NEXOF-RA

NESSI Open Framework – Reference Architecture

IST- FP7-216446

Deliverable D2.1

Service Centric System Architecture Contributions to Model and Architecture

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Change History

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0.1	21/12/2008	Draft	Katharina Mehner (Siemens)	First draft.
0.2	09/02/2009	Draft	Katharina Mehner (Siemens)	Completion of section 1. More details on section 2, 3 and appendix 4.
0.3	16/02/2009	Draft	Katharina Mehner (Siemens)	Merge of section 2 (activities) and section 3 (contribution and results). No appendix needed. 2.1-2.4 completed.
0.4	09/03/2009	Draft	Franz Kudorfer (Siemens)	Integration of Investigation team results (Service Composition and Discovery)
0.5	11/03/2009	Draft	Franz Kudorfer (Siemens)	Added Investigation team result (Service Description) Version for internal review
0.6	12/05/2009	Draft	Antonio De Nigro (Engineering) Francisco Javier Nieto De-Santos (ATOS) Francisco Pérez Sorrosal (UPM)Evelyn Pfeuffer (Siemens)	Changes due to the comments of the internal review in: Section 3.2.1 Section 3.2.2 and 3.2.3 Section 4.2.2 all other sections and Integration of improved section 3.2.1, section 3.2.2 and section 3.2.3 and section 4.2.2 , references added, abbreviation added
1.0	15/6/2009	Final	Evelyn Pfeuffer (Siemens) Antonio De Nigro (Engineering) Francisco Javier Nieto De-Santos (ATOS) Francisco Pérez Sorrosal (UPM)	Section 5 CONCLUSION, LESSONS LEARNED AND FUTURE WORK added, and some minor corrections due to the comments of the internal review (05/2009)

EXECUTIVE SUMMARY

The NEXOF-RA work package "Service-Centric systems engineering" is devoted to "Service Centric Systems Engineering" (SCSE), which focuses on the four areas for engineering of service based software (SW) systems: specification, discovery, design and management of services. The goal of the work package "Service-Centric Systems Engineering" is to contribute within this context to the NEXOF reference architecture specification. The scope of it' ranges from engineering on the business process level down to composition on the service execution level. According to the NEXOF-RA project structure this work package contributes to other work packages.

The work package "Service-Centric System Engineering" provides one deliverable, the deliverable D2.1. This document is an intermediate version provided at month twelve. The final version will be provided at the end of the project.
The aim of NEXOF is to deliver reference architecture for NESSI Open Service Framework. In the NEXOF work packages "Reference Architecture: Model" and "Reference Architecture: Specification" nine concerns turned out to be a guideline for the whole project (see Figure 2 in section 2). The focus of the work package "Service-Centric System Engineering" is not on all of them but on the following four out of those nine concerns:

- **Services** – It addresses the underlying building blocks of SOA
- **Messaging** – It enables services to communicate and interact
- **Discovery** – It provides the bases for reuse
- **Composition** – It links services into business processes and in a smaller amount on the fifth concern
- **Analysis** – It enables continuous process improvement.

During the reporting period the concern Analysis was not yet in the scope.

The project NEXOF-RA depends on the active involvement of external partners, in particular on contributions from NESSI Strategic Projects. Nevertheless, NEXOF-RA should be used and properly instantiated into a broad range of application domains by a number of end-user communities. NEXOF benefits from external contributions. It allows the project to leverage the best-of-breed architectures and technologies, thereby enhancing the quality and applicability of the overall architecture.

Therefore this document starts with a short description of the work package "Service-Centric System Engineering" (section 1) with a view of the initial position of the work package in the overall context of NEXOF-RA (section 2), before the interaction with the external contributors (section 3) is described by two aspects: collaboration with NESSI Strategic Projects (NSPs) (section 3.1) and the activities related to the Open Process (section 3.2). In this context, investigations teams (IT) on four different topics (service description, design time service composition, service discovery and interoperability of message-

based service invocation) were established. Especially the reports of the first three investigation team results give a deeper insight in the nature of contributions and the decisions and choices taken there.

The target of the service description investigation team was to provide an answer to the question: “what is a service?”. In order to answer this question, a deep analysis about the service characterization was needed to avoid ambiguity, vagueness and, more in general, to provide a solution that try to fill the gap bared by existing standards. The result obtained contributes to the NEXOF-RA conceptual model and provides a reference for all the decisions concerning architectural choices of NEXOF Compliant Platforms. NEXOF-RA adopts the following definition of service (see section 3.2.2):

A Service is an action performed by one entity (provider) that matches a request of another (requesting entity), according to the interpretation of the latter.

The design time service composition investigation team received and analysed ten main contributions. They can be categorized as follows:

- some contributions on the semiautomatic composition of services using assisted techniques like semantic reasoning, AI planning, aggregation of composite primitives, selection and expansion of business process templates
- some contributions for the validation/verification and simulation of compositions
- a contribution on the prediction of non-functional requirements such as composition performance
- a contribution for the modelling and the validation of choreographies,
- other contributions on concrete technical problems encountered in choreographies
- a contribution for the materialization of business process as composite services, involving actors with different expertise and background, etc.

As expected, most of the focus was captured by semiautomatic composition and validation of orchestrations. Less attention has been received by the collaborative approach between services in choreographies. Some aspects were only partially covered, such as the collaborative involvement of domain experts and SOA designers in the modelling of business processes and their materialization as composite services. Other aspects suggested in the call for contributions have not yet received any attention, such as the participation of human roles in long lasting service compositions. Due to these contributions several design patterns and a set of concepts related to the topic have been identified and published in the related investigation team report [10].

The service discovery investigation team showed that an important part of the received contributions to the service discovery topic focused on the available algorithms for service matchmaking, ranking and selection, both based on IR or semantic reasoning techniques. Those techniques are complemented by template-based techniques (described in other contributions) to specify consumer's requirements which are translated into the canonical format imposed by the particular discovery engine. It turned out that most of the contributions focused on the provisioning of WS using service discovery features; WS advertisement received less attention. Maybe there was confusion with the scope of Service Discovery and Service Description. This implies that important aspects of service advertisement were not covered well by the IT, while provisioning is much better covered.

The report of the investigation team about Interoperability is still incomplete and contains only available information. This topic needs further evaluation.
The document ends with the report about the contribution to the NEXOF vertical work packages. These results were directly contributed to the deliverables of the related work package, section 4 gives an overview about what can be found in which section of a specific deliverable.

Document Information

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1 INTRODUCTION TO WORK PACKAGE "SERVICE-CENTRIC SYSTEM ENGINEERING"

The NEXOF-RA work package “Service-Centric System Engineering” is devoted to “Service Centric Systems Engineering” (SCSE), which focuses on the four areas for engineering of software (SW) systems: specification, discovery, design and management of services. The goal of the work package “Service-Centric System Engineering“ is to contribute in this SCSE context to the NEXOF reference architecture specification. Thus, work package “Service-Centric System Engineering“ is focusing on both the engineering of single services and engineered service composition. The scope of the work package “Service-Centric System Engineering” activities ranges from engineering on the business process level down to composition on the service execution level.

Work package “Service-Centric System Engineering“ addresses the process-related point of view of service-oriented systems by focussing on the following parts of the service centric system engineering process:

- service process description,
- service coordination and choreography (investigating static as well as dynamic composition techniques),
- service discovery (including also semantic techniques), and
- service deployment.

While the work package “Service-Centric System Engineering” clearly focuses on functionality, it also provides a basic framework that allows accommodating aspects of non-functional service properties and the concepts of service level agreements (SLAs) within the above listed topics.

Work package “Service-Centric System Engineering” addresses the service foundation, that is, the technological point of view by focusing on interoperability. Thus, the work package identifies suitable interaction and invocation concepts, in particular analysing reliable messaging, event-driven mechanisms, transaction mechanisms, and the concept of statefulness, etc. In the work package, also best practices for implementing, deploying and managing services will be identified and analysed, such as, for instance, the Service Component Architecture (SCA) and Java Business Interoperability (JBI).

Work package “Service-Centric System Engineering” relates to the other horizontal work packages as follows (see Figure 1):

- Work package "Open Specification Process" (WP4) deals with non-functional requirements (NFRs) and has identified security, scalability, availability, and management as its key candidates. However, NFRs cannot be treated completely orthogonal to functional requirements since they are affecting the services and their composition. Therefore, the work package

"Service-Centric System Engineering" will provide a framework of generic technologies for the support of NFRs such as policies, other kind of metadata and also service level agreement (SLA) extensions.

- Work package "Adaptive Service Aware Infrastructure" (WP3) aims at providing the architectural framework for adaptive infrastructure services, abstracting from physical systems. It will provide infrastructure services needed by application level services. Accordingly, it aims at platform independence and support for NFRs. The work package "Service-Centric System Engineering" and the work package "Adaptive Service Aware Infrastructure" look at infrastructure from different perspectives: Work package "Service-Centric System Engineering" identifies what is needed for its service centric system engineering approach; work package "Adaptive Service Aware Infrastructure" identifies what it can provide.
- Work package "Advanced User-Service Interaction" (WP1) is looking at advanced user service interaction and provides the front end to the components and technologies of work package "Service-Centric System Engineering". There might be an overlap depending on the extent to which work package "Advanced User-Service Interaction" is looking at end user orchestration techniques.

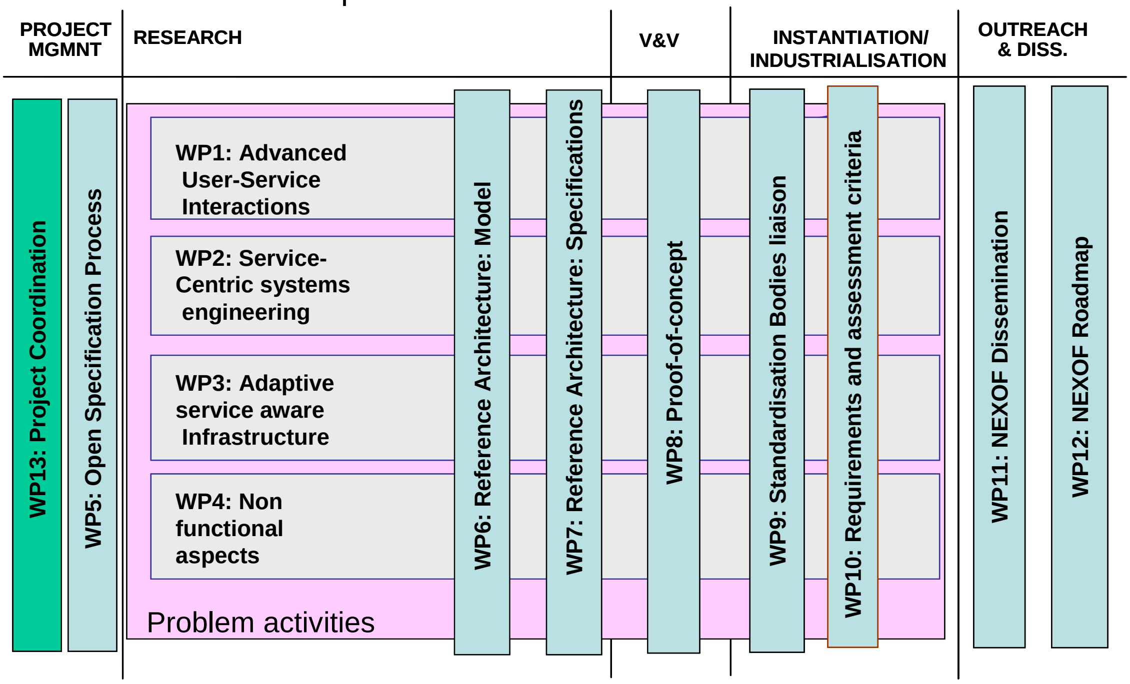

Figure 1 NEXOF-RA Project Structure

The following subsections give an overview of the objectives and activities of the work package "Service-Centric System Engineering" – Service Centric Systems Engineering – according to the DoW (Deliverable of Work) [1].

