an identifiable market.

- **eCommerce Leveraged.** SOA4All aims at providing an easy way for end users to use third party services offered through the framework, enabling them to build eCommerce applications in order to market and sell their own products.

Additionally, the project has applied the technologies devised to a number of shorter targeted applications in order to better validate the applicability and potential impact of the results achieved. Notably, SOA4All has produced 3 additional demo applications built on top of SOA4All technologies. One of these applications assists users in annotating videos with information coming from the Web of Data so that audio-visual libraries are enriched and can be better structured and categorised. The second application exploits the annotations generated for the audio-visual material and combines it with further services available on the Web in order to provide an advanced multimedia access application. Finally, the third application illustrates how, by means of SOA4All technologies, developers can devise new solutions that exploit linked data that is being generated by governmental institutions to provide added-value services to the citizens. This last application has been developed for the iPhone and iPad devices and therefore also demonstrates that SOA4All technologies can be exploited also by mobile devices.

The project consortium, coordinated by ATOS ORIGIN, consists of 17 partners drawn from across the European Union. It includes the leading semantic technologies and Service-oriented Architectures research organisations committed to its business use, and a broad spectrum of companies, both large industries and SMEs, keen to assess the benefits to their productivity, competitiveness and profitability for their use of SOA4All solutions (see section 1.10 for full details of partners).

SOA4All will significantly impact the competitiveness of the European Software and IT Services industry and more widely address the Lisbon goals. For that purpose SOA4All, as NESSI Strategic Project, has used the support of the NESSI constituency and contributed significantly to the NESSI Open Framework, which is one of the main challenges of the European Technology Platform on Software and Services.

1.3 Who can benefit from SOA4All

SOA4All has focused on supporting the entire life-cycle of services and service-based applications. As such, it provides the necessary infrastructure and software for devising, combining, deploying, invoking, and managing services and applications that exploit them. The project's result can thus be beneficial for a number of actors and activities.

At the lowest level, SOA4All provides the Semantic Spaces infrastructure supporting synchronous and asynchronous communication between services and applications with advanced monitoring and management support. This kind of infrastructure can thus be valuable for integrators and companies requiring large integrations of diverse distributed software.

On top of this infrastructure, SOA4All provides a number of core infrastructure services for reasoning, service invocation, process orchestration and service discovery and ranking. These core services can be exploited individually or jointly by enterprises and software developers to devise service-based solutions. Some of these infrastructural services like the discovery engine include user interfaces allowing end-users (possibly with a certain technical background) to locate useful services.

Finally, SOA4All provides an integrated Web-based user interface giving access to all the functionality previously cited in a seamless manner. By means of this Web GUI, namely the SOA4All Studio, humans can exploit and manage from the infrastructure up to end-user applications. Thus, the tooling provides coverage to a large number of users ranging from highly technical users dealing with the infrastructure deployed, up to final end users wishing solely to make use of some third-party provided services for their daily activities. Indeed, derived by the fact that SOA4All technologies can also be accessed and exploited by common people, we can say that the benefits of SOA4All can reach society in general. Some of the use cases devised, e.g., the eGovernment application, do demonstrate this large range of potential impact.

1.4 Highlights of Achievements

SOA4All has attained a considerable number of achievements in several areas concerning the development of service-oriented applications. The detailed results can be found within the deliverables produced within each of the work packages. Herein we shall list those that we believe are the main ones, focusing first on the conceptual achievements and then on more technical concerns.

From a conceptual perspective SOA4All has significantly contributed to revisiting traditional service-orientation concepts in the light of recent technological evolutions in the Web. Notably, SOA4All embraces Web 2.0 technologies such as Web APIs and social networks as core elements to creating a Service Web and provides technologies that exploit these. In doing so, SOA4All allows combining traditional services with modern Web APIs that populate most Web sites nowadays, at the same time that it enables the interaction with a large diversity of (mobile) devices which have been somewhat more distant from earlier work around traditional services. Additionally, SOA4All has identified, highlighted, and exploited the existing symbiosis between services and the emerging Web of Data. This pioneering research has indeed already had impact and is expected to bring further benefits in the future providing proper means for the construction of applications for the, now relatively young, Web of Data.

From a technical perspective SOA4All has produced a large number of advanced integrated software of which it is worth highlighting:

- A semantic spaces infrastructure enabling the effective communication between service parks either synchronous or asynchronously.
- An integrated tool-suite – SOA4All Studio – providing an end-to-end Web-based interface for creating, composing, retrieving, invoking and monitoring services and service-based applications.
- A new set of conceptual models for describing heterogeneous services (WSDL and Web APIs) and their context retaining the necessary simplicity for these models to be generated easily as well as to be managed and reasoned over in an efficient manner.
- A novel way for publishing services as linked data in order to better support their discovery and a set of state of the art discovery algorithms that exploit these descriptions.
- A model for capturing lightweight service mashups supported by an integrated set of engines enabling the composition and orchestration of services.
- A set of use-case applications demonstrating the applicability of SOA4All

technologies in different scenarios but also providing value on their respective domains and users, e.g., eGovernment, online retailing, state agents, telecommunications, etc.

Finally it is worth mentioning that the high integration of the main achievements listed herein maximise the potential impact and the value of each of them separately.

1.5 The results

Our technology has been applied in three real-world use cases as detailed in this section.

