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ANALYSIS OF SOFTWARE ARCHITECTURES BASED ON REFERENCE ARCHITECTURES: A SURVEY PROTOCOL

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Index

Executive Summary

Nowadays, enterprises deal with complex applications and their alignment with business needs. In order to keep an edge over the competition, enterprise applications' architectures should be evolvable to satisfy latest business requirements. Constantly improving the architecture could be a cumbersome task if it does not have an appropriate design.

In September 2011, Everis commissioned GESSI to analyse the impact of using Everis' reference architecture for designing software architectures of large enterprises. Everis' references architecture aim to design easily evolvable software architectures and guarantee quality in the development of enterprise applications based on these software architectures.

Purpose

The purpose of this survey is to provide readers with a study to understand the impact of using software architectures (based on Everis' reference architecture) on their organizations. GESSI's aim is to clearly show how all data will be recollected and analysed by means of this survey protocol. Readers should use the study to better understand the benefits from investing in software architectures based on Everis' reference architecture.

Approach

A six-step approach from [CLV+03] will be used for this study:

1. Study definition – determining the goal of the survey;
2. Design – converting the survey goals into a set of questions;
3. Implementation –to design and to make the survey executable;
4. Execution – the actual data collection and data processing;
5. Analysis – interpretation of the data; and
6. Packaging – reporting the survey results.

1 Introduction

1.1 Fundamentals

1.1.1 Reference Architectures

Nowadays, the size and complexity of information systems (IS), together with critical time-to-market needs, demand new software engineering approaches to design software architectures (SA) [NAB11]. One of these approaches is the use of reference architectures (RA) that allows to systematically reuse knowledge and components when developing a concrete SA [CMV+10] [GA11].

As defined in [NAB11], an RA "encompasses the knowledge about how to design concrete architectures of systems of a given application [or technological] domain; therefore, it must address the business rules, architectural styles (sometimes also defined as architectural patterns that address quality attributes in the reference architecture), best practices of software development (for instance, architectural decisions, domain constraints, legislation, and standards), and the software elements that support development of systems for that domain. All of this must be supported by a unified, unambiguous, and widely understood domain terminology".

Due to their reusable nature, RAs are becoming a key asset of information technology consulting firms (ITCFs). Therefore, their exhaustive assessment (e.g., in terms of quality, cost and time reduction) becomes necessary.

Context of Reference Architectures in IT Consulting Firms

We are interested in the case in which an ITCF has designed an RA with the purpose of deriving SAs for client organizations. This usually happens when the ITCF is regularly contracted to create or maintain ISs in client organizations. Each IS is built upon the derived SA (we call it RA-based SA) and includes many enterprise applications implemented on top of this SA (SA-based enterprise applications), see figure below.

The use of RAs allows ITCFs to reuse their architectural knowledge and software components (normally associated to particular technologies) for the design of RA-based SAs in client organizations. Thus, a good RA guarantees a certain level of quality for each RA-based SA. Resulting RA-based SAs provide a baseline that facilitates standardization and interoperability as well as the attainment of business goals during enterprise applications' development and maintenance.

In the scenario depicted in the following figure, there are three kinds of projects with different targets: 1) RA projects; 2) RA-based SA projects; 3) SA-based enterprise application projects. Each kind of project has its own stakeholders who need to be clearly defined for assessment purposes [ATG08]. RA projects are run exclusively by an ITCF team, specialized in architectural knowledge management. RA-based SA projects involve one ITCF team and likely another team from the client organization; their members are specialised in architectural design and have relevant knowledge of the organisation business domain. Finally, SA-based enterprise application projects can involve teams from the client organization and/or subcontracted ITCFs (which may even be different than the RA owner) whose members are usually very familiar

with the specific organisation domain. The participation of the client organization in these two last types of projects is one possible strategy for ensuring the continuity of their ISs without having much dependency on the ITCF.
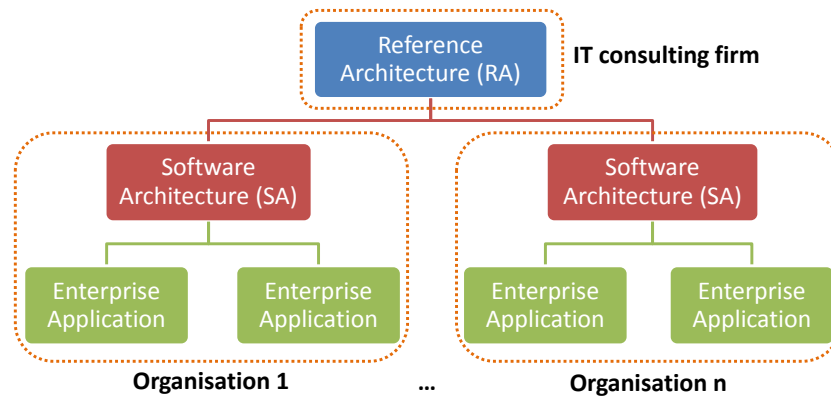
Figure 1. Relationship among RAs, SAs and enterprise applications.