1.1 Objectives

This work package focuses on providing the core layers of the reference architecture model (RM) and reference architecture specification (RS) of the

NESSI Open Framework and it will contribute to the principles and guidelines of the NESSI Open Framework architecture. It addresses the following concerns in NEXOF reference architecture (NEXOF-RA): composition, discovery, message and service (see Figure 5). They are comprised as service centric system engineering (see section 1). The main challenge is to provide a coherent and consistent model and architecture.

Work package “Service-Centric System Engineering“ contributes with its work to the NEXOF reference architecture which aims at technology independence at the level of concepts. Instances of the reference architecture will have to rely on concrete standards referring to available technologies. The reference architecture specification will ensure the use of those standards in a consistent manner, but will nevertheless remain vendor independent.

The work package’s initial approach to develop its contribution to the reference architecture specification is to collect functional and non-functional requirements from business processes in concrete business scenarios. The scenarios will be taken from several domains and this will allow for the derivation of generic requirements, which, in turn, will be used to derive architectural patterns for specific SOA features, leading to dedicated components that support the implementation of these patterns.

For the first version of the reference architecture specification, the work package “Service-Centric System Engineering” provides state of the art concepts and an analysis of relevant existing standards.

1.2 Description of work

This work package will investigate the core layers of a service-oriented architecture (SOA layers). Thereby it will provide the basis for the development of the RM and RS. This work package will include, integrate and consolidate technologies that are State-of-the-Art and it will also address technologies that are at the fringe of development thus providing also the necessary coverage of best practice.

- At the service layer, this work package covers software engineering for individual services. The scoping of services is becoming important in order to provide composability, reusability and adaptability. This layer also addresses lifecycle management of services. This layer interfaces with work package “Adaptive Service Aware Infrastructure” (see section 1).
- At the service composition layer, this work package covers specific aspects of service composition. It addresses service coordination, mediation, transaction concepts as well as SLA negotiation ranging from functional features to non-functional quality of services attributes. This layer also covers deployment, interoperability, administration, and registry/discovery mechanisms. This layer aims at providing the necessary concepts that are used in the business process layer.

- At the business process layer, this work package covers the support for service orchestration and choreography that support the fulfilment of desirable quality of service attributes. Business process modelling is supported at the heart of this layer. This layer also addresses the use of semantic technologies and meta-data for service description and service selection. Also management, i.e. the monitoring and control of processes is addressed. This layer interfaces with the work package "Advanced User-Service Interaction" (see section 1).

Semantic technology is crosscutting the three layers and will also be addressed. The work in "Service-Centric System Engineering" takes place during the investigation phase of the project and will deliver its results to the work package "Reference Architecture: Model" and to the work package "Reference Architecture: Specification". This work package will therefore closely collaborate with the work packages "Reference Architecture: Model" and "Reference Architecture: Specification" It is likely, that inconsistencies and missing parts will be identified when surveying and monitoring existing reference architecture models and reference architecture specifications. These gaps are used to trigger work from the external contributors. The procedure follows the open process, which is called Open Construction Cycles [2]. This work package will collaborate with the work package "Open Specification Process" in order to align the core SOA architecture covered here with architectural decision for non-functional properties.

1.3 Tasks

In the DoW [1], the work package has been structured according to the following tasks that are ongoing during the entire duration of the work package.

- T2.1: Monitoring and gap analysis:
  In this task, existing reference architecture models and reference architecture specifications will be surveyed and monitored. This task will perform gap analysis with respect to the overall NEXOF architecture. This task is also responsible for the interaction with the relevant external contributors, especially NESSI Strategic Projects SOA4ALL and SLA@SOI.
- T2.2: Contributions to NEXOF Reference Model:
  This task will comprise the efforts to contribute to the NEXOF Reference Model (RM). According to the three SOA layers, it will identify relevant parts for the RM, it will select suitable standards conforming to the RM, and it will focus on the consistency and coherence of the RM. It will propose and elaborate the terminology for the common glossary.
- T2.3: Contributions to NEXOF Reference Architecture:
  This task will comprise the efforts to contribute to the NEXOF Reference Architecture Specification (RS). According to the three SOA layers, it will identify architectural concepts that conform to the conceptual reference model (RM). It will investigate into architectural choices and provide contributions to a flexible, sustainable and evolvable reference architecture

specification. It will seek to be open to incorporate non-functional architectural decisions.

1.4 Document Structure of Deliverable D2.1

This deliverable D2.1 is the only deliverable of the work package "Service-Centric System Engineering". An intermediate version (this version) is provided after the month 12 of life of the project, the final version will be provided at the end of the project.

The deliverable D2.1 summarizes the contributions to the reference architecture model and the reference architecture specification. It describes the status of interaction with the external contributors.

The document starts with a short description of the work package "Service-Centric System Engineering" (section 1) with a view of the initial position of work package "Service-Centric System Engineering" in NEXOF (section 2). Section 3 is about the interaction with the external contributors (section 3), which has to aspects: collaboration with NESSI Strategic Projects (NSPs) (section 3.1) and the activities related to the Open Process (section 3.2). In particular, section 3.2 contains the reports of the investigation teams founded to the 4 different topics (service description, design time service composition, service discovery and interoperability of message-based service invocation) done until month 12. The report of the investigation team of the fourth topic is incomplete and contains only available information - the topic is still under evaluation. Section 4 shows the contribution done until month 12 to deliverables of vertical work packages.

2 INITIAL POSITION

The work package "Service-Centric System Engineering", as well as all other work packages of the complete NEXOF-RA project, started its work in the awareness, that there are already SOA architecture specifications in place. They realize different prioritised and different domain-specific requirements. Hence, it is not surprising, that they do not have a common structure. Further it was already clear that they do not cover all aspects to be sufficient for the project's ambition. Work package "Service-Centric System Engineering" contributed to the deliverable "State of the art report" (D7.1) of the work package "Reference Architecture: Specification" (see [23], section 2), in which the details of the analyses the state of art of the service oriented architectures are documented.

Further starting from typical application scenarios the consortium had collected in work package "Requirements and assessment criteria", requirements were derived. In work package "Service-Centric System Engineering" these requirements were analysed and helped to specify and detail the scope of work package „Service-Centric System Engineering". The result of the requirement analysis (result is included in deliverable "RA Model V2.0" (D6.2) [27], sections 7 – 9) as well as the analysis of present models (listed in section 4.2.3, result is included in "Reference Architecture Model V1.0" (D6.1), section 3.1, 3.2 and appendices) was run in work package „Reference Architecture: Model" and work package „Reference Architecture: Specification". The analyses were driven by the competencies available in the team of work package „Service-Centric System Engineering".

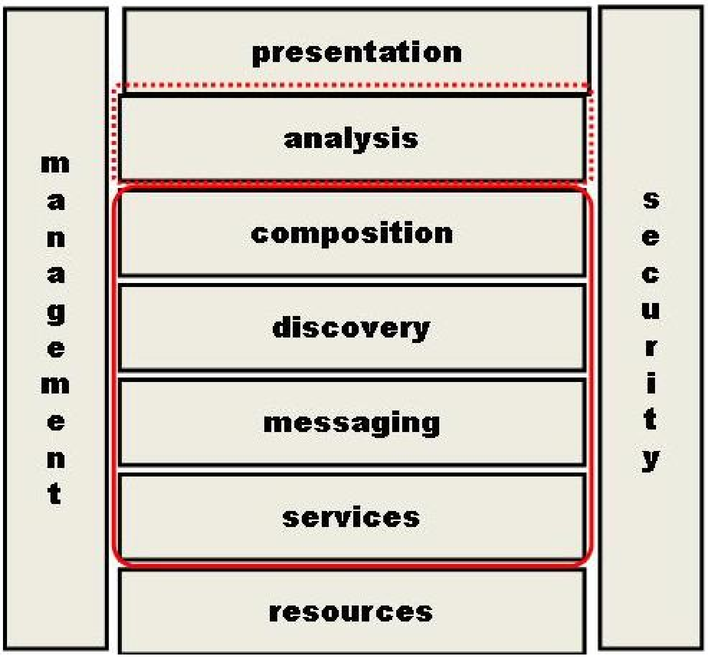

Figure 2 Position of work package „Service-Centric System Engineering" concerns in NEXOF-RA

After a first analysis of present models and the user requirements the following separation of concerns (done in work package “Reference Architecture: Model” and work package “Reference Architecture: Specification“) turned out to be a guideline for the whole project (see Figure 2, see “NEXOF RA Model” (D6.2), section 4.3, [27]). These concerns correspond to the top-level requirements introduced in the concepts and the main concerns of a NEXOF Compliant Platform (see “NEXOF RA Model” (D6.2), section 4 [27]):

- **Services** – It addresses the underlying building blocks of SOA
- **Messaging** – It enables services to communicate and interact
- **Discovery** – It provides the bases for reuse
- **Composition** – It links services into business processes
- **Analysis** – It enables continuous process improvement
- **Presentation** – It incorporates people into the SOA equation
- **Management** – It addresses service levels and governance
- **Security** – It makes SOA reliable
- **Resources** – It makes SOA effective

Though the work of work package “Service-Centric System Engineering” and its contributions to the model and specifications the focus of work package “Service-Centric System Engineering” is on the concerns Services, Messaging, Discovery, Composition and in a smaller amount on Analysis. During the reporting period the topic Analysis was out of scope.

Beyond the concerns, the analyses of requirements and models showed that architectural components for creating, describing, and composing services meeting business requirements shall cover the following three topics:

- The entire service lifecycle
- Consistency and coherence of the reference architecture
- Pattern, Principles and guidelines for building instances of NEXOF-RA architectures

3 INVITATION TO CONTRIBUTE

The aim of NEXOF is to deliver reference architecture for NESSI Open Service Framework. It depends on the active involvement of external partner, in particular on contributions from NESSI Strategic Projects. Nevertheless, NEXOF-RA should be used and properly instantiated into a broad range of application domains by a number of end-user communities including large enterprises and Small and Medium Enterprises (SME) on different technologies. NEXOF profits from external contribution. It allows the project to leverage the best-of-breed architectures and technologies, thereby enhancing the quality and applicability of the overall architecture.

This section summarizes the activities to involve external partners. In section 3.1 the collaboration with the NESSI Strategic Projects is described. Section 3.2 gives an overview about the activities and the resulting achievements promoting the involvement of further external partners by use of the Open Process.

3.1 Collaboration with NESSI Strategic Projects

The collaboration with the NESSI Strategic Projects took place via the Architecture Board that was held every 6 weeks.

The content of work package „Service-Centric System Engineering“ is more closely related to those of SOA4All and SLA@SOI than those to EzWEB, MASTER or RESERVOIR.

The link to SOA4All and SLA@SOI is such that an agreement on the basic architecture has to be reached. SOA4All and SLA@SOI both focus on a particular aspect of a SOA but of course need a starting point.

Since these projects started some time later than NEXOF-RA, the collaboration took place in one way, i.e. these projects assessed the results of NEXOF-RA but did not yet deliver concrete results to our project so far. There have been statements and comments about this situation in the NEXOF-RA architecture boards meetings (see [30]). This also had an impact on the choice of topics for the open process as described in the next section.

3.2 Activities related to the Open Process

As part of the open process invitations (the first and the second call) to contribute to the Open Reference Architecture for service frameworks by NEXOF-RA have been published. The work package „Service-Centric System Engineering“ played a major role in preparing and executing call 1 and 2 for the open contribution process (see [13]), since finally most of the topics are related to the concerns of the work package “Service-Centric System Engineering”.

From an analysis of existing research and in particular from ongoing NESSI strategic projects, which was done by the other horizontal work packages, too, The work package “Service-Centric System Engineering” chose topics for the first call and provided topics for later calls.

For analysing all RFP (request for proposal) topics have been collected in a table. The work package “Service-Centric System Engineering” evaluated and rated it with respect to the concerns of the work package “Service-Centric System Engineering” and discussed the overlap with work package “Non functional aspects”.

The complete analysis matrix (the open process topics matrix) is too big as it can be published here, but it can be found in the NEXOF-RA Wiki (see [29]). One important criterion was the availability of results from the results of the NESSI strategic projects. Since the projects that can deliver results to the work package “Service-Centric System Engineering” area started later than NEXOF-RA, for the first call no results could be expected. Hence the topics were chosen in order to cover the baseline of the work package “Service-Centric System Engineering”.