1.5.1 Service Platform for the Public Sector

In this use case, we implemented an open service delivery platform that allows civil servants to handle typical administrative procedures (such as an application for registering a new business). More specifically, using the Web-based tools of the SOA4All Studio, civil servants can search, model, annotate, modify, share, analyze, and execute administrative procedures in the form of lightweight processes. These processes may be composed of Enterprise Services (hosted by SAP), public Web services (hosted by 3rd party service providers), and human activities (to be executed by end users). The goal of this use case was to investigate the public sector as a business case for the SOA4All concepts and technologies, and to thoroughly evaluate the developed prototypes from a technical and end user point of view. While the focus was on the public sector, the results obtained can also be applied to other domains with similar types of users and usage scenarios. Of particular interest to SAP as the leading project member of this use case was the semantic handling and integration of the WSDL-based SAP Enterprise Services that provide standardized access to the different SAP business software products.

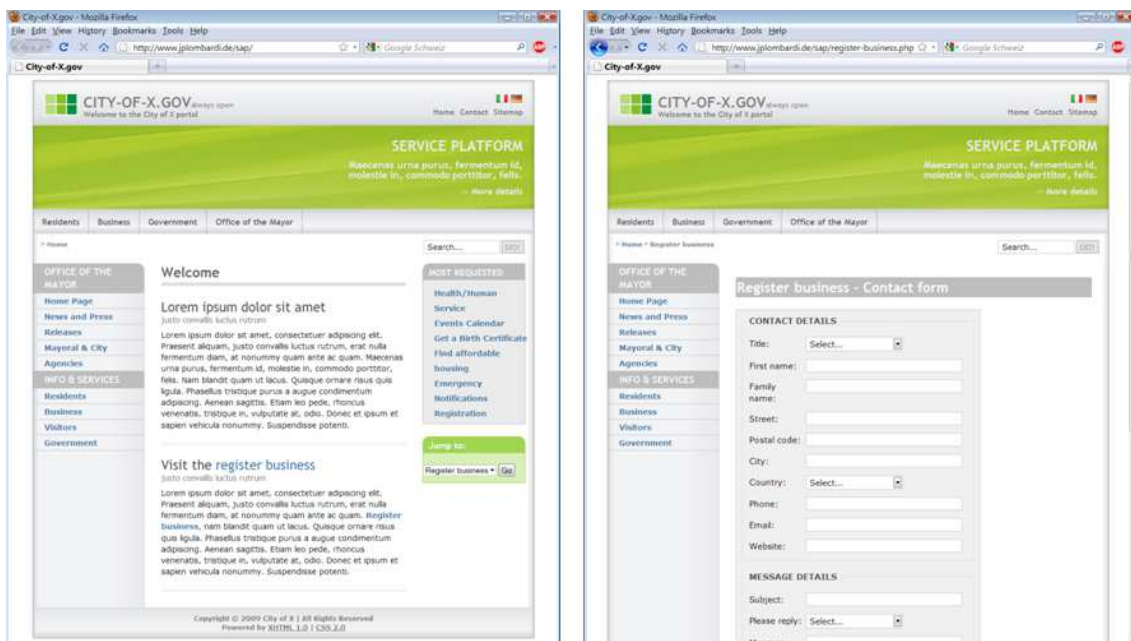


Figure 2. City of X portal

The service delivery platform was largely implemented by leveraging the functional components provided by the technical work packages of SOA4All. Additionally, in order to meet the specific requirements of the use case scenario, some customizations and

extensions have been developed: a service adaptation and integration layer together with semantic artifacts so that SAP Enterprise Services can be consumed in SOA4All, additional tools and services for handling human tasks, a wizard plugin for supporting users of the SOA4All process editor, an extension of the process optimizer realizing KPI-based process modeling, and a City Portal as frontend for consuming administrative procedures (see Figure above). The scientific concepts behind the realized prototype have successfully been published in conference papers and a book chapter. For the purpose of the use case, we have implemented and evaluated a total of six different storyboards (for details see below). Of particular interest for these storyboards was to investigate whether business users with limited IT skills (i.e., users who are able to surf the Internet and use Office and business applications for their daily tasks but cannot program) can leverage SOA4All to search, consume, compose, and monitor Web services. Our storyboards therefore reflect typical usage patterns in the public sector domain where civil servants of the fictional “City of X” are to handle administrative procedures over the combined SOA4All Service Delivery Platform. All scenarios involve different actors with different roles and responsibilities to reflect the typical division of work in larger organizations.

Storyboard 1: the first storyboard focuses on the composition of administrative processes by combining Web services using the SOA4All Studio tool “Process Editor” (or Composer) as well as the management, execution, and monitoring of such processes. As an example, the process for registering a new business at the City of X was modeled (see Figure below) by the cooperative, joint effort of different experts. In this example, a process expert first creates process models for selected standardized administrative procedures for the City of X using the Composer. Before such a process is ready to be deployed, the responsible manager can verify that it actually complies with all legal requirements and regulations. Minor modifications of a process can then be performed independently by the respective domain experts. Therefore the workload for these adjustments can be distributed among the employees of the City of X. Once a process is deployed via the SOA4All process execution engine, citizens can access them via the Internet portal of the City of X and enter all required data electronically. In case procedures contain manual steps such as checkpoints, the responsible civil servant can handle them via the SOA4All human task tool.

