Title:	*Report on Alignment of Long-term Research Agendas of Beneficiaries*
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Management Summary

This deliverable reports on the alignment of the long-term research agendas of the individual beneficiaries and of the network as a whole. The analysis results presented in this deliverable are based on input obtained from all partners (including the associate members) concerning a set of consolidated information elements obtained within this WP and within other integration and research WPs. The performed analysis aims to show how the research activities of the individual partners are aligned with the goals and objectives of the network. It also demonstrates how the research activities and results of S-Cube as a whole have progressed with respect to the overall research agenda. As a major result of this analysis, this deliverable provides evidence that a strong alignment of the research agendas within the network has been achieved.

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The S-Cube Deliverable Series

Vision and Objectives of S-Cube

The Software Services and Systems Network (S-Cube) will establish a unified, multidisciplinary, vibrant research community which will enable Europe to lead the software-services revolution, helping shape the software-service based Internet which is the backbone of our future interactive society.

By integrating diverse research communities, S-Cube intends to achieve world-wide scientific excellence in a field that is critical for European competitiveness. S-Cube will accomplish its aims by meeting the following objectives:

- Re-aligning, re-shaping and integrating research agendas of key European players from diverse research areas and by synthesizing and integrating diversified knowledge, thereby establishing a long-lasting foundation for steering research and for achieving innovation at the highest level.
- Inaugurating a Europe-wide common program of education and training for researchers and industry thereby creating a common culture that will have a profound impact on the future of the field.
- Establishing a pro-active mobility plan to enable cross-fertilisation and thereby fostering the integration of research communities and the establishment of a common software services research culture.
- Establishing trust relationships with industry via European Technology Platforms (specifically NESSI) to achieve a catalytic effect in shaping European research, strengthening industrial competitiveness and addressing main societal challenges.
- Defining a broader research vision and perspective that will shape the software-service based Internet of the future and will accelerate economic growth and improve the living conditions of European citizens.

S-Cube will produce an integrated research community of international reputation and acclaim that will help define the future shape of the field of software services which is of critical for European competitiveness. S-Cube will provide service engineering methodologies which facilitate the development, deployment and adjustment of sophisticated hybrid service-based systems that cannot be addressed with today's limited software engineering approaches. S-Cube will further introduce an advanced training program for researchers and practitioners. Finally, S-Cube intends to bring strategic added value to European industry by using industry best-practice models and by implementing research results into pilot business cases and prototype systems.

S-Cube materials are available from URL: http://www.s-cube-network.eu/

Contents

List of Acronyms

SBA   Service-based Application

SLA   Service Level Agreement

BPM   Business Process Management

IRF   Integrated Research Framework

SAM   Service Adaptation and Monitoring

SED   Service Engineering and Design

SCC   Service Composition and Coordination

SI   Service Infrastructure

SQ   Service Quality (including definition, negotiation and assurance)

1 Introduction

The primary objective of workpackage (WP) IA-3.1 is to define a coherent, holistic Integrated Research Framework (IRF) for service engineering and adaptation. The framework fosters the conceptual integration of principles, techniques and methodologies for the engineering and adaptation of service-based applications (SBAs), building on technology layers of service-based applications, namely service infrastructures, service composition and coordination, and business process management.

This WP, together with the alignment of research activities happening in the individual JRA WPs, plays an enabling role in ensuring overall consistency and harmonization of S-Cube research activities and research agendas.

This deliverable reports on the results of an analysis performed within WP-IA-3.1 aiming to assess the alignment of the long-term research agendas of the individual beneficiaries and of the network as a whole.

The analysis performed in this WP aims to:
- show how the research activities and results of the individual S-Cube partners are aligned to the research challenges of the network;
- demonstrate how the research activities and results of the S-Cube as a whole have progressed since the last assessment with respect to the overall research agenda;
- show how the research results of the beneficiaries are aligned with each other in terms of joint research results, thereby evaluating the integration of research agendas among the partners (research results are accepted and submitted research publications, as well as publications under preparation).

1.1 Data Collection

To obtain up-to-date information with regard to the research challenges and the results of partners (both full and associate members), we proceeded as follows:
- First, together with the WP leaders we ensured that the list of research challenges represents an up-to-date list of challenges (also ensured with IA-3.1.7).
- Second, we used a template to gather input from all the beneficiaries of S-Cube, including full and associate members. The template was designed in such a way to allow understanding and analyzing the progress in terms of individual research results of S-Cube partners towards the research challenges. Additionally, the information collected using the template allowed us to assess the degree of integration and collaboration between the partners in terms of joint research results.