Work package “Service-Centric System Engineering” partners authored and managed the following four topics in the first call.

- service description (managed by Engineering)
- design time service composition (managed by ATOS)
- service discovery (managed by ATOS)
- interoperability of message-based service invocation (managed by Siemens)

For the kickoff of the open investigation process, the work package “Service-Centric System Engineering” prepared and gave an overview presentation and the work package „Service-Centric System Engineering“ started the work in the teams.
Meanwhile, call 2 was prepared as well. Here, the topic on run time service composition (managed by ATOS) was chosen and published.

The following 4 subsections report about the up to now reached results of the investigation teams that worked on the topics in the first call. The working groups handling the topics service description, design time service composition and service discovery finished their tasks. But the interoperability working group has not yet finished its task and neither end results nor a final report are available at the time of writing of this deliverable. Thus in section 3.2.4 only a brief description of the activity and its current status will be given: Results will be published in the next version of this deliverable.

3.2.1 Service Description (managed by Engineering)

Rationale

The concept of service plays a key role in SOA infrastructure characterization providing the basic element for a rational treatment of the related subjects. It is the “glue” concept amongst all the concerns related to SOA infrastructures and

they can be managed in a consistent way if they use a clear, consistent and unambiguous basis. Thus, it is fundamental to provide a clear and shared characterization of the service-concept.
On the other hand, the analysis of the most used standards provided by W3C [5], OASIS [6], OMG [7] point out a lack of deep analysis about service characterization, providing in most cases unclear, vague, ambiguous or even contradictory definitions of service. In literature the term "service" is used with a multitude of meaning, e.g. in some case it is used to indicate an *action* performed by somebody, in other cases a *capability* to perform some action, or even to indicate the *result* of an action that is a change affecting an object or a person. Moreover, despite the goal of future Internet of Services is to allow peoples and computers to smoothly interact with services in the real life, both traditional Web services approaches, as well as the more recent Semantic Web Services (SWS) proposals, seem to focus mainly on the aspects related to data and control flow, considering services as black boxes whose main characteristic is to interoperate in a well-specified way [8].
A deep analysis addressing the issues related to service concept cannot be found in literature, thus it was the goal of the service description investigation team to address these issues, motivated by the strategic importance of this concern for NEXOF and NSPs.

Objectives

The team results aim to contribute to the NEXOF-RA conceptual model and to provide a reference for all the decisions concerning architectural choices. Therefore, all the architectural choices of NEXOF-RA compliant architectures would take into account the characterization of service provided by the service description investigation team.

Criteria to issue the call

Because of its strategic importance, the call concerning the service description topic required to be issued as early as possible since it affects the whole architecture, even impacting on NESSI Strategic Projects which was called to contribute during the definition phase. Thus, the call was issued during the first phase of the NEXOF-RA open construction process.

Setup of the team

The Investigation Team was constituted as one team wherein all interested participants collaborate.

The team was constituted by 14 persons representing 9 different affiliations:

- Francesco Torelli, Engineering I.I., SLA@SOI
- Nicola Guarino - Roberta Ferrario, ISTC-CNR
- Sophie Ramel - Eric Grandry, CRP Henri Tudor, Adict
- Agustin Yague Panadero, Universidad Politécnica de Madrid, OVAL/PM, FLEXI
- Antonio Puliafito - Francesco Longo - Salvo Distefano, University of Messina

- Arne J. Berre, SINTEF, SHAPE
- Luis Rodero - Juan Caceres, Telefonica I+D, RESERVOIR
- Francesca Arcelli, University of Milano Bicocca, Adict
- Xavier Franch, Universidad Politécnica de Catalunya

The position papers submitted by the participants are available on NEXOF-RA web site[1].

Concrete objective

During the kick off meeting, a brainstorming session with the participants focused on the target of the service description topic and the position papers submitted to point out the concrete objectives and final results that the team would address. The participants identified the following two tasks:

1. Identification of the properties of services that are mandatory for the definition of the service concept. The goal of this task is the definition of a conceptual pattern that captures all the behavioural aspects concerning services from a very general perspective.
2. Identification of the informational aspects of service definition that can be managed by Information Technology. Then, the team aims to recognize the features of a software system to properly help the automation of the services.

Results

The target of the service description investigation team was to provide an answer to the question: "what is a service?". To answer this question a deep analysis about the service characterization was needed to avoid ambiguity, vagueness and, more in general, to provide a solution that try to fill the gap bared by existing standards and ongoing research works.
The result obtained contributes to the NEXOF-RA conceptual model and it provides a reference for all the decisions concerning architectural choices of NEXOF Compliant Platforms.
The notions existing in literature [8], and shortly addressed in the rationale, are somehow connected, and they contributes to better specify the notion of service but the experts participating to the Service Description Investigation Team agreed on the fact that none of them can be properly identified with what people are commonly referring to when asking for a service.
Moreover, it was stated that the service definition is required to address the second task of the investigation team that is to address the problem of describing and representing services to identify the features of a software system to properly help the automation of the services.

At a first stage the team identified the concepts that are relevant for the definition of service, then the definition of service were selected according to the consensus of the team's participants.

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[1] http://www.nexof-ra.eu/sites/default/files/SDIT%20Position%20papers.zip

NEXOF-RA adopts the following definition of service:

Definition of Service:
An action performed by one entity (provider) that matches a request of another (requesting entity), according to the interpretation of the latter

Such definition captures the following things:

- a requesting entity (R) that makes a request (Q) to a provider entity (P) to perform a certain action (A);
- a provider entity (P) that performs the requested action (A).

Thus, it is stated that the service depends on a provider entity, a requesting entity and an action that depends on an explicit request. Shortly it is possible to express this concept by using these notations:

- (textual): C2 =def [P,A(Q),R]
- (graphical):

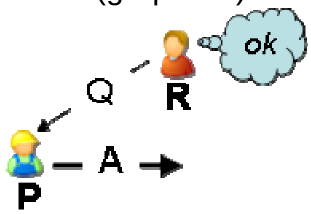

Figure 3 Graphical Notation

- (UML):

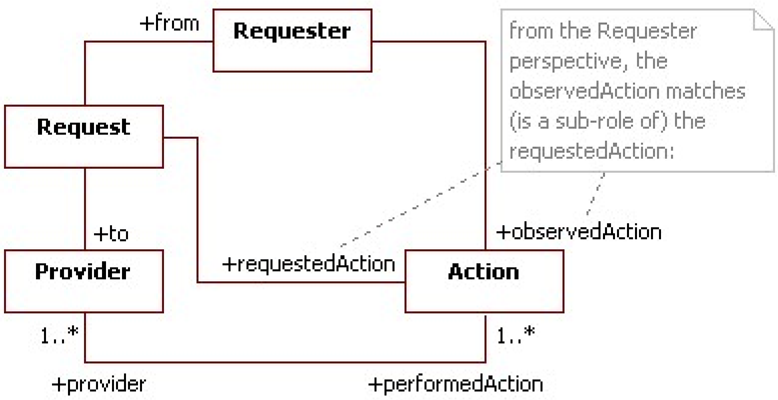

Figure 4 UML Notation

The definition of service is captured by a very general perspective and it is independent from Information Technology. However, it is useful to fit such definition to the Information Technology in order to provide a definition of Software Service. It is required to add some constraint to the current definition in order to address which the entities are interacting to request/perform an action.

Therefore, a Software Service is a Service which requester and provider are software agents. It is important to specify that:

- the interaction between requester entity and provider entity is mediated by software agents, which are requester agent and provider agent. The direct interaction never happens between humans
- it is not excluded that humans can interact among them. Indeed, to fulfil their duty software agents can make use of human interaction

The results here described are reported with more details in the Service Description Investigation Team final report [11] available on NEXOF-RA portal and they were also reported in deliverable D6.2 as part of the NEXOF-RA conceptual model.

Roles assigned

The work was organized as a "virtual round table" and each member of the team was invited to share their experience with the other participants. No explicit role was assigned to the participants who share a common role of contributor to provide inputs to the investigation team and to address the objective defined by the tasks.

Moreover, Arne J. Berre who is a member of OMG proposed the discussion held by the team to OMG, promoting a comparison between service description investigation team and OMG.

Process followed

The tools activated to enable the collaboration among the participants are the following:

- a mailing list (service-description_it@nexof-ra.eu), to enable the comparison among participants by email exchange
- a Google spreadsheet [9], to fix and share definition of concepts and related information useful for the active discussion
- a repository to share documents, available on the NEXOF-RA portal [10]

The work was mainly performed by mail exchange, but conference calls were also arranged to consolidate partial results and to speed up the work when the mail exchange was not sufficient. Two conference calls were scheduled when a straight comparison among participants was required by the status of the work.

The plan for assessment and finalization of the results was defined as follows:

- December 1st, 2008 end of the first phase and assessment of the results of the first task. Start of the second phase addressing the subjects of the second task.
- January 31st, 2009 end of the second phase and assessment of the results of the second task. Finalization of a document to report the results obtained.

Moreover, the progress of the work was assessed by periodical check and the partial results of the investigation work were steadily evaluated.

At the first deadline on December 31st the objective of the first task was partially achieved and the rearrangement of the plan was needed. Then, the deadline to assess the first task results was delayed to January 31st, 2009.

At the final deadline on January 31st the team provided an answer to the first task issues. The answer provides the definition of the service concept and also the definition of other concepts that are useful to define the service.
The definition of the service concept affects the NEXOF-RA conceptual model, and of course the NEXOF-RA glossary.

The time was insufficient to address the objective of the second task.

Impact on standardization
As the deep analysis performed by the investigation team cannot be found in literature, the team aims to impact the initiatives of the standard organizations with the achieved results. As already stated in this document, the comparison with OMG was accomplished and the inputs provided by the service description investigation team to the OMG UPMS/SoaML standard has been appreciated. Actually, this discussion is still ongoing inside OMG group.

3.2.2 Design Time Service Composition (managed by ATOS)

Rationale
SOA encourages the building of ICT systems by combining software components which expose services, since those services behave as composable building blocks. This procedure is quite common not only in the SOA domain but in other component-based approaches. SOA speeds up the software development process since it relies on already available and tested services which can be combined to create rapidly and efficiency more complex software components which offer extra functionality, thanks to the standards applied, which abstract the implementation of services from the functionalities they offer.
SOA standards enable the quick creation of composite services which may be specified with XML-based languages, what does not require a heavy engineering process (coding, compiling, deploying, testing, debugging) and speeds up the composition process.

This composable SOA approaches have proven quite useful to realize business processes, since each activity to be performed in the process can be mapped to a concrete operation offered by some service. Thereby, SOA composite services have received much attention, not only in the SOA domain but also in the BPM domain.

Even if SOA composite services have been the focus of both academic and industrial initiatives, there are still important challenges in the field, as described in this Investigation Team (IT) call, since the composition process is mostly manual, prone-to-error, time-consuming, not suitable for long lasting processes with human participation, not suitable to account for exceptional situations, with poor support for self-healing, self-configuring, self-adaptation, etc.

Due to the importance of composite service in SOA world and within the NEXOF core service area, we selected this topic within the first list of potential candidates. Considering the magnitude of this topic, we decided to split it into two topic call, one for design time service discovery (this one) and another one for runtime service discovery (issued for call 2).

Objectives

The service composition topic was identified as a core concern within the WP2 since the very beginning, deserving an important place in the service core architecture. SOA developments are mostly based on the aggregation of existing services to realise more complex and featured applications.

Thereby, it was understood that the service composition system would have an important place in the NEXOF reference architecture model and specification.

Considering the relevance of this topic and the vast knowledge acquired during the last and current research initiatives, it is not affordable by the limited number of ICT experts involved in NEXOF core service area to cope with an intensive survey and critical analysis of existing results and missing gaps. Therefore, we targeted at complementing our group of experts recruiting other experts and researchers who are being working on the topic in the last years. These researchers provided their (different) vision and solutions for the problem of composing services, so we have been able to gather more information and analyse those patterns applied in the tools developed for creating compositions.

Criteria

Due to the importance of this concern we included it in the first list of potential topics to issue in the first IT call. Besides, some NEXOF-RA partners have participated and/or are participating in some national and EC FP6/7 projects where the service composition concern was intensively studied, such as GODO [4], Composetour [5], SeCSE [6], SUPER [7], INFRAWEBS [8], SOA4ALL [9], etc. Therefore, we were aware of the promising available results and improvements on this topic domain and the current research baseline.