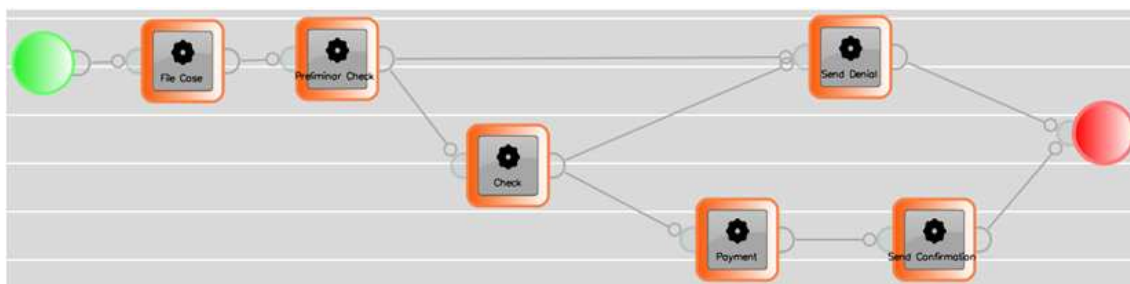


Figure 3. Register business process model

Storyboard 2: Storyboard 2 investigated (1) the preparation of existing services such as the SAP Enterprise Services so that they are accessible at the SOA4All platform e.g., to introduce new functionalities that can be used to model new administrative procedures, (2) service discovery by expert and business users, and (3) the consumption of selected services. The storyboard has the following three phases: (1) service discovery, (2) service preparation or provisioning, and (3) service consumption. In the first phase, a service developer checks via the SOA4All Service Discovery whether all services are already available. In the second phase, the developer uses the SOA4All tools SOWER and

Grounding Editor to prepare the missing services such that they become available for discovery, consumption, and composition within SOA4All. In the third phase, a process expert Barbara uses the SPICES consumption platform to find a specific service for a process, to invoke it for test purposes, and to bookmark it for later reuse in process modeling.

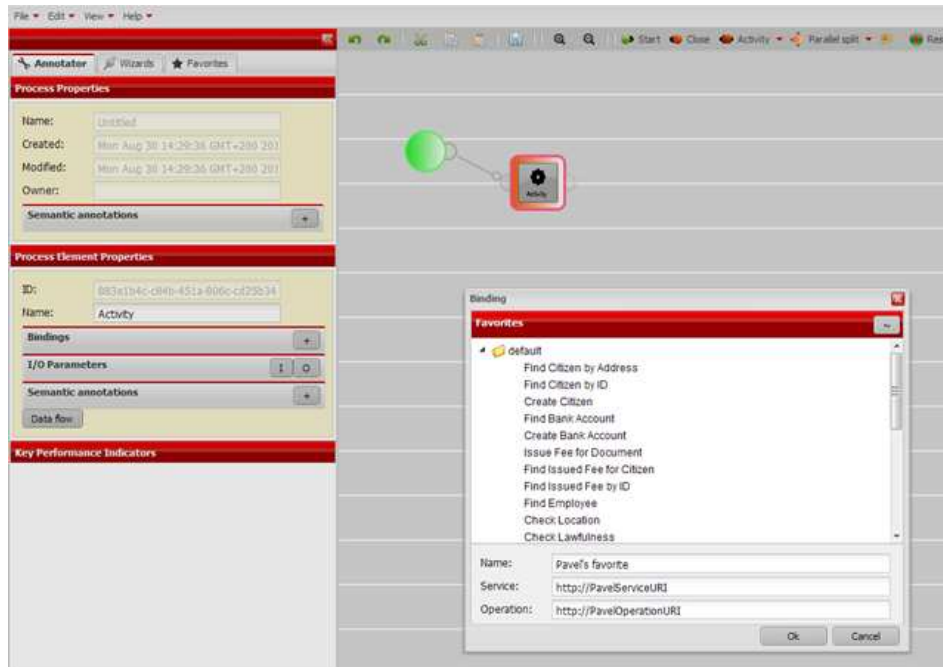


Figure 4. Process modelling with SOA4All

Storyboard 3: The third storyboard supports civil servants during service selection and administrative process modeling: Civil servants (and other business users) are primarily not interested in the technical details of a Web service such as the definition of parameters (which is often the focus in service annotations) but on the business aspects associated with that service, e.g., the pricing model, the service quality, the security level etc. Thus, in this storyboard a civil servant can specify certain business requirements in the form of Key Performance Indicators (KPIs) for the business process at hand. Then, the best Web services are selected automatically by SOA4All so that the overall process is optimal with respect to these KPIs. From a technological point of view, the Web services in this scenario have been annotated semantically with business properties following the novel USDL notation (see <http://internet-of-services.com>). In order to simplify the process modeling task for the targeted end users even further, we have additionally implemented a wizard-plugin for the SOA4All Composer that guides the user through the required steps (see figure below: Assisted, KPI-based Process Modeling).