The analysis results presented in this deliverable was based on the input obtained from all partners concerning a set of consolidated information elements obtained within this WP and within other integration and research WPs. In particular, it used the information about:
- The consolidated research problems identified within the research WPs and reported in the Integrated Research Framework by the network as a whole (c.f., IA-3.1.7).
- The research results obtained by the individual beneficiaries within the research activities and WPs.
- The joint research results obtained through the collaboration between the beneficiaries within the research activities of the JRA WPs.

Note: As part of the readjustment of the DoW after year 2 of the network, IRF activities have been consolidated. Thus, the research questions and the corresponding results have no longer been

individually stored and cross-linked within the IRF tool. For the analysis performed in this deliverable, we therefore have not been able to exploit the same level of details from the IRF as for the previous deliverable IA-1.1.4.

1.2   Relation to other WPs

To perform the analysis activities reported in this deliverable, the work was done in a close collaboration with other S-Cube activities and WPs. More specifically, the relation between this deliverable and the S-Cube WPs and activities are the following:

- The research results obtained within the S-Cube research activities (JRA-1 and JRA-2) have been analyzed in order to understand the progress of the research towards the coverage of the S-Cube strategic areas and roadmap.
- The elements of the Integrated Research Framework provide an overview of the research of the network as a whole. We remark that this activity is different from the IRF validation activities undertaken in WP-IA-3.2, as the latter aims at analyzing the structure and evolution of the IRF, while here we are targeting the progress and alignment of the research activities of beneficiaries with respect to the research agenda, and of the network as whole.
- The S-Cube mobility program (WP-IA-2.1) aims to support the integration and exchange of competences between the beneficiaries through the mobility of researchers. The corresponding deliverable shows the results of mobility visits for beneficiaries by analyzing their joint research results within JRAs.

Finally, the goal of this WP is to foster the harmonization of the research activities in the S-Cube JRAs, that is, the alignment and integration of research agendas of individual beneficiaries with each other and with respect to the S-Cube research roadmap. On the contrary, the alignment of the S-Cube research agendas to industry needs is a subject of analysis undertaken in Integration Activity IA-2.2 "Alignment with European Industry Practices".

2   Assessment of the Alignment of Research Agendas

In this section, we report on several analysis results obtained from the collected information (see Section 1.1). In particular, we report on:

- Coverage of the research areas by research challenges. This information shows the degree of alignment between the research activities (addressing the research challenges) carried out in the context of the different JRA WPs with the overall research agenda of S-Cube (see Section 0).

- Coverage of research challenges by individual research results. The coverage will be evaluated based on individual research results from full members and associate members of S-Cube. This information shows the alignment of the research results of the beneficiaries with the research agenda of S-Cube (see Section 2.2).

- Integration and collaboration between the research activities of the partners based on joint research results between the full members, and with the associate members. This information indicates the degree of alignment of research activities in JRA WPs and the degree of alignment between the research results and agendas of the S-Cube members (see Section 2.3).

2.1 Coverage of Research Areas by Research Challenges

The list of research challenges presented in Table 1 shows the list of current challenges defined in the Integrated Research Framework.

	Research Challenges Names	**BPM**	**SCC**	**SI**	**SED**	**SAM**	**SQ**
RC1	Business Transactions in Service Networks	X	O			O	O
RC2	End-to-end Processes in Service Networks	X	O		O		
RC3	Support Agile Service Networks with context modelling	X			O		
RC4	Analysis and Prediction of Quality Characteristics of Service Compositions		X			O	O
RC5	Formal Models and Languages for QoS-Aware Service Compositions		X	O			O
RC6	Monitoring of Quality Characteristics of Service Orchestrations and Service Choreographies		X			O	O
RC7	QoS Aware Adaptation of Service Compositions		X			O	O
RC8	Deployment and Execution Management			X		O	
RC9	Process Mining for Service Discovery			X			
RC10	Definition of a Coherent Life Cycle for Adaptable and Evolvable SBA				X	O	
RC11	HCI and Context Aspects in the Development of Service Based Applications				X	O	
RC12	Measuring, Controlling, Evaluating and Improving the Life cycle and the Related Processes				X	O	
RC13	Understand when an Adaptation Requirement should be Selected				X	O	
RC14	Identify Best Practices for SOA Migration				X		
RC15	Comprehensive and Integrated Adaptation and Monitoring Principles, Techniques, and Methodologies	O	O	O		X	O
RC16[1]	Proactive Adaptation and Predictive Monitoring					X	O
RC17	Context- and HCI-aware SBA Monitoring and Adaptation				O	X	
RC18	Mixed Initiative SBA adaptation				O	X	O
RC19	Multi-level and Self-adaptation		O	O		X	
RC20	End-to-End Quality Reference Model	O	O	O			X
RC21	Exploiting User and Task Models for Automatic Quality Contract Establishment		O		O		X
RC22	Proactive SLA Negotiation and Agreement		O				X
RC23	Online Quality Prediction Techniques to Support Proactive Adaptation	O	O	O		O	X
RC24	Rich and Extensible Quality Definition Language	O	O	O			X
RC25	Run-time Quality Assurance Techniques				O		X
Total		7	13	8	11	15	14

Table 1: List of Research Challenges and Corresponding Research Areas. "X" indicates main area for the challenge and "O" indicates a secondary area.