Placement in architecture

Service composition concern is part of the service core area, that is, an essential SOI feature, located between the underlying SOI and the SOA applications. Service composition system is located in the same layer as service creation, messaging, discovery, mediation, interoperability, etc.

Investigation Team Reports

The results of the design time service composition IT have been collected in an IT report [10]. This IT report contains all the received contributions and an analysis and integrated overview of those contributions highlighting similarities, differences, relationships, subtopics not or insufficient covered and a short summaries of suggested standards. The number of received contributions was up to ten. There were up to 5 active contributors.

Topics

Design time service composition IT identified several subtopics relevant in the domain scope of the team. However, most of the different subtopics were so interwoven that there was not a real chance to split the IT into small teams. It was better decided, as aforementioned, to split the whole IT across calls, one topic at design time and another at runtime, which are closely related but represent a logical separation.

Setup of the team

The IT was constituted as a unique team with all interested participants within. Active participants were:

- Franz Brosch, from FZI
- Natallia Kokash, representing REO project
- Annapaola Marconi, representing ASTRO project
- Francisco Javier Nieto, from ESI, representing SeCSE project
- Richard Sanders, from SINTEF, representing SIMS project
- Bruno Volckaert, from IBBT

Those participants have background expertise in the scope of service composition using orchestration and choreography approaches, validation and verification, semantic, AI planning and other techniques for automatic composition, UML2 modelling of service collaborations, and so on.

Concrete objective

As described in this IT topic call, the objectives of this IT are

- To describe the most suitable techniques and solutions available both from the industrial and research initiatives to satisfy the functional and non functional requirements of the service composition domain at design time.
- To address both the orchestration and choreography approaches, although the former has received much more attention than the latter so we expect more results in that case.
- To propose best techniques to reduce the development cost (time and resources) and improve the accuracy (error-free) and reliability of composite services at design time, to include the participation of human actors within long lasting process implemented as composite services, the validation, simulation and verification of composite services, and others concerns relevant during the design of composite services.

Summary of activities

Except the initial kick off meeting there were not more physical meetings. We hold three conference calls, one before starting the first iteration and two more after each iterative phase.

IT participants submitted their contributions during the first iteration. They were integrated by the IT coordinator who tried to provide a coherent and consistent view of those contributions relating each other when possible, highlighting similarities, dissimilarities, complementarities, etc. IT participants were asked on concrete topic points for clarifications, which were incorporated to this holistic view.

During the second iteration, IT participants were asked to provide additional contributions, to refine those already submitted according to the comments issued by email or during the previous conference call. At the end of this second iteration, a refined version of the IT report was issued and commented by the IT participants. This IT report was finalized and submitted to NEXOF-RA consortium by the end of the IT.

Results

This IT has received and analysed 10 main contributions. They can be categorized as follows:

- some contributions on the semiautomatic composition of services using assisted techniques like semantic reasoning, AI planning, aggregation of composite primitives, selection and expansion of business process templates
- some contributions for the validation/verification and simulation of compositions
- a contribution on the prediction of NFR such as composition performance
- a contribution for the modelling and the validation of choreographies,
- other contributions on concrete technical problems encountered in choreographies
- a contribution for the materialization of business process as composite services, involving actors with different expertise and background, etc

As expected, most of the focus was captured by semiautomatic composition and validation of orchestrations, which represent the main generic patterns in the field, implemented in different ways. Some concepts have been highlighted, such as business process templates, autonomic computing algorithms, goals, semantics, etc.

The collaborative approach between services in choreographies has received less attention (an important gap). Some aspects have been partially covered, such as the collaborative involvement of domain experts and SOA designers in the modelling of business process and their materialization as composite services. Other aspects suggested in the IT topic call have not received attention, such as the participation of human roles in long lasting service compositions.

Thanks to these contributions, several design patterns and a set of concepts related to the topic have been identified and published in the mentioned IT report [10].

Roles assigned

The work was organized as a "virtual round table" and each member of the team was invited to share their experience with the other participants during the meetings and teleconferences. No explicit role was assigned to the participants

who share a common role of contributor to provide inputs to the investigation team and to address the objective defined by the tasks.
Only J. Gorroñogoitia had the role of chair during the meetings and integrator of results.

Process followed

The working methodology followed by the IT was as follows. The IT working period was roughly divided into two even iterative phases. Each phase was organised similarly: a first time slot to prepare and submit contributions, a second time slot to understand and integrate contributions, a third time slot to received further comments upon the integrated view and refine it.
The first iterative phase aimed at providing a first working document describing those design patterns relevant in the topic domain. The second iterative phase aimed at fulfilling the gaps identified during the first phase and refining the received contributions.
Communication and collaborative tools were: a) the NEXOF-RA portal repository, b) email discussions, c) regularly scheduled conference calls.
The IT coordinator decided to accept all received contributions since a) all of them were within the topic scope, b) we were not only interested in documental contributions, but in recruiting the experts behind those contributions, in order to participate in the discussions.
Unfortunately, we failed in involving the IT participants to discuss among them, since most of the interactions were between each individual participants and the IT coordinator, through the email usage. Even during the scheduled conference calls, most of the interactions occurred only between the IT coordinator and each individual IT participant. Besides most of the interactions occurred as reactions to the IT coordinator requests, lacking a real discussion of ideas between participants.

Innovative points

More than emphasizing innovative points this IT has posed the baseline of the state of the art for service composition at design time, since the received contributions are a good representation of the past and current research initiatives in the domain of semiautomatic composition mostly following a choreographed approach. Indeed, most of the contributions share similar accepted principles and patterns, such as requirement-driven service composition, the usage of repositories of available composite primitives or business activities, the intensive use of reasoning on the interface and behaviour description of services, etc, which can be also encountered in other research initiatives not contributing to the IT. So, the main result of the IT is the identification of widely accepted service composition patterns and the current trends on the research domain.

Impact on standardization

The purpose of the IT was not to influence or impact on any ongoing standardization process, even if some standards or those still under standardization are used or commented within the contributions: WSDL [11],

WSMO [12], OWL-S [13], SAWSDL [14], WS-BPEL [15], WS-CDL [16], WS-CL [17], BPMN [18], SCA [3], JBI [19] etc.

3.2.3 Service Discovery (managed by ATOS)

Rationale

As SOA presents services as functionalities published and reused by many applications, so the selected services will be able to cover some expected requirements (functional and non functional) when they are invoked. In this SOA approach there are three main roles: a consumer, a provider and a broker. The consumer invokes a particular service exposed by the provider. But this invocation it is not possible if there is not a mechanism to enable both the consumer and provider to know each other and collaborate in a loosely manner. This mechanism consists on a combination of service advertisement and provisioning, conducted by the broker role. The broker enables service providers to advertise their services by posting services descriptions into a public registry. The broker enables service consumers to procure useful services through a lookup mechanism.

This complete picture is crucial for the successful implementation of a SOA system since, otherwise, tight-coupled connections between service consumers and providers need to be established in advance, limiting a lot the SOA loose coupling principle.

Hence, providing powerful advertising and provisioning mechanisms is an essential feature expected in a SOI.

There are some SOA related standards that cover this area, such as UDDI [20] and ebXML [21], but with some limitations especially in case of machine processable service advertising and provisioning. Past and current research in this area has intensively explored techniques to overcome this and other limitations, obtained promising results.

Service advertising and provisioning can be considered a cross-cutting concern since it is required and used by other SOA concerns like composition, messaging, service front-ends, etc. Those links reinforce the importance of this concern.

Those reasons have motivated us to issue a call on Service Discovery to collect and describe the techniques a service oriented infrastructure (SOI) should offer to consumers and providers for the advertisement and provisioning of services.

Objectives

The service discovery topic, which covers service advertisement and provisioning, was identified as a core concern within the work package “Service-Centric System Engineering” since the very beginning, deserving an important place in the service core architecture.

Besides the reasons aforementioned to justify this concern in the overall SOA landscape, we realized that a coherent and consistent core service area architecture description would not be possible due to the strong dependencies of other core service area concerns on the service discovery concern.

Thereby, it was understood that the service discovery system would be an essential building block both for the NEXOF reference model and architecture.

Considering the relevance of this topic and the vast knowledge acquired during the last and current research initiatives, it is not affordable by the reduced number of ICT experts involved on NEXOF core service area, to cope with an intensive survey and critical analysis of existing results and missing gaps. Therefore, we considered to complement our group of experts recruiting other experts and researchers who are being working on the topic in the last years.

Criteria used

Due to the importance of this concern and the number of dependencies of other SOA concerns on it, we included it in the first list of potential topics to issue in the first IT call. Besides, some NEXOF-RA partners have participated and/or are participating in some EC FP6/7 projects where the service discovery concern was intensively studied, such as SeCSE [6], INFRAWEBS [8], SOA4ALL [9], etc. Therefore, we were aware of the promising available results and improvements on this topic domain and the current research baseline.

Placement in architecture

Service discovery concern is part of the service core area, that is, an essential SOI feature, located between the underlying SOI and the SOA applications. Service discovery system is located in the same layer than service creation, messaging, composition, etc.

Investigation Team Reports

The results of the service discovery IT have been collected in an IT report [22]. This IT report contains all the received contributions and an analysis and integrated overview of those contributions highlighting similarities, differences, relationships, subtopics not or insufficient covered and a short summaries of suggested standards. The number of received contributions was up to eight. There were up to 4-5 active contributors.

Topics

Service discovery IT identified several subtopics relevant in the domain scope of the team. However, the different subtopics were so interwoven that there was not a real chance to split the IT. Besides the reduce number of IT participants discouraged us of splitting the team.

Setup of the team

The IT was constituted as a unique team with contributors from several projects. Active participants were:

- Aliaksandr Birukov, from Trento University
- Mike Boniface and Nikolaos Matskanis from IT-Innovation, representing the GRIA project
- Costas Kotsokalis, representing the SLA@SOI project
- Andras Micsik, from SZTAKI, representing INFRAWEBS project
- Valentín Sánchez, from Robotiker Technalia, representing the e-NVISION project
- Dimitris Skoutas, from IMIS

Those participants have background expertise in the service advertising and provisioning domain, in the specification of services (functional and non-functional capabilities) with textual and semantic metadata, in the storage of WS descriptions within federated repositories, in the procurement of WS in B2B scenarios, in the SLA-based service discovery, in the IR and semantic matchmaking and ranking algorithms, and so on.

Concrete objective

The IT identified some subtopics relevant for the successful implementation of a complete service discovery system. We identified two main features: a) advertising of WS, b) provisioning of WS. WS advertising focused on service catalogues, since the specification of WS is provided elsewhere. Concrete categorization of services within catalogues, support for browsing and subscription, lookup, etc was included. WS provisioning focuses on the lookup techniques available to discover adequate WS which may match the consumer expectations.

Regarding all those subtopics, we were interested in describing the most suitable techniques and solutions available to satisfy the functional and non functional requirements associated to services.

Summary of activities

Except this kick off meeting there were not more physical meetings. We hold three conference calls, one before starting the first iteration and two more after each iterative phase.

IT participants submitted their contributions during the first iteration. They were integrated by the IT coordinator who tried to provide a coherent and consistent view of those contributions relating each other when possible, highlighting similarities, dissimilarities, complementarities, etc. IT participants were asked on concrete topic points for clarifications, which were incorporated to this holistic view.

During the second iteration, IT participants were asked to provide additional contributions, to refine those already submitted according to the comments issued by email or during the previous conference call. At the end of this second iteration, a refined version of the IT report was issued and commented by the IT participants. This IT report was finalized and submitted to NEXOF-RA consortium by the end of the IT.

Result

The main result obtained after analysing all the contributions is a set of related concepts for service discovery, as well as a set of architectural patterns related to the tools which give solutions for performing service discovery.