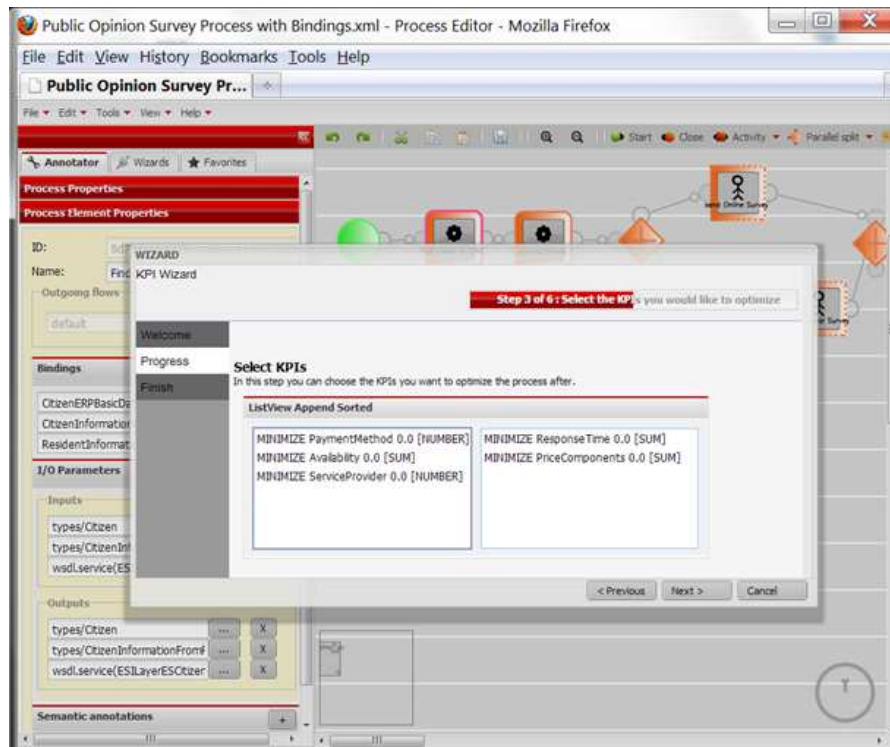


Figure 5. Assisted, KPI-based Process Modeling

Storyboard 4: The fourth storyboard was created in order to investigate the concept of wizard-based, assisted process modeling in more detail. In order to allow business users to perform modeling tasks more efficiently and error-free, it is necessary to offer them an appropriate, more user-friendly Business Process Modeling (BPM) approach. Thus, we have developed a step-by-step instruction design pattern (“wizard approach”). A wizard is a special interaction paradigm where the user of a software is guided actively in small steps to achieve a specific task rather than leaving the user the initiative. Wizards are particularly successful when the corresponding task is performed rarely, is complex, requires several dependent steps, or cannot be undone easily. Subsequently, we anticipated that a wizard can help to ease the development of lightweight service compositions using the SOA4All Composer especially for inexperienced business users. Starting from simple process editing operations (create, modify, or delete a single process activity or connection), a wizard can help the user also in complex process modifications, e.g., when a process model has to be updated due to new business regulations.

Storyboard 5: The fifth storyboard focuses on the phases of service provisioning and service discovery. 1) first the user semantically annotates a pre-defined service with a WSDL interface using the SOWER tool and then checks the service availability in the iServe service registry, (2) then the user checks his/her annotations for correctness by searching the annotated service via the SPICES tool, and (3) the user models a complete process.

Storyboard 6: The final storyboard is around the registration process that oversees students go through while getting admission in UK universities. In this respect, students start by searching for suitable universities and after choosing a university they register for a course in the University of their choice. The next step is to pay the university fee. At this stage, students open a bank account and get the funds transferred into that account. The bank account is then used to set up payment of university fee. In the other case, students get a letter from their sponsor (funding body) and submit that letter to the university. Finally,

students arrange accommodation and register with the NHS. The storyboard covers the three phases in a typical service and process modeling lifecycle: (1) first, the user semantically annotates a pre-defined service with a WSDL interface using the SOWER tool and verifies the service availability in the iServe service registry, (2) then the user checks his/her annotations for correctness by searching the annotated service via the SPICES tool, and (3) the user models the complete process as outlined above.

1.5.2 Web21c Futures.

This use case in the telecommunications sector focussed on exploiting BT's Ribbit platform which exposes telecommunications functionality via web technology. BT's Case Study was concerned with the creation of novel applications based on these exposed functionalities and looked into a number of scenarios that would be of interest to different user groups. Two prototypes were created, the first was focussed on supporting consumers or 'prosumers' in building service mashups while the second was focussed on supporting businesses in rapidly building and monetising business propositions to address an identifiable market. An evaluation exercise was also carried out to gauge the extent to which SOA4All technology made it easier for users to create novel applications combining Ribbit and third party services on the web. Below we briefly describe each prototype and the results of the evaluation.

The first prototype involves composing Ribbit and other web services to create a new web application. The application allows the end-user to dynamically organise a meeting with a group of friends in close proximity and on the weather, and works as follows:

- Get list of friends from a social networking site (for example last.fm);
- Identify those closest to your current location using services from sites such as FireEagle or Multimap;
- Filter the meeting location list depending on the weather (obtained from, for example, a BBC web service);
- Select a location and get travel information for the proposed meeting (e.g. Google Maps);
- Send out invitations and directions using Ribbit SMS to those users that are within a set range, customised depending on the weather information (e.g. only walk if it is not raining).