Everis' Reference Technological Architectures

Everis provide software architectures that are based on its reference architecture to guarantee quality in business solutions development. Everis defines reference architectures as "the collection of components, services and procedures that guide and support the development and operation of a business solution ensuring the quality, completeness and operability of the result". Their objective is to enable the construction of software components that satisfy both business and technological requirements.

Everis' Reference Technological Architectures include four sub-architectures (see Figure 2):

- **Execution architecture**. It consists of software components and their relationships. There are designed to meet business and technological requirements.
- **Development architecture**. It aim is to ensure the optimal development of software with tools, standards and methodologies.
- **Technical Architecture**. It is the technical infrastructure (hardware and software) to support the development process and system operation.
- **Architecture of operation**. It consists of the mechanisms, techniques and components to ensure the operation level of service, maintenance and security of the software solution.

Characteristics

Everis' reference *execution* architecture is multi-layer and service-oriented. Since it is distributed and modular, it can be adapted to the very specific requirements of every enterprise by selecting and modifying its modules as necessary. All these modules or services:

- cover a wide range of functionalities,
- are interoperable (being able to coexist with legacy systems),
- are reusable (lowering the time-to-market of developments),
- and are up-to-date with latest open-source frameworks.

Modern methodologies to construct references architectures (and over it) are used in the *development* architecture.
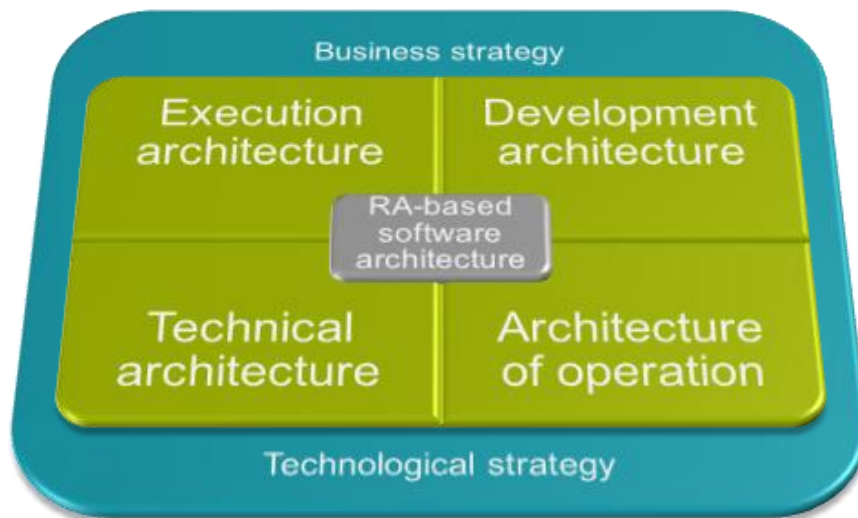
Figure 2. Everis' reference architecture scheme.

Classification

Following the criteria found in [1], Everis" RA can be seen as a Practice RA, since it is defined from the accumulation of practical knowledge. According to the classification of [2], it is also a classical, facilitation RA for multiple organisations designed by a software organisation in cooperation with user organisations. It is classical because its creation is based on experiences, and its aim is to facilitate guidelines for the design of systems, specifically for the IS domain. Fattah presents in [8] another classification scheme that would consider it as an enterprise RA because it is "a blueprint for the Solution Architecture [RA-based SA] of a number of potential projects [SA-based enterprise applications projects] within an organisation that embodies the EA principles, policies, standards and guidelines".

1.1.2 Surveys

A usual problem of the Software Engineering (SE) discipline comes from the lack of empirical evidence to support research hypotheses and the subsequent evaluation of proposed solutions [AHC+11]. Our goal is to become aware and more precise about RA-based software architectures currently used by Everis. For that purpose, we are going to perform a survey over nine projects for different countries (Spain, England,…) in which Everis' reference architecture has been used. During this survey, we have the following sub goals:

- To determine the impact of RA-based software architectures for enterprises.
- To become aware of current practices for RA-based software architectures in the industry. We focus our research on:
    - Requirement engineering.
    - Architectural knowledge (AK) and decisions.
    - Business qualities and architectural competence.
    - Software development methodology.
    - Tools and languages.

1.2 Research method and development of protocol

Engineering means, among other things, that we should be able to understand, plan, monitor, control, estimate, predict and improve the way we engineer our products. Empirical methods (such as surveys and case studies) are needed to help us evaluate and validate the research results. With their help it is possible to scientifically state whether something is better than something else [WHH03].

Surveys are a system for collecting information to describe, compare, or explain knowledge, attitude and behaviour [Gra09]. Unlike other empirical methods, they are often performed in retrospect (for instance, to study tools or techniques that have been used in the past) and taking a sample that is representative from the population to be studied. They are then generalized to the population from which the sample was taken [WHH03].

To design the survey protocol, we have used the methods for preparing, conducting, and analyzing a software engineering survey presented in [CLV+03] and [Gra09]. This document is reported following the method presented in [CLV+03], which consists of a process of 6 steps as it is defined in the following picture.