An important part of the received contributions have focused on the available algorithms for service matchmaking, ranking and selection, both based on IR or semantic reasoning techniques. Those techniques are complemented by template-based techniques (described in other contributions) to specify consumer's requirements which are translated into the canonical format imposed by the particular discovery engine. Some contributions extend this approach to embrace not only functional and not functional requirement but SLA constraints, so that the discovery process is extended to incorporate the negotiation phase. Another contribution proposes a multimodal service discovery approach which combines consecutive different techniques (in precision and time-cost) upon an iteratively constrained target of available services, in order to improve the trade-off between precision and response time. Other contributions complement the canonical service discovery approach (based on requirements versus capabilities matchmaking and ranking) with a service usage experiences historic. Last but not least, one contribution focused on federating P2P service registries to improved scalability and domain specialized services. Additional details can be found in the IT report.

The patterns identified are in line with the contributions received, but it is clear that the main generic pattern identified is Service Discovery matchmaking and ranking. The concepts have been extracted from the analysis of the contributions as well (templates, matchmaking, ranking, selection, etc.).

As can be realized, most of the contributions have focused on the provisioning of WS using service discovery features; WS advertisement has received less attention. Maybe there was confusion with the scope of this IT topic and the Service Description IT, since they are closely related and they should be in the same line. That implies than important aspects of service advertisement have not been covered well by the IT, while provisioning is much better covered.

Roles assigned

The work was organized as a "virtual round table" and each member of the team was invited to share their experience with the other participants during the meetings and teleconferences. No explicit role was assigned to the participants who share a common role of contributor to provide inputs to the investigation team and to address the objective defined by the tasks.

Only J. Gorroñogoitia had the role of chair during the meetings and integrator of results.

Process

The working methodology followed by the IT was as follows. The IT working period was roughly divided into two even iterative phases. Each phase was organised similarly: a first time slot to prepare and submit contributions, a second time slot to understand and integrated contributions, a third time slot to receive further comments upon the integrated view and refine it.

The first iterative phase aimed at providing a first working document describing those design patterns relevant in the topic domain. The second iterative phase aimed at fulfilling the gaps identified during the first phase and refining the received contributions.

Communication and collaborative tools were: a) the NEXOF-RA portal repository, b) email discussions, c) regularly scheduled conference calls.

The IT coordinator decided to accept all received contributions since a) all them were within the topic scope, b) we were not only interested in documental contributions, but in recruiting the experts behind those contributions, in order to participate in the discussions.

Unfortunately, we failed in involving the IT participants to discuss among them, since most of the interactions were between each individual participants and the

IT coordinator, through the email usage. Even during the scheduled conference calls, most of the interactions occurred only between the IT coordinator and each individual IT participant. Besides, most of the interactions occurred as reactions to the IT coordinator requests. The exception to this rule occurred during the KOM hold in Brussels to constitute the IT, where there was a live discussion and active participation. Face to face meetings are proven to be more fruitful.

Innovative points

More than emphasizing innovative points this IT has posed the baseline of the state of the art for service discovery, since the received contributions are a good representation of the past and current research initiatives in the domain of service advertising and provisioning. Indeed, most of the contributions share similar accepted principles and patterns, such as matchmaking and ranking, template-based querying, multiphase discovery, etc, which can be also encountered in other research initiatives not contributing to the IT. So, the main result of the IT is to pose the wide accepted service discovery patterns and the current trends on the research domain.

Impact on standardization

The purpose of the IT was not to influence or impact on any ongoing standardization process, even if some standards or those still under standardization are used or commented within the contributions: UDDI [20], ebXML [21], WSMO [11], OWL-S [12], SAWSDL [13], WS-Policy, etc.

3.2.4 Interoperability of Message-Based Service Invocation (managed by Siemens)

The interoperability working group, nevertheless it is part of the first call for contributions, has not yet finished its task at the end of the reporting period; thus, neither end results nor the planned final report are available at the time of writing of this deliverable. Results will be published in the next version of this deliverable.

Nevertheless, a brief description of the activity and its current status at the end of the reporting period will be given here:

Rationale

Interoperability is a core feature of service interaction: services basically operate by exchanging messages with each other. And thereby, they need to understand each others' messages completely and unambiguously. Services, however, are developed independently according to different standards and techniques and, furthermore, standards are often used in different ways. This clearly jeopardizes the interoperability between services.

Objectives

The objectives of the "INTEROP Investigation Team" are

* to provide a survey of standards related to interoperability in the context of message-based service interaction,
* to collect guidelines, best practices and patterns for the solution of the messaging-related interoperability problems, and
* to place the findings into the context of the ensuing conceptual NEXOF Reference Architecture.

Criteria

Message-based interoperability is concerned with (data) format interoperability, protocol interoperability and, most importantly, with the semantics of the exchanged messages. Interoperability is also highly relevant with respect to higher level (application and domain independent) protocols that describe how sequences of messages are interrelated, in particular, if transactions or sessions are involved.

In the presence of standards, interoperability is often impeded by ambiguities and incomplete specifications. Here, additional constraints or new versions are used to unify and formalize the intent of a standard.

Regarding higher level protocols, standards are not commonly adopted or are still missing and best practices vary a lot. In particular, sessions are implemented using very different standards.

In the absence of standards or in the presence of conflicting standards, interoperability becomes a mediation challenge.

This topic is therefore one of the key features for services. The situation concerning standards leads to the expectation to cope with many gaps.
Due to the importance of this concern, we included the topic in the first list of potential topics to be issued in the first call.

Placement in architecture

Interoperability of message exchange is part of the service core area and is located in the same layer than service creation, messaging and composition.

Investigation Team Reports

The investigation team report is under preparation. Until now a structure of the document has been developed. It includes the following topics:

* Interoperability Concepts & Dimensions
* Examples (good practices & pitfalls) and standards application from existing projects
* Integration of the thereby collected Guidelines/Best Practices into the NEXOF Conceptual Architecture

The collection and definition of the concepts and dimensions is ongoing. The extraction of interoperability examples and good practices from the projects of the participants is still ongoing as well.

Topics

The topics defined by the "INTEROP Investigation Team" are – in accordance with the structure of the envisaged investigation team report: (a) The embedding of message based interoperability into the overall SOA interoperability concepts, (b) good practices, guidelines and applicable standards, selected according to practice in existing projects, and (c) a mapping of the found proposals into the NEXOF Conceptual Architecture.

Setup of the team

The "INTEROP Investigation Team" was formed within the first Open Construction Cycle of NEXOF's Open Architecture Specification Process in the Core Service Framework Area and is concerned with the topic Interoperability of Message-Based Service Interaction in relation to the NEXOF work package 2. Nine position papers were submitted, all from different affiliations.

The Investigation Team was constituted as one team wherein all interested participants collaborate. Active Participants are:

- Peter Graubmann, Siemens
- Stanislav Pokraev, Telin
- Eric Piel, TU Delft, representing the project Poseidon (see [22])
- Francisco Javier Diez, Tekniker, representing the projects KOBAS and eEe (see [21],[20])

Concrete objective and result

The Investigation Team identified the following concrete objectives:

1. identification of interoperability models to use as a conceptual base
2. derivation of a taxonomy of problems in the context of message-based interoperability
3. identification of concrete examples with appropriate solutions
4. extracting best practises and relevant standards

Results are not yet available, but will be published in the follow-up of this deliverable.

Roles assigned

The team members were invited to share their experiences. There were no particular roles assigned to the participants during the set-p of the team. Each participant is intended to act as contributor to the Investigation Team and everyone is, in principal, invited to address all the objectives defined by the investigation tasks.

During the reporting period Peter Graubmann played the driving role in co-ordinating the collection of examples and best practices, in providing input for the conceptual base and as writer of the document.

Process followed
The nine contributors of position papers took part at the kick-off meeting. During this meeting, the team formed itself as a group with three contributors from outside NEXOF-RA (see them listed in the section "Setup of the Team"). The actual working period started at the beginning of 2009. A first draft of concrete objectives was discussed and agreed. The next step was the collection of requirements relevant for interoperability, based on the experience of the participants. This was done in parallel to the definition of the document structure, according to which the work on the concrete tasks (see section "Concrete objective and result") was organised. The work is still ongoing.

Communication and collaboration take place via conference calls and email exchange. There were no face-to-face meetings.

Innovative points
This is still under evaluation.

Impact on standardization
This is still under evaluation.

4 CONTRIBUTIONS TO VERTICAL WPS DELIVERABLES

This section describes the actual work carried out in work package „Service-Centric System Engineering“ until month 12 and the results. Firstly, the initial steps including organisational issues are described. Secondly, the core work activities are described and their resulting contributions to other work packages.

4.1 Initialisation Phase

The work package „Service-Centric System Engineering“ internal collaboration was set up by bi-weekly conf calls and by face-to-face meetings. Minutes of each meeting and minutes of conf calls are collected in the NEXOF-RA Wiki and can be provided on demand.

During the starting phase, the scope, the approach and the relationship to other horizontal NEXOF-RA WPs (work package „Advanced User-Service Interaction“, work package „Adaptive Service Aware Infrastructure“ and work package „Open Specification Process“) and NSPs were defined and documented in an internal 2-page position paper. It shows that work package “Service-Centric System Engineering” is devoted to service centric systems engineering. The scope of work package „Service-Centric System Engineering“ is detailed by two views: the service process point of view and the service foundation point of view. In particular, the position paper elaborated on the dimensions of design time and runtime and on the dependencies and potential risk of overlap with other horizontal work packages. Here, the boundary between work package „Service-Centric System Engineering“ and work package „Advanced User-Service Interaction“ was clarified and the boundary between work package „Service-Centric System Engineering“ and work package „Adaptive Service Aware Infrastructure“.

4.2 Activities and Contributions

This section describes the key activities of work package „Service-Centric System Engineering“ that took place until the date of this deliverable and the achieved results of work package „Service-Centric System Engineering“.

- In the subsection 4.2.1 the activity of the lead of work package „Service-Centric System Engineering“ is comprised. The deliverable is an interim report, so of course the activity is ongoing. The ongoing activity of work package „Service-Centric System Engineering“ lead aims at refining and evolving the overall vision of NEXOF rsp. NEXOF-RA so that the individual activities of the work package „Service-Centric System Engineering“ partners will work towards coherent and consistent results
- In the other subsections (4.2.2 to 4.2.5) activities according to the defined tasks T2.1, T2.2, and T2.3 are shown, which results in contributions to other work packages. Please note that there are contributions that result from more than one task

- Of course, the activities and contributions described in the subsections of section 4.2 comprise
  - further activities regarding collaboration with other work packages and project committees such as the architecture board and
  - the activities in preparing and managing the open contribution process. These activities are implied, as they lead to the contributions.

4.2.1 Lead activity

As work package „Service-Centric System Engineering“ lead, Siemens was focussing on enabling the creation of coherent and consistent results based on which NEXOF can become real. Therefore, Siemens initiated a discussion in work package „Service-Centric System Engineering“ that was later consolidated with other WPS on concretizing and evolving the vision of NEXOF rsp. NEXOF-RA, started to make the vision more concrete.

The key contributions are as follows:

- Clarification of NEXOF rsp. NEXOF-RA *scope* which covers SOA not only addressing the implementation of enterprise business processes (enterprise SOA) but also addressing the different layers of the automation pyramid and the implementation of industrial automation (industrial SOA). By industrial SOA we refer to the vertical integration that comprises software applications and platforms as well as embedded devices and requires be loosely coupling and basing on automation related standards.
- Clarification of NEXOF, which is to be an open service framework and of the NEXOF-RA reference architecture model, which has to be a construction kit of patterns, containing state of the art solutions, but also solutions for new/upcoming trends and white spaces (see “Scope, objective, ambition level, and baseline of the Reference Architecture” (D13.5))
- Furthermore, it was intended to analyse which services playing the role of elements of the component catalogue could be useful.