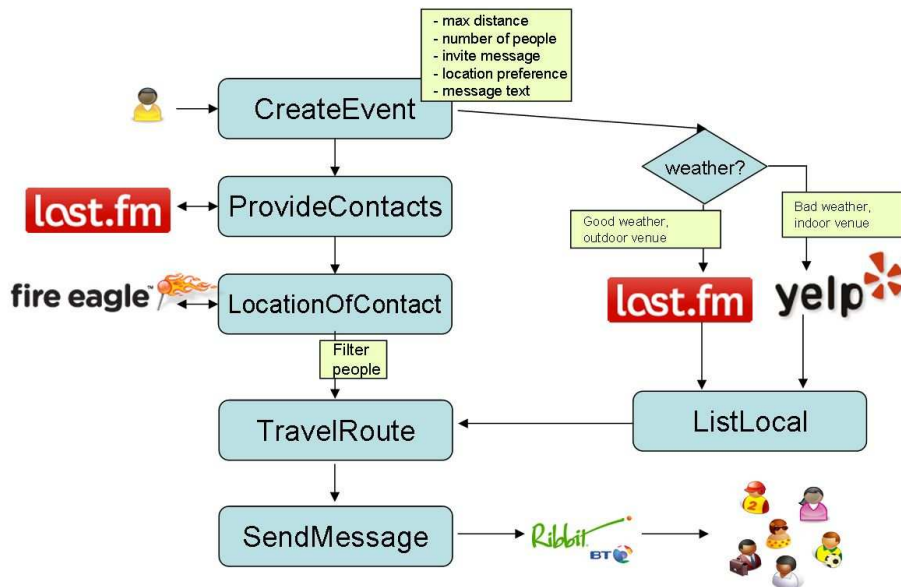


Figure 6.:First prototype features

The second prototype, Offers4All, was developed as a B2B example of how BT and a partner can collaborate to develop a business with communication-enabled processes at its heart. SOA4All technology will greatly enhance such a business by allowing the partner to quickly build, reconfigure and deploy business processes that integrate BT and third party services. For the purposes of the description, we will assume that Offers4All is provided by a company OfferNet who can be seen as an upstream customer of BT, that is they are using BT's infrastructure to generate value for end users (who can be described as downstream customers).

The Offers4All service allows companies e.g. retail organisations, entertainment providers, travel / hotel companies to advertise offers to subscribers of the service. These offers might be "last-minute" travel or entertainment deals or predefined campaign offers from retail organisations. The Offers4All service allows an offer provider to create a new offer by describing what the offer is and who and how many people it wants to target with the offer. An appropriate set of subscribers are then chosen and are made aware of the offer via a communication channel. Offer providers pay to use the service but subscribers do not.

Based on the information entered regarding the offer, a set of subscribers are chosen to receive details of it. On joining the service subscribers will be invited to provide information on their interests and willingness to receive certain kinds of offers. This will be incorporated with data already held by BT such as address, age, devices and contact details to form a profile. The profile is then used to match subscribers with appropriate offers and determine an appropriate communication channel for the offer message. A key element of value add for the service from BT is that the communication channel could be selected based upon what BT knows about the current status of the user e.g. they may have signed up to location based services allowing BT to determine their location and suitability for the offer on those terms. Alternatively, they may have recently used their home phone and would probably be contactable via this medium. The service is attractive to customers because they get to hear about offers that are relevant to them using the medium that they prefer but also because they do not need to share any personal details with offer providers. Since their details are held by one central trusted party i.e. BT, they have more control over the flow of information

to them and can be sure that their personal data is not abused.

The data that BT holds about its customers is an important differentiator which allows them to retain competitive advantage in this kind of scenario vs. a new entrant who would just use basic communication channels. By communicating with users via the most appropriate device and increasing the likelihood of a successful communication occurring, greater value can be attached to the service.

An Android application was developed as an end-user application to the service as shown in the figure below.



Figure 7.:Android Offers4All app

1.5.3 eCommerce Leveraged

In order to demonstrate the features of SOA4All in the eCommerce domain, this use case has been defined. It is centered on providing a C2C eCommerce framework operating on an ISP's infrastructure and accessible by its customers.

The eCommerce application framework enables consumers to conduct business with other consumers. This approach is similar to popular Web 2.0 platforms such as Facebook where the company (e.g., Facebook or Google Checkout) provides a framework that allows customers to create solutions for C2C business.

The eCommerce Use Case is entirely focused on providing an easy way for end users to use third party services offered through the framework, enabling them to build eCommerce applications in order to market and sell their own products, such as photos or furniture or by providing their own innovative services built from a mash-up of existing service offers.

End customers are able to use various SOA4All-enhanced tools offered through this framework to build their own end customer applications. While people may use the SOA4All

results to build generic applications, the eCommerce framework provides eCommerce specific functionality and is in itself also using the SOA4All services for achieving this.

For example, the eCommerce framework provides an eCommerce Dashboard to keep track to expenses and advertising clicks. It also contains connectors allowing to combine service outputs with Twitter or Facebook Apps. The following image shows the different tools that have been created within the use case:



The use case has put all its results under an open source license (Apache 2.0) and published them on Sourceforge allowing third parties to freely use, evaluate and extend the use case results.

SOA4All Real Estate Finder (SOA4Re) This use case created a prototype implementation showing how external information from the linked open data (LOD) principle can be integrated and used in combination with SOA4All and the wide applicability of the SOA4All project results in the mobile domain.