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[1] RC16 and RC23 address the same research goal from two different, complementary angles.

Table 1 shows the coverage of research challenges to the research areas of S-Cube: namely: *"Business Process Management" (BPM)*, *"Service Adaptation and Monitoring" (SAM)*, *"Service Composition and Coordination" (SCC)*, *"Service Engineering and Design" (SED)*, *"Service Infrastructure" (SI)*, and *"Service Quality" (SQ)*.

The results of the coverage evaluation show that the S-Cube research areas are well-covered by the research challenges of S-Cube. Each research area is covered by at least 7 research challenges and all but 2 research challenges touch on more than one research area.

2.2 Coverage of Challenges

2.2.1 S-Cube Full Members Working on a Research Challenge

The following Table 2 shows which S-Cube full members have achieved research results addressing the research challenges.

	UniDue	Tilburg	CITY	CNR	FBK	INRIA	Lero-UL	POLIMI	SZTAKI	TUW	UCBL	UoC	UPM	USTUTT	UniHH	VUA	Total
RC1		X				X	+				+	+		X	+	+	8
RC2		+					+					+		+			4
RC3							+	+								+	3
RC4	+	+			+			+		X	+		X	X			8
RC5				+	+	+		+	+		+	X	X	+		+	10
RC6		+						X	+	+	+		X	X	+		8
RC7	+			+	X	+		+	+	X	+		X	X	X		11
RC8		+					+		X	X				+		+	6
RC9				+						+	+						3
RC10	X	X			+	X	X	X		X	+	X		X		X	11
RC11	X	X	X		X			X		X	X		X		+		9
RC12		X	X		+		+	+		X						+	7
RC13	X	X			X			X		X				X			6
RC14		+				+		+						+		+	5
RC15	X	X	X	X	X	X	+	X	X	X	X		+	X		+	14
RC16	X			X	X	X				X	X		X	X			8
RC17	X		X		+	+		+	+						+		7
RC18										X	X					X	3
RC19				X	+	X		+	X	X		+		X	+		9
RC20	X	X	X		X	X	+	X	X	X	X		X	X			12
RC21			X					X		X		X					4
RC22	+	X	X				+	+	X	X	+		+	+			10
RC23	X	X	+	X	X	X		+		X	X		X	X			11
RC24	X	X	X					X	X	X	X		X	X	X		9
RC25	X	X	+		X	X	X	X	X	X	X		X	X			12
total	13	16	10	7	14	12	10	19	12	18	16	6	12	18	6	9	

Table 2: Coverage of Research Challenges by S-Cube Results from Full Members. "X" indicates the partner has at least one research result addressing the corresponding challenge. "+" means additional coverage since last report (IA-1.1.4).

The above table shows that the partners have research results addressing several research challenges. Additionally, the majority (with some exceptions) of the research challenges are addressed by more than 5 partners. Linking to the coverage of research areas by research challenges in Table 1, the evaluation results in Table 2 indicate the individual research agendas and the research efforts are well-aligned with the research agenda and roadmap of S-Cube. Furthermore, they indicate that there has been very strong integration and collaborations among the S-Cube partners that lead to having results covering several research challenges. This indicates that the network as a whole has achieved a successful coverage towards the S-Cube research roadmap. Furthermore, in contrast to what has been reported since the last assessment in PO-IA-1.1.4, the "+"'s show additional coverage of challenges in terms of research results of individual partners. These results show a visible progress and strong interaction among the partners within the WPs.

2.2.2 S-Cube Associate Members Working on a Research Challenge

In this section, we report on the results for evaluating the coverage of research results of the associate members of S-Cube with respect to the research challenges of S-Cube. The coverage results are summarized in Table 3.