The NEXOF reference architecture is depicted in Figure 5:

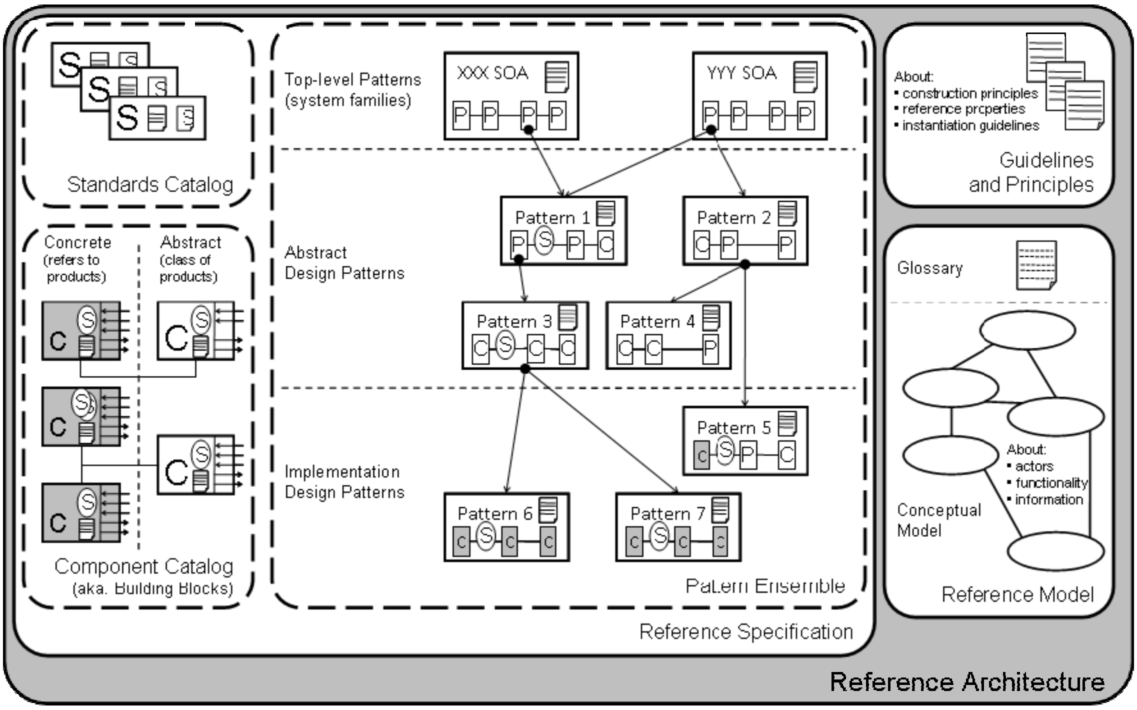

Figure 5 NEXOF-RA, Reference Architecture, Basis of Construction Kit Approach

The NEXOF Reference Architecture is part of a construction kit approach. It will be open for future trends and developments such as cloud computing, software as a service and others.

Details of the construction kit approach are described in “Scope, objective, ambition level, and baseline of the Reference Architecture” (D13.5), section 3.4 Usage of the NEXOF Reference Architecture).

“RA Specification Samples” (D7.4) contains a sample description according to these principles and structures (section 5 Example Patterns).

Part of the lead activity is to ensure that emerging standards will play a role in NEXOF-RA and thus give it a realistic approach. A particular attention was paid to SCA by OASIS (see [12]), since this is an emerging yet technology independent standard in the SOA world. Although it cannot yet been characterized as a wide spread state of practice approach, since only a few tools support it, it can already be forecasted that more and more tools wills adapt it in near future.

4.2.2 State-of-the-Art (contributions to “State of the art report” (D7.1))

Introduction

In this section the state of art of specific SOA aspects is addressed. The work package „Service-Centric System Engineering“ covers the following top level categories.

- Service Process: Process Description, Orchestration, Choreography, Transactional Concepts, Process Execution
- Service Foundation: Service Description, Service Discovery, Service Publication, Service Interaction, Service Execution, Service Implementation, Service Deployment
- Engineering Perspective: Modelling/Design Time, Deployment time, Execution Time

Service Description

In service description the standards that describe a service are collected. Service description is needed from several perspectives.

- In order to find a suitable service. This encompasses semantic technologies.
- To describe how interaction with a service can take place. This encompasses policies, protocols, structure and contents of messages and the like.

The basic standard related to service description is *Web Service Description Language (WSDL)* (See Section 4.2.1 in “State of the art report” (D7.1), [23]). Using WSDL, a service provider can describe the expectations and functionality of a single web service in a platform-independent way, so that potential requestors can understand how to correctly interact with the service. WSDL plays a central role for interoperability among services implemented in different platforms. It enables one to separate the description of the abstract functionality offered by a service from concrete details of a service description such as “how” and “where” that functionality is offered.

WS-Policy (Section 4.2.2 in “State of the art report” (D7.1), [22]) defines a framework and a model for expressing other properties of Web Services such as capabilities, requirements and constraints. Policies may be used for both providers and consumers.

Web services use metadata to describe what other endpoints need to know to interact with them. *WS Metadata Exchange* (Section 4.2.3 in “State of the art report” (D7.1), see [22]) allows bootstrapping communication with a Web service by defining request-response message pairs to retrieve the Web Service’s metadata.

Finally, several specifications related to Web Services semantics have been studied (Sections 4.2.4, 4.2.5, 4.2.6 and 4.2.7 in “State of the art report” (D7.1), see [22]). *OWL-S* supplies Web Service providers with a core set of markup language constructs for describing the properties and capabilities of their Web Services in unambiguous, computer-interpretable form. *Web Service Modelling Ontology (WSMO)* is another ontology for semantically describing Semantic Web Services. It is a model for the description of semantic web services that tries to overcome the limit of the existing technologies for the service description, in particular OWL-S. The WSDL 2.0 does not include semantics in the description of Web Services. The other two specifications, *Web Services Semantics (WSDL-S)* and *Semantic Annotation for WSDL (SAWSDL),* try to define how to add semantic information to WSDL documents.

Business Process Modelling / Workflows

Business Process Modelling (BPM) provides standards to describe Business Processes, BP. Standards identified so far can be grouped into two main categories: BPM graphical notation standards and BPM executable languages.

BPM graphical notation standards provide means to describe BP using graphical representations easy to be understood, since the semantics are implicit in the graphical notation. Process executable languages describe BP in a way suitable to be directly executed by a BP engine. Process Executable Languages comprise BPM executable languages (XPDL, Wf-XML), orchestration languages for WS (BPEL4WS) and choreography languages for WS (WS-CDL). There is a bidirectional link between BPM graphical notation standards and process executable languages, in the sense that the formers allows the derivation of executable BP specifications, while the later allows the derivation of graphical representations.

Business Process Execution Language (BPEL) (Section 4.3.1 in "State of the art report" (D7.1), see [22]) is an XML language specification conceived to describe business processes in a way suitable for being executed (orchestrated). *WS-BPEL for People (BPEL4PEOPLE)* (Section 4.3.2 in "State of the art report" (D7.1), see [22]) extends BPEL to describe the interactions between BPEL processes and human participants in the same business process, since in most real-world business processes human intervention is required. WS Human Task (WS-HT) (Section 4.3.11 in "State of the art report" (D7.1), see [22]) is also included as part of the WS-BPEL Extension for People (BPEL4People) Technical Committee, but it is a complete specification. The purpose of the BPEL4People TC is to define interfaces to allow introducing people tasks as services in an SOA independently of WS-BPEL. Finally, *Business Process Modelling Language (BPML)* (Section 4.3.5 in "State of the art report" (D7.1), see [22]) is another superset of BPEL offering a complete language to specify real-world complete business processes. However, it is not supported anymore since the driving organization, BPMI, has been acquired by OMG, which encumbrances BPEL.

There are three main specifications related to the exchange of messages between Web Services in order to be integrated (choreography). The *Web Services Choreography Description Language (WS-CDL)* (Section 4.3.3 in "State of the art report" (D7.1), see [22]) is an XMLbased language that describes peer-to-peer collaborations of participants by defining, from a global viewpoint, their common and complementary observable behaviour. Also the Web Services Conversation Language (WS-CL) (Section 4.3.12 in "State of the art report" (D7.1), see [22]) is a simple language "to define the minimal set of concepts necessary to specify conversations" between Web Services, so it results in a light-weight interface specification language. Therefore related implementations are very simple, but at the same time expressiveness of WS-

CL specifications is quite reduced. WS-CL is specifically targeted at public workflow types. Finally, The Web Service Choreography Interface (WS-CI) (Section 4.3.13 in “State of the art report” (D7.1), see [22]) is an XML-based interface description language for describing the observable behaviour of a Web Service through the flow of messages exchanged by a Web Service joining in choreographed interactions with other services. WS-CI describes the dynamic interface of the Web Service taking part in a given message exchange, reusing the operations defined for a static interface. WS-CI usually works together with the Web Service Description Language (WS-DL), the basis for the W3C Web Services Description Working Group. Sometimes, it can work with other service definition languages; in any case they should be quite similar to WSDL.

The *Business Process Modelling Notation (BPMN)* (Section 4.3.4 in “State of the art report” (D7.1), see [22]) is a standard specification of a graphical notation to represent business processes as workflows. The primary goal of this graphical notation is to represent business processes in a way easily understandable by main business process participants (such as stakeholders, business analysts, technical developers, business managers, etc.) which have a quite different technical background.

There is one initiative, BPDM (Section 4.3.6 in “State of the art report” (D7.1), see [22]) to provide a metamodel easing BPM sharing between different BPM tools.

The *XML Process Definition Language (XPDL)* (Section 4.3.7 in “State of the art report” (D7.1)) is an XML based language specification to describe workflow automation supported by a workflow management system (WfMS). XPDL aims at supporting process definition interchange between WfMS tools, like editors, engines, etc.

Wf-XML (Section 4.3.8 in “State of the art report” (D7.1), see [22]) is a BPM standard developed as an extension of the OASIS Asynchronous Service Access Protocol (ASAP) to manage and monitor the life cycle of long lasting processes. ASAP allows monitoring abilities to detect changes in the process execution status. Wf-XML extends ASAP by offering additional WS operations to exchange process execution definitions. Wf-XML also permits invocations between different BPM processes executed in different BPM engines.

The ebXML architecture specification (Section 4.3.9 in “State of the art report” (D7.1), see [22]) is a model/architecture for B2B Interoperability. ebXML is strongly promoted by OASIS. ebXML is composed of a set of infrastructure components (Messaging Service, Registry and Repository Services etc.), and several other efforts such as ones focused on document creation, business process definition, etc. The infrastructure components are orthogonal in design. They may be used together or separately in implementing an infrastructure.

The Process Definition for Java (Section 4.3.10 in “State of the art report” (D7.1), see [22]) was an initiative that aimed to standardize the automation of business processes on a J2EE server. Specifically, the expert group that created it was in charge of defining metadata, interfaces, and a runtime model to allow business processes to be easily and rapidly implemented using Java and deployed in J2EE containers. The specification was announced in 2003, but since then, there has been no recent development and public documentation.

Transactional Support

Transactions provide atomicity guarantees to client applications. The atomicity is provided with respect to concurrent accesses and with respect to failures. Atomicity with respect concurrent accesses is known as isolation. The most well-known isolation is serializability. The semantics of serializability are very powerful since applications are programmed as there is no concurrency, that is, as sequential programs, much simpler than concurrent programs. The failure atomicity also provides a strong semantics; it guarantees that transactions have an all-or-nothing effect. That is, that either the transaction is complete successfully and its effects will be permanent or if there is a failure, the result will be as the transaction was never executed. Serializability plus failure atomicity together with transaction durability (updates from successful transactions are never lost) are typically known as ACID properties. In the following, the main standards for transactional support are surveyed. Since ACID transactions alone are typically not enough in SOA, standards provide also support for advanced transactions that are more relaxed than ACID transactions (especially with respect to isolation). There are also specifications that standardize the protocol to guarantee transaction atomicity in a distributed setting, known as two-phase commit (2PC).

The *Business Transaction Protocol (OASIS BTP)* (Section 4.4.1 in "State of the art report" (D7.1), see [22]) was the first attempt to define a coordination protocol for Web Service-based transactional applications. BTP was designed to allow coordination of application work between multiple participants controlled by autonomous organizations. BTP used a two-phase (2PC) outcome coordination protocol to ensure the overall application achieves a consistent result. BTP permitted the consistent outcome to be defined a priori - all the work is confirmed or none is- (an atomic business transaction or atom) or for application intervention into the selection of the work to be confirmed (a cohesive business transaction or cohesion). The BTP allowed flexibility in the implementation of business transaction participants. Such participants enable the consistent reversal of the effects of atoms. BTP participants may use recorded before- or after-images, or compensation operations to provide the "roll-forward, roll-back" capacity which enables their subordination to the overall outcome of an atomic business transaction.