For providing a real world use case, a mobile application in the real estate domain was created allowing iPhone users to query localized information by invoking a range of services via the SOA4All infrastructure. Information can be combined with local information from LOD such as UK crime rates or school and neighbourhood information.

The software is based on the iOS system, meaning that it runs on Apple iPhone and iPad systems. It's available free of charge and has been tested and certified by Apple. The software is being distributed via the Apple App Store, which is meant as the single point of distribution of iOS software and is common sense for iPhone users as the installation procedure doesn't require any user interaction. The following image shows a screenshot of the use case application in the Apple iTunes store showing the application listing as well as 2 application screens.

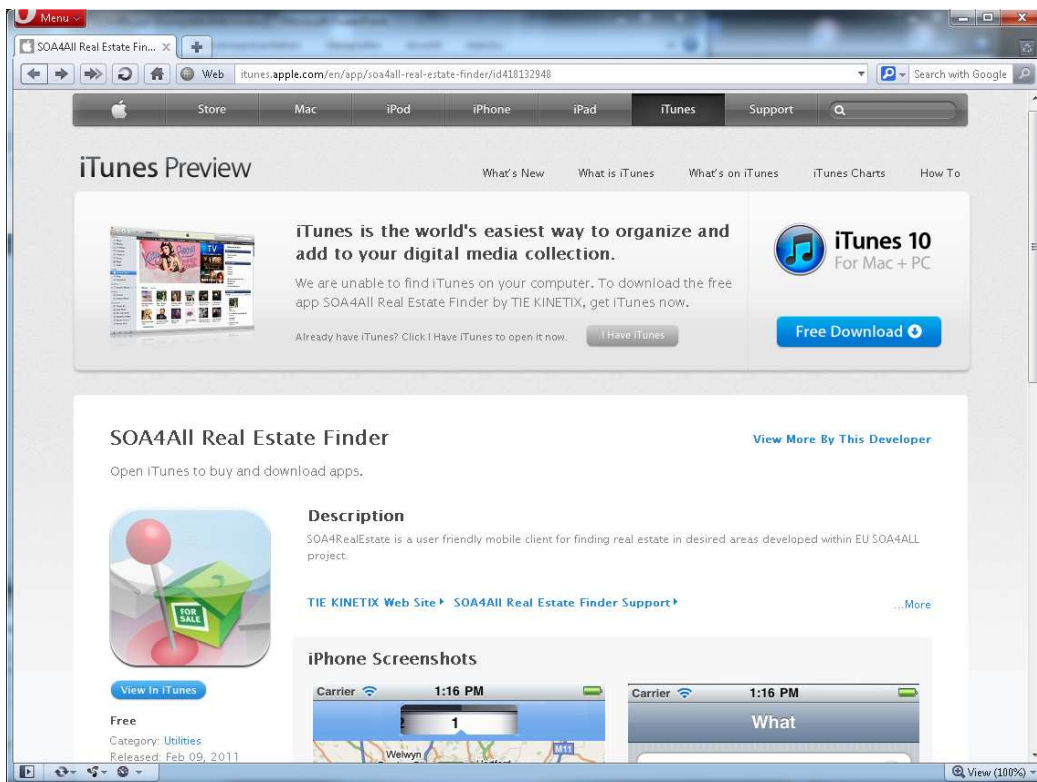


Figure 8: SOA4All real-estate finder (I)

Additionally, the application has been submitted to the UK Open Data initiative and has been accepted as a listing on the official website data.gov.uk. The following screenshot shows the listing of the application:

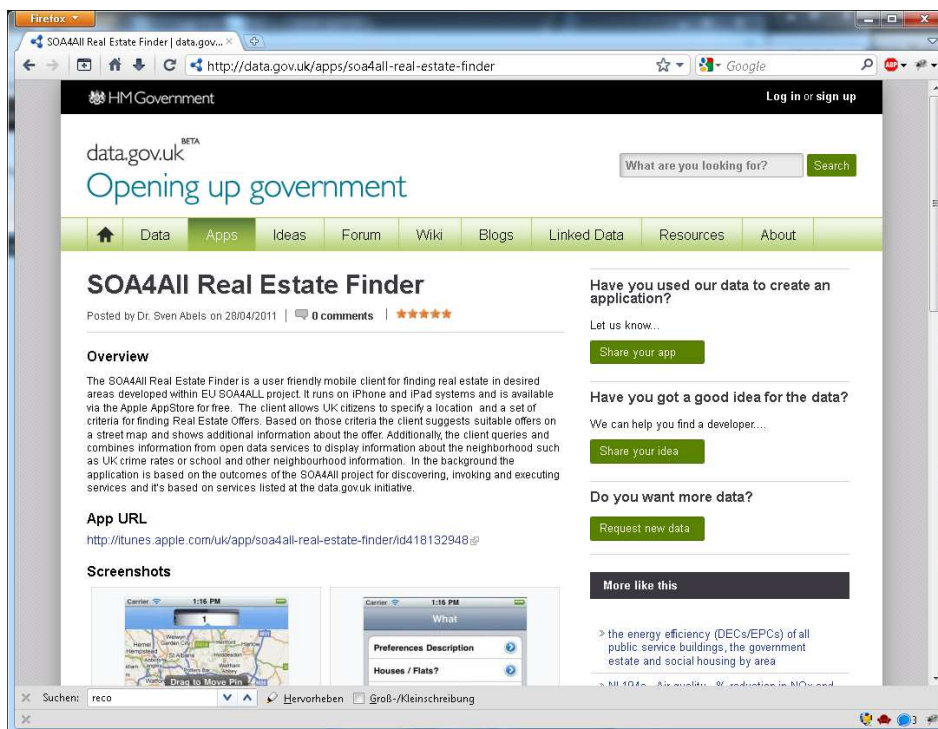


Figure 9: SOA4All real-estate finder (II)

1.6 Availability of results

As highlighted in the previous section SOA4All has produced a large number of software components and applications. These results and the academic publications have been made available publicly online. In particular the project's publications can all be found at www.soa4all.eu, whereas the software has been released as open source in diverse stand-alone project in order to maximise their take up and evolution both jointly and separately.