	CETIC	Uni Manchester	Uni Pisa	USI	Uni Münster	Uni Dortmund	IT Innovation	KIT	Tsinghua Uni	Uni Innsbruck	UPC	SINTEF	SEERC	Uni L'Aquila	Uni Européenne de Bretagne	Uni Groningen	Uni Sevilla	Total
RC1																X		1
RC2																		0
RC3																		0
RC4				X														1
RC5		X	X													X		3
RC6	X				X				X		X	X					X	6
RC7		X							X		X	X						4
RC8											X					X		2
RC9																		0
RC10					X							X						2
RC11								X	X							X		3
RC12					X													1
RC13					X													1
RC14												X						1
RC15				X	X		X		X	X	X	X				X		8
RC16					X		X			X	X	X	X					6
RC17												X						1
RC18																		0
RC19												X		X				2
RC20							X										X	2
RC21							X										X	2
RC22												X					X	2
RC23					X		X				X		X				X	5
RC24				X													X	2
RC25				X	X		X		X		X	X	X				X	8
Total	1	2	1	5	7	0	4	3	5	2	8	9	3	1	0	5	7	

Table 3: Coverage of Research Challenges by S-Cube Results from Associate Members.

The results demonstrate that almost all of the associate members have been actively involved in producing research results within the JRA WPs. Moreover, some of the partners have research results covering several research challenges. This active involvement of the associate members has strengthened the alignment of the research activities of the JRA WPs with the research agenda and roadmap of S-Cube. In addition, it has enriched the integration and collaboration within S-Cube and as well as external communities. These findings are further supported by the results summarized in Section 2.3.2.

2.3 *Collaborative Research*

2.3.1 **Collaborations and Joint Research Results from Full Members**

To analyze the progress towards integration and alignment of research agendas between members, we employ the joint results between the members as an indicator. Table 4 represents the joint research results between full members of S-Cube.

	UniDue	Tilburg	CITY	CNR	FBK	INRIA	Lero-UL	POLIMI	SZTAKI	TUW	UCBL	UoC	UPM	USTUTT	UniHH	VUA
UniDue		X	X	X	X	X	X	X	X	X			X	X		
Tilburg	X				X	X	X	X	X	X	X	X	X	X	X	X
CITY	X				X				X							
CNR	X					X			X	X						
FBK	X	X	X				X	X	X					X		
INRIA	X	X		X				X	X	X				X		
Lero-UL	X	X			X			X			X	X		X	X	X
POLIMI	X	X			X	X	X		X		X	X	X	X		X
SZTAKI	X	X	X	X	X	X		X		X				X		
TUW	X	X		X		X			X					X	X	
UCBL		X					X	X					X	X		
UoC		X					X	X					X	X		
UPM	X	X						X			X	X				X
USTUTT	X	X			X	X	X	X	X	X	X	X			X	
UniHH		X					X			X				X		
VUA		X					X	X					X			
Total	11	13	3	4	7	7	9	11	9	8	5	5	7	11	4	4

Table 4: Collaborations among the S-Cube Full Members. "X" indicates that there has been at least one joint research result addressing at least one research challenge. The entries are symmetric along the diagonal and thus the table can be read in both directions (horizontal and vertical).

From these results, one can see that there has been a very intensive collaboration among the partners. All the partners have research results with multiple partners. This also indicates that there has been a good integration achieved among the different JRA WPs. The joint results are distributed across the research challenges and research areas (see Table 1). Based on these findings, we can conclude that S-Cube has achieved a strong integration and alignment of the research agendas of the S-Cube full members.

2.3.2   Collaborations and Joint Research Results with Associate Members

We further analyse the integration and collaborations involving associate members. The results are summarized in the following list which represents the collaborations and the joint research results reported between full and associate members of S-Cube.

- UniDue:
    - Uni Münster
    - IT Innovation
    - UPC
    - SEERC
- Tilburg:
    - Uni Groningen
- FBK:
    - Uni Münster
    - UPC
    - Uni L'Aquila
    - Uni Groningen
- INRIA:
    - SINTEF
- POLIMI:
    - USI
    - Uni Münster
    - Uni Sevilla
- SZTAKI:
    - UPC
- UCBL:
    - CETIC
- VUA:
    - Uni Groningen
    - Uni L'Aquila

In addition to the strong collaboration and integration among the full members of the network, the above list demonstrates that the majority of the associate members (10 out 17) have been actively involved. This indicates a strong integration of results and thus research agendas of those partners.

Furthermore, we may note that S-Cube has fostered the collaboration amongst the associate members. 8 out of the 17 associate members have achieved joint research results.

3   Conclusion

In this deliverable we have reported on the analysis results undertaken within the scope of WP-IA-3.1, for what concerns the alignment of the long-term research agendas of the individual beneficiaries and of the network as a whole. The results presented in this deliverable are based on input obtained from all partners concerning a set of consolidated information elements obtained within this WP and within other integration and research WPs.

The analysis shows that in general a high degree of integration and alignment of research activities among the S-Cube beneficiaries has been achieved. It also demonstrates that the research activities and results of the S-Cube have achieved significant progress towards the overall research agenda of the network.