When BTP was deprecated, the WS Composite Application Framework (OASIS WS-CAF) (Section 4.4.2 in "State of the art report" (D7.1), see [22]) became its successor in the OASIS consortium. The main purpose of the OASIS WS-CAF was to define a generic and open framework for applications that contain multiple services used in combination (composite applications). It includes three specifications that can be implemented incrementally to address the range of requirements needed to support a variety of simple to complex composite applications: WS Context (WS-CTX), WS Coordination Framework (WS-CF) and WS Transactions (WS-TXM). The overall aim of the combination of these three specifications is to provide a complete solution that supports various transaction processing models and architectures. WS-CAF specifications are designed to compliment Web Services orchestration and choreography technologies such as WS-BPEL and WSCI and are compatible with other Web services specifications.

The OASIS consortium also deprecated the WS-CAF in favour of WS Transactions (OASIS WS-TX) (Section 4.4.3 in "State of the art report" (D7.1), see [22]). WS-TX is quite similar to WS-CAF (in fact, it is based on WS-CAF). However the OASIS consortium decided to join both committees and let WS-TX as the standard for transactions in Web Service infrastructures. It is composed by three specifications: WS-Coordination, WS-Atomic Transactions and WS-Business Activity. The WS-Coordination specification describes an extensible and generic framework for providing protocols that coordinate the actions of distributed applications. Such coordination protocols are used to support a number of applications, including those that need to reach consistent agreement on the outcome of distributed activities. The WS-AtomicTransaction specification provides the definition of the Atomic Transaction coordination type that is to be used with the extensible coordination framework described in WS-Coordination. It is similar to the ACID transactions in databases. Finally, the developers can use the WS-Business Activity protocols when building applications that require consistent agreement on the outcome of long-running distributed activities.

Finally, in Section 4.4.4 in "State of the art report" (D7.1), see [22] several Java specifications related to Java can be found. The main specification is the *Java Transaction API (JTA)* that allows applications to demarcate ACID transactions at the middleware level. JTA is a standard part of the J(2)EE platform and every Enterprise JavaBeans (EJB) application server should also include a JTA implementation. Advanced transaction models are supported by means of the *J2EE Activity Service for Extended Transactions* specification. The J2EE Activity Service defines a framework on which extended models of units of work (called activities) can be constructed. An extended activity model might simply provide a means for grouping a related set of tasks that have no transactional properties or it may provide services for a long-running business activity that consists of a number of short-duration ACID transactions. This provides powerful structuring mechanisms for workflow engines, component management middleware (EJB containers...) and other systems that allow creating implementations of advanced transaction models. Finally, the *Java API for XML Transactions (JAXTX)* was a trial to define a set of APIs that allow the management (creation and lifetime) and exchange of transaction information between participating parties in a loosely coupled environment. The parties would use SOAP and XML document exchange to conduct business transactions. If these transactions are to be conducted in an ACID transaction manner, information (e.g., the transaction context) would need to accompany these XML documents and be managed appropriately.

Publication / Discovery

With regard to the discovery and publication of Web Services the main specification is the *Universal Description Discovery and Integration (UDDI*) (Section 4.5.1 in “State of the art report” (D7.1), see [22]). UDDI is an initiative for creating a global registry of services and companies. The specification of UDDI is the output of an industrial-led consortium started in 2000, originally led by IBM, Microsoft and Ariba, and now driven by the OASIS Consortium.

UDDI defines a universal method for enterprises to dynamically discover and invoke Web services. The aim of UDDI is to create a global, platform-independent, open framework to enable businesses to discover each other; define how they will interact over the Internet; and share information in a global registry that will rapidly accelerate the global adoption of B2B eCommerce. Even if the main focus of UDDI is on Web Services, the registries have been designed to be able to manage information about different kind of services. UDDI registries are a sort of yellow pages for services that support publication and automated service discovery. Service Providers can register information about the services they offer with these registries, and this information can then be discovered and accessed by Service Requestors.

UDDI can be considered as extending the functionality provided by SOAP to allow the querying of services and the describing of services. Within the model the business registry is logically centralised, but physically distributed with data replicated across nodes on a regular basis.

Service Interaction / Messaging Specifications

Service interaction is related to the messages exchanged by the services. The standards and specifications described in the following paragraphs have to deal with the following issues:

- statelessness
- no coherence of messages
- subject to network faults
- no reliable addressing
- interoperability problems on the level of the exchanged messages
- limited to point-to-point communication

The basic messaging protocol is called *SOAP* (See Section 4.6.1). SOAP is a lightweight protocol intended for exchanging structured information in a decentralized, distributed environment based on XML. It consists of three parts:

- an envelope that defines a framework for describing what is in a message and how to process it,
- a set of encoding rules for expressing instances of application-defined datatypes,
- and a convention for representing remote procedure calls and responses.

A SOAP message contains the following elements:

- a required envelope which identifies it as a SOAP message
- an optional header that allows to include extended information
- an required body which contains the actual message
- an optional fault to define exceptions

SOAP can be used with any protocol but in order to circumvent firewalls, it is often used with HTTP or HTTPS in the context of Web Services. The *Web Service Interoperability (WS-I) Basic Profile* (Section 4.6.2 in "State of the art report" (D7.1), see [22]) specifies constraints on how to use SOAP, HTTP, and WSDL.

SOAP is a request/reply protocol (synchronous). The main purpose of *ASAP* protocol (Section 4.6.10 in "State of the art report" (D7.1), see [22]) is to create a very simple extension of the SOAP protocol to enable generic asynchronous Web Services and long-running Web Services and making them easy to implement and connect to. SOAP is a request/reply protocol. ASAP is an asynchronous protocol to allow the monitoring control and development of Web Services that have long response times (e.g. a service that includes some human task in workflow).

Moreover, SOAP over HTTP is not sufficient when an application-level messaging protocol must also guarantee some level of reliability and security. The used infrastructure may be unreliable. *WS-ReliableMessaging* (Section 4.6.3 in "State of the art report" (D7.1), see [22]) allows including reliability in Web Services. The specification includes reliability as SOAP header extensions that are independent of the underlying protocol.

The topic of adding event mechanisms such as publish/subscribe to Web services still sees competing standards (See Section 4.6.4 in "State of the art report" (D7.1), see [22]). *WS-Notification* defines a pattern-based approach for disseminating information amongst Web Services. It provides a standardized way for one Web service (or other entity) to disseminate information to another set of Web Services, without having to have prior knowledge of those services. It adopts the publish/subscribe pattern from event-driven architectures. *WS-Eventing* is another standard submitted to W3C that describes a protocol that allows Web services to subscribe to or accept subscriptions for event notification messages. Finally, *WS-EventNotification* is an initiative to harmonize the previous standards. It has not yet become a standard. It is expected that it replaces WS Eventing but not completely WS Notification.

WS-Addressing (See Section 4.6.5 in "State of the art report" (D7.1), see [22]) provides transport-neutral mechanisms that allow web services to communicate addressing information. WS-Addressing is a standardized way of including the HTTP-specific data in the XML message itself.

WS-Enumeration (Section 4.6.6 in "State of the art report" (D7.1), see [22]) describes a general SOAP-based protocol for enumerating a sequence of XML elements that is suitable for traversing logs, message queues, or other linear information models. This specification defines a simple SOAP-based protocol for enumeration that allows the data source to provide a session abstraction, called an enumeration context, to a consumer that represents a logical cursor through a sequence of data items.

The *Message Transmission Optimization Mechanism (MTOM)* (Section 4.6.7 in “State of the art report” (D7.1), see [22]) describes a mechanism for optimizing the transmission and/or connection format of a SOAP message by selectively re-encoding sections of the message exposing an XML information set to the SOAP application.
MTOM also describes an inclusion mechanism that works in a binding-independent way, plus a specific binding for HTTP.

By itself, Web Services are nominally stateless, so the main and fancy goal of *WS Resource Framework (WS-RF)* (Section 4.6.9 in “State of the art report” (D7.1), see [22]) is to provide Web Services with a standard and complete way to access and manage states. For this reason Web Services implemented according to WSRF can have one or more persistent states. This feature is mainly achieved by specifying, inside the request, the resource that should be used (e.g. encapsulated within the WS-Addressing endpoint reference) and a set of properties for it. These properties could be used to manage resource states. *WS-Transfer* (Section 4.6.8 in “State of the art report” (D7.1), see [22]) also specifies the means to make web services stateful. However, unlike WS-RF, WS-Transfer satisfies compliance with the basic rules of the web services community, that is to say it keeps functionality to a minimum, therefore allowing mixing of different specifications to extend functionalities.

SOA Infrastructure / Implementation

With regard to the SOA infrastructure, three different kinds of technology have been studied.

Section 4.7.1 in “State of the art report” (D7.1), see [22] includes a survey on most active and relevant workflow engines supporting process standards for executable languages, ranging form BPM (XPDL) to service orchestration. The workflow engines studied based on BPEL4WS have been ActiveBPEL, Nova Orchestra, JBoss jBPM BPEL and Apache ODE. With regard to the XPDL-based workflow engines, the engines studied have been Nova Bonita, JaWE, Shark, JPEd and WfMOpen.

Section 4.7.2 in “State of the art report” (D7.1), see [22] studies semantic technologies. Firstly, WSMX (Web Service Modelling eXecution environment), the reference implementation of WSMO (Web Service Modelling Ontology) is studied. It is an execution environment for dynamic discovery, selection, mediation and invocation of semantic web services. Its internal language is WSML (Web Service Modelling Language). Then, the IRS Internet Reasoning Service, a Semantic Web Services framework, used by applications to semantically describe and execute WS is commented. Finally, Triple Space (TS), a technology that provides semantic data persistence over a virtualised single shared space has also been studied.

Finally, Section 4.7.3 in “State of the art report” (D7.1), see [22] studies the SeCSE Registry. Registries like UDDI and ebXML have several limitations in how users can search for services. These limitations are related to how services are described. The SeCSE registries use a solution to overcome this problem that is based on the usage of facets. Facets are a set of pairs key-value that describe properties of a system including both functional qualities (e.g., data formats supported, functionalities offered, etc.) and non-functional ones (e.g., price, reliability, response time, etc.). Facets allow providers to describe in a structured way the relevant aspects of a software system.

4.2.3 Model/Conceptual Architectural View (models analyzed and contributed to work package “Reference Architecture: Model“)

As one of the horizontal work packages, work package “Service-Centric System Engineering“ has analysed and provided reference architecture models specific for work package “Service-Centric System Engineering“ scope. The resulting models were provided as separate documents to work package “Reference Architecture: Model“ and were collected in the appendix of D6.1. Then work package “Reference Architecture: Model“ integrated these models. Please note that some of the models have appeared already as models underlying the standards and technologies looked at for “State of the art report” (D7.1), see [22].

For the contribution to the reference architecture model, work package “Service-Centric System Engineering“ looked into state of practice and state of the art approaches for SOA to collect models. Some of these approaches, in particular best practice approaches do not provide reference architecture models or the reference architecture models they provide are not technology independent which was required by work package “Reference Architecture: Model“. In these cases, work package “Service-Centric System Engineering“ has created corresponding reference architecture models.

The key responsibilities were assigned corresponding to the competencies and experiences of the partners as follows.

- Siemens analysed OSGi (Open Service Gateway interface), a small footprint service model for Java applications that is widely used. For OSGi no reference architecture model existed, only a code-centric specification that was moreover technology dependent because OSGi was created for Java. In literature, only one paper was found that provided a partial reference architecture model for OSGi. Moreover, this model was of course based on Java. Based on this, an exhaustive reference architecture model was created that was technology and language independent (see appendix of D6.1).
- Siemens analysed SCA (Service Component Architecture), a language and technology independent service model supporting separation of business logic from service invocation protocols that is an emerging standard. For SCA, a reference architecture model exists. However, this model contained

references to existing languages and technologies which were not desirable. Therefore, the SCA model of OASIS was consolidated.