All the Open Source components are available to download from the SOA4All web page (<http://www.soa4all.eu/open-source-components.html>). Any individual interested in the results can download them and use the tutorial and guidelines available on the web. See the table below with the components list you can find on the SOA4All web.

SOA4All Open Source Components		
List of open source components developed in the SOA4All project and available for download.		
Component (and related Work Package)	OS License	Partner(s)
DSB, fDSB (WP1/a)	LGPL	DSB: EBM / fDSB: INRIA
Semantic Spaces (WP1/b)	Apache V2.0	UIBK
Distributed Semantic Spaces (WP1/b)	GPL V3	INRIA
Monitoring Infrastructure, Ontologies and Aggregators (WP1/c)	Creative Commons / LGPL for the WP1/a related software	INRIA
SOWER (Sweet is nOt a WsdI Editor) (WP2)	LGPL	ONTOTEXT
SWEET (Semantic Web sErvices Editing Tool), SWEET-ExtGWT (WP2)	Apache V2.0	OU
iServe (WP2)	Apache V2.0	OU
Feedback Management Framework (Linked User Feedback) (WP2)	Apache V2.0	ISOCO
Consumption Platform (SPICES) and Recommender System (WP2)	Apache V2.0	ISOCO / CEFRIEL
Analysis Platform (WP2)	Apache V2.0	INRIA
Studio Dashboard and UI Widgets (WP2)	Apache V2.0	TIE
Graphz Library (WP2.24)	Apache V2.0	SAP / TIE
Canvas / Modelling API (WP2.24)	Apache V2.0	TIE
Infrastructure Services (WP2)	LGPL	TIE
SOA4All Composer / Process Editor (WP2)	Apache V2.0	SAP / TIE / KIT
WSML2Reasoner (WP3)	Apache V2.0 / LGPL	UIBK
WSMO4J (WP3)	LGPL?	UIBK
IRIS Reasoner (WP3)	Apache V2.0	UIBK
ELLY Reasoner (WP3)	Apache V2.0	UIBK
WSL4J (WP5)	Apache V2.0 / LGPL V3	KIT
Discovery and Ranking engine (WP5)	Apache V2.0 / LGPL	KIT
SOA4All Integrated Ranking (WP5)	Apache V2.0 / LGPL V3	USE
Composer and Template Generator (WP6)	Apache V2.0	ATOS / TXT
Optimizer (WP6)	Apache V2.0	UNIMAN
Execution Environment (WP6)	Apache V2.0	CEFRIEL
eCommerce Dashboard (WP9)	Apache V2.0	TIE

Table 1 : SOA4All Open Source components

1.7 Potential impact of the results

SOA4All have produced various tools in the Web services area to help in:

- a) discovery
- b) composition
- c) invocation and execution,
- d) analysis (through analysis and monitoring tools)

To support the benefits listed above, SOA4All developed:

- e) annotation tools and
- e) recommendation frameworks

The expected impact is high as there are already products containing SOA4All results on the market from the project partners. The results are exploitable within many different scenarios, however we have identified the most common exploitation paths for the SOA4All assets. Those are in:

- The Enterprise:

Key applications that are foreseen to emerge from SOA4All are Communications-enabled Business Process applications – sophisticated multi-channel communications apps which remove the friction from many types of customer contact applications. I.e. 80% of outgoing calls to customers meet voice mail, causing waste of time and effort – CeBP apps attempt to contact the customer at a time and using a channel of their convenience, increasing customer satisfaction and reducing cost. Current Enterprise issues include time and effort spent related to solution maintenance and process efficiency – helping with those will result in an income increase. Facilitating management and use of services within a structured internal environment is main SOA4All benefit in the Enterprise sector.

- The Open Web:

Current barriers to the use of Web services include issues with different programming languages, security issues, location/discovery of the Web services, annotation, composition, and others – all of those have been looked at whilst developing SOA4All assets. The aim of the project is to discover and compose services on the Web easier, enabling adding value by creating new offerings. Also, benefit lies in the ability to then execute and monitor such applications. We can envisage plenty of business scenarios where someone is making use of services on the Web and adding value in the process – either as a standalone service or as an application.

In addition, there is a real confirmation in the rising trends – as other initiatives confirm the need to easily integrate services together. Facebook's Open Graph protocol enables integration of existing Web pages into Facebook's social graph – people, connections they have and everything else they care about. At the same time, more providers are encouraging the use of semantic technologies, example being Google recommending using Good Relations Vocabulary and "rewarding" the usage with enhanced display of the information in Google search results. Those and similar initiatives are helping the uptake of semantic information and enabling richer application development.