- Engineering analysed WSA, which provides a conceptual model and a context for understanding Web services and the relationships between the components of this model, and OASIS reference models, which are an abstract framework for understanding significant entities and relationships between them within a service-oriented environment.
- Engineering and ATOS both have background on SeCSE and participated in the contribution of SeCSE results, namely on service description and service registry rsp. discovery.
- UPM did the analysis of EGA and of the paper "A Reference Architecture for Self-organizing Service-oriented Computing" by Liu, L.; Thanheiser, S.; Schmeck, H.

4.2.4 Reference Architecture (Contribution to Deliverables "NEXOF RA Model" (D6.2)/" Conceptual architectural view," (D7.3), "Definition of an architectural framework and principles" (D7.2) and "RA Specification Samples" (D7.4))

Work package "Service-Centric System Engineering" participated in the discussion of the principles and contributed to "Definition of an architectural framework and principles" (D7.2) about the principles of the architecture.

For deliverable "Conceptual architectural view" (D7.3), which was merged with "NEXOF RA Model" (D6.2), work package "Service-Centric System Engineering" reviewed the system requirements and provided input to the initial reference architecture specification. Work package "Service-Centric System Engineering" contributed to the topics Service, Messaging and Discovery, which are handled in the sections 7, 8 and 9 of the deliverable "NEXOF RA Model" (D6.2)[2]. For the topic composition work package "Service-Centric System Engineering" prepared a first draft, describing the procedure of composing services. It considers the following aspects:

- How to describe processes, which should be implemented by services, and which languages and tool to use to describe them;
- How to identify and select the component services that can be aggregate in a process, considering both functional and not functional;
- Which engines can be used to enact processes.

The integral part of the draft comprised:

- system requirements for design time composition and run time composition and
- functionalities and information entities, spitted in service composition functionals and service composition data elements.

[2] The deliverable "NEXOF RA Model" (D6.2) has completely removed from the DoW. In the final version of D2.1 it will be referenced no longer.

Some of the details are not yet worked out and need some further engagement. It was contributed to work package “Reference Architecture: Model“, but in agreement work package “Service-Centric System Engineering“/work package “Reference Architecture: Model” it was nor included in “NEXOF RA Model” (D6.2) nor published.
For “RA Specification Samples” (D7.4) work package “Service-Centric System Engineering” is preparing a sample architecture description in accordance with the construction kit approach described in section 4.2.1).

Each section contains a revised version of the system requirements, a description of the core functionalities of the respective part of the architecture and a so called information model. This model defines the entities that are created and modified by the functionalities.

4.2.5 Contribution to Work Package „Proof-of-Concept“

Although not defined explicitly in DoW [1], it turned out that in order to achieve results in time and in order to set up the software baseline in time it was necessary that horizontal WPs contributed to work package “Proof-of-Concept”.
The work package “Service-Centric System Engineering” therefore collected software components for the baseline and initial practical example of concept examples.

Engineering provided results from SeCSE. Siemens provided SCA related software components. Siemens also provided an SCA proof of concept demonstrating three best practice patterns: separation of business and infrastructure concerns, automatic choice of bindings and services.

5 Conclusion, Lessons learned and Future work

The result presented in this deliverable is the status of the work of the package "Service-Centric System Engineering" at the end of the reporting period.
The scope of work package „Service-Centric System Engineering" is detailed by two views: the service process point of view and the service foundation point of view. In particular, the position paper of the work package "Service-Centric System Engineering" elaborated on the dimensions of design time and runtime and on the dependencies and potential risk of overlap with other horizontal work packages. Here, the boundary between work package „Service-Centric System Engineering" and work package „Advanced User-Service Interaction" was clarified and the boundary between work package „Service-Centric System Engineering" and work package „Adaptive Service Aware Infrastructure".
The actual work carried out in work package "Service-Centric System Engineering" (until month 12) resulted in contributions to the reference model and architecture (work package "Reference Architecture: Model" and work package "Reference Architecture: Specifications") and to direct contributions to the deliveries or the two work packages "Reference Architecture: Model" and work package "Reference Architecture: Specifications":

- Specific reference models (results included in "Reference Architecture Model V1.0" (D6.1)):
  Analysis of OSGi, SCA, SeCSE, WSA, OASIS
- State-of-the art report (results included in "State of the art report" (D7.1)):
  Survey of standards/technologies related to SOA, incl. acceptance and competing standards
- Conceptual architecture (results included in "Definition of an architectural framework and principles" (D7.2), "NEXOF RA Model" (D6.2)/ "Conceptual architectural view" (D7.3))
  Contribution to principles and functionality of core service area Service, Message, Discovery

In work package "Service-Centric System Engineering" external partners have been involved by use of the Open Contribution Process. The resulting achievements here, in core service framework area, are:

- Topic identification, definition, prioritization resulted in 13 topic candidates, from them 4 topics was selected for call 1
- These base topics for call 1 (results documented in IT reports) are:
  - Service Description
  - Design Time Service Composition
  - Service Discovery
  - Interoperability of Message-based Service Invocation
- Base topic for call2 is Runtime Service Composition (constituted on 23rd March 09)

The results of the Investigation Teams working on the identified topics of call 1 show that a deeper gap and trend analysis has to be performed. In the beginning of the activity, the progress of work suffered on low guidance by the work package "Reference Architecture: Specifications". It is now available (see deliverable "RA Specification Samples" D7.4).

The Open Contribution Process leads to interesting proposals, but the identification of the topics needed more time than expected. External partners provided many position papers. Their participation during work decreased to a low level. So the collaboration is very time consuming and the procedure seems not to be efficient as it could be.

The interoperability investigation team (Topic Interoperability of Message-based Service Invocation), nevertheless it is part of the first call for contributions, has not yet finished its task at the end of the reporting period; It is planned that the results are available in the next period. These results will be published in the next version of this deliverable. Already now it is obvious, that for that topic the investigation team contribute with less best practice or pattern. It is necessary to analyse why the expectations about best practice and patterns have not been fulfilled.

The further planning of the work package "Service-Centric System Engineering" has to be updated in respect to the project review recommendations and the resulting adaptations of the projects and its work packages.
Further work will comprise the results of the interoperability working group documented in the IT report "Interoperability of Message-based Service Interaction" and the final version of this deliverable "Service Centric System Architecture Contributions to Model and Architecture" (D2.1). Instead of putting new topics into call 3 topics from call 1 and 2 shall be resumed in order to get more insight. The analysis for contributions to Reference Architecture has to be continued and the analysis of results regarding gaps and new trends has to be executed. IT Call 2 will bring an extension of an existing topic, which has to be integrated. The further planning for work package "Service-Centric System Engineering" has started just now.

ABBREVIATIONS

API	application programming interface
ASTRO	research project in the field of web services and service-oriented applications , http://www.astroproject.org/
ATOS	ATOS Origin, international information technology service company, see DoW p.71
B2B	Business-to-Business
BPDM	Business Process Definition MetaModel http://www.omg.org/docs/dtc/07-07-01.pdf
BPEL4WS	Business Process Execution Language for Web Services http://www.oasis-open.org/committees/download.php/2046/BPEL%20V1-1%20May%205%202003%20Final.pdf
BPML	Business Process Modelling Language http://www.ebpml.org/bpml.htm
BPMN	Business Process Modelling Notation http://www.omg.org/docs/formal/09-01-03.pdf
CRP Henri Tudor	Public Research Centre Henri Tudor, http://www.tudor.lu/
DERI	Digital Enterprise Research Institute, http://www.deri.org/
DoW	Deliverable of Work [1]
ebXML	Electronic Business XML http://www.ebxml.org/
EC FP6/7	European Commission Framework Program 6/7
ESI	Engineering Ingegneria Informatica S.p.A, see DoW p. 69
EzWEB	EzWeb project is based on the development of key technologies to be employed in building the front end layer of a new generation SOA architecture , ezweb.morfeo-project.org
FLEXI	Project Flexible Integration in Global Product Development, www.flexi-itea2.org/
FZI	Forschungszentrum Informatik in Karlsruhe, http:// www.fzi.de/
GODO	Goal-oriented Service Discovery, project http://godo.atosorigin.es/
GRIA	a service-oriented infrastructure designed to support B2B collaborations through service provision across organisational boundaries in a secure, interoperable and flexible manner., http://www.gria.org/
IBBT	IBBT (Interdisciplinary Institute for Broadband Technology) is an independent research institute founded by the Flemish government to stimulate ICT innovation
ICT	Information and communication technologies
IMIS	Institute for the Management of Information Systems, http://www.ipsyp.gr/
IR	Information Retrieval
ISTC-CNR	Institute of Cognitive Science and Technology Italian National Research Council, http://www.loa-cnr.it/
IT	Investigation Team
J2EE	Java 2 Platform Enterprise Edition

JBI	Java Business Interoperability
JCP	Java Community Process http://jcp.org/en/home/index
KOM	European commission (Europäische Kommission)
MOMA	Modelli matematici ed applicazioni S.r.l, see DoW p. 77
MTOM	Message Transmission Optimization Mechanism http://www.w3.org/TR/soap12-mtom/
NEXOF-RA	NESSI Open Framework – Reference Architecture
NFR	non-functional requirement
NSP	NESSI strategic project
OASIS	Organization for the Advancement of Structured Information Standards http://www.oasis-open.org/home/index.php
OCC	Open Construction Cycles
OASP	Open Architecture Specification Process
OCP	Open Construction Process (aka. Open Architecture Specification Process)
OMG	Object Management Group
OSGi	Open Service Gateway interface
OVAL/PM	MODELO DE PROCESO CENTRADO EN REQUISITOS DE OPERACIÓN Y PRUEBAS DE VALIDACION (OVAL/PM) TIN2006-14840 http://www2.upm.es/observatorio/vi/actividad.jsp?id_actividad=2985
OWL-S	Web Ontology Language for Web Services http://www.w3.org/Submission/2004/SUBM-OWL-S-20041122/
REO	Project, http://reo.project.cwi.nl/
RFP	request for proposal
RM	Reference architecture model
RS	reference architecture specification
SAWSDL	Semantic Annotations for WSDL http://www.w3.org/2002/ws/sawsdl/
SCA	Service Component Architecture
SCSE	Service Centric System Engineering
SeCSE	project: SeCSE - Service Centric System Engineering, FP6-IST (IP) , http://secse.eng.it
SHAPE	Project Semantically-enabled Heterogeneous Service Architecture and Platforms Engineering, http://www.shape-project.eu/
SIMS	Project Semantic Interfaces for Mobile Services, http://www.ist-sims.org/
SINTEF	Norwegian: Stiftelsen for industriell og teknisk forskning is an independent research organisation in Scandinavia. http://www.sintef.no
SLA	Service Level Agreement
SLA@SOI	Service Level Agreement@Service Oriented Infrastructure
SME	Small and Medium Enterprise
SOA	Service oriented Architecture
SOA4All	Service Oriented Architectures for All , a FP7 ICT 2007 Call 1 Integrated Project, http://sla-at-soi.eu/

SZTAKI	Computer and Automation Research Institute Hungarian Academy of Sciences, http://www.sztaki.hu
TIE	TIE Nederlands B.V., international B2B software company, see DoW, p. 83
UDDI	Universial Discription Discovery and Integration – a SOAP standard http://uddi.xml.org/
UML2	Unified modelling language 2 http://www.omg.org/docs/formal/07-11-04.pdf
UPM	Universidad Politécnica de Madrid, see DoW p. 85
V&V	Verification & Validation
W3C	World Wide Web Consortium, http://www.w3.org/
WfMC XPDL	Workflow Management Coalition XML Process Definition Language
Wf-XML	Workflow- Extensible Markup Language
WP	Work package
WS	Web Service
WSA	web service architecture
WS-CDL	Web Services Choreography Description Language http://www.w3.org/TR/2004/WD-ws-cdl-10-20041217/
WS-CL	Web Services Conversation Language http://www.w3.org/TR/wscl10/
WSDL	Web Service Description Language http://www.w3.org/TR/wsdl.html
WS-HT	Web Services Human Task (WS-HumanTask) http://download.boulder.ibm.com/ibmdl/pub/software/dw/specs/ws-bpel4people/WS-HumanTask_v1.pdf
WSMO	Web service modelling ontology http://www.wsmo.org/
WS-Policy	Web Service-Policy http://www.w3.org/Submission/WS-Policy/

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