- Web of Data:

Recent explosion in opening up public data resulted in a large amount of apps that are using it in a novel and useful way. Linked Open Data Initiative is about using the Web to connect

related data that was not previously linked, or using the Web to lower the barriers to linking data currently linked using other methods. In essence, it is about data (RDF) and a unique naming (URI) model on the Web – creation of a “Web of Data”. Public bodies (governments, universities, BBC, etc.) essentially release data for free, but reap benefits in cost saving – not having to maintain different types of websites and harnessing editor capabilities of a community (e.g. BBC). Other parties can make money by providing value-adding applications and SOA4All can make the creation of these applications easier and more discoverable (as they automatically become part of the linked data cloud). SOA4all can support the creation of applications on top of Linked Open Data in an easy and straightforward manner, making this an attractive benefit of the project.

In addition, the SOA4All results are being utilized in many other projects already:

- ONTOTEXT have already applied SOA4All results in successful commercial scenarios such as for the real-time semantic publishing platform behind the BBC’s 2010 World Cup website.
- The semi-assisted process modelling features developed in SOA4All will be reused and extended in the FI Core Platform developed in the FIWARE project.
- Open University is exploring the possibility with the BBC of applying SOA4All principles and technologies in an effort to open up and publish large amounts of archive data about the World War I that is preserved by the Imperial War Museum, London.
- The Resonance project, which is a multi-platform science-fiction TV programme, intends to use SOA4All principles and technologies to link all the resources of the project, and to support engagement with the audience, who will be able to add new plot lines and characters in this evolving interactive narrative.
- LarkC is using the SOA4All service annotation models. Now it is working to improve the wsml2reasoner framework.
- TEXO project is re-using existing service description vocabularies and existing ontologies for describing things from SOA4All.
- COIN is interested to be connected to iServe.
- NoTube and mEducator are using iServe.

1.8 Lessons learned during the project

Throughout the project there are indeed a large number of lessons that have been learnt. Many of these lessons are specific to concrete technical details or research areas which would be difficult to convey in a summary report. The reader is referred to the papers for concrete details. From a more general perspective the project has drawn a number of key conclusions that are worth summarising. These conclusions are reported in more detail in the project’s white paper¹.

The importance and interest on services which slowed gradually in the last 5 years after the initial hype and high expectation, is growing back again impelled by a new wave of lighter services originating from Web 2.0 technologies which are called Web APIs. This “new” kind

¹ <http://www.soa4all.eu/file-upload.html?func=fileinfo&id=217>

of technology has been embraced successfully by major Web sites and Web-based companies leading to an unprecedented level of technological innovation on the Web most prominently exemplified by mashups.

A large number of these services are based on the exploitation of (large quantities of) valuable data as opposed to providing mere functions from a pure computational perspective which was perhaps the main role played by “traditional” Web Services. It seems now that the economic relevance of these publicly provided services together with the need for a continuous innovation on the Web are providing the necessary ingredients for a wide use of services in the Open Web. The interest on providing eServices over the Internet is more accentuated than ever.

Other trends like the ever growing quantities of heterogeneous data that need to be efficiently handled on a daily basis are generating a number of opportunities, notably for cloud computing solutions, but are also accentuating the need for improving the means by which data is shared and integrated. Linked Data is the main initiative in this respect and has already gathered a notable take up as highlighted by the 250 datasets providing around 25 billion RDF statements.

Given the aforementioned trends and technological evolution, the widespread use of “classical” Web Services on a Web scale as initially envisioned following the hype behind WSDL and related technologies, does not seem realistic. However, it is increasingly evident that the use and provisioning of services over the Internet (including the Web) is gaining a central role; one that is most likely to increase over the years. These services which we refer to as Internet Services will be predominantly business oriented and will contemplate a wide range of distribution channels in addition to the Web per se.

In the project we have devised and exposed a technical outlook on the main aspects that we believe will drive the future of Internet Services including notably cloud computing, the Web of Data and the social Web. In this context, we have highlighted, where appropriate, the role and solutions that SOA4All technologies can provide. Notably, we have presented the vision of Linked Services as a promising refocus of Semantic Web Services and have highlighted the main principles and technologies these shall build upon. Although by no means exhaustive this paper sketches a number of lines for future work and development embracing and exploiting latest technological and socio-economic trends that we believe will characterise the Future Internet.

1.9 Partners

Partner full name	short name	Country	Contact name and details
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The Open University	OU	United Kingdom	John Domingue j.b.domingue [AT] open.ac.uk
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Leopold-Franzens-Universitaet Innsbruck	UIBK	Austria	Dieter Fensel dieter.fensel [AT] sti2.at
CEFRIEL - Societa Consortile a Responsabilita Limitata	CEFRIEL	Italy	Maurilio Zuccalà Maurilio.Zuccala [AT] cefriel.com
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Sirma Group Corp.	SIRMA	Bulgaria	See Ontotext
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Universidad de Sevilla	USE	Spain	Antonio Ruiz Aruiz [AT] us.es

Table 2 : SOA4All partners and contacts

1.10 Contacts

The project website is: www.soa4all.eu and the project logotype is:



For further information please contact the SOA4All coordinator Elies Prunes at Atos Origin: elies.prunes [AT] atos.net, or individual partners as detailed in the partner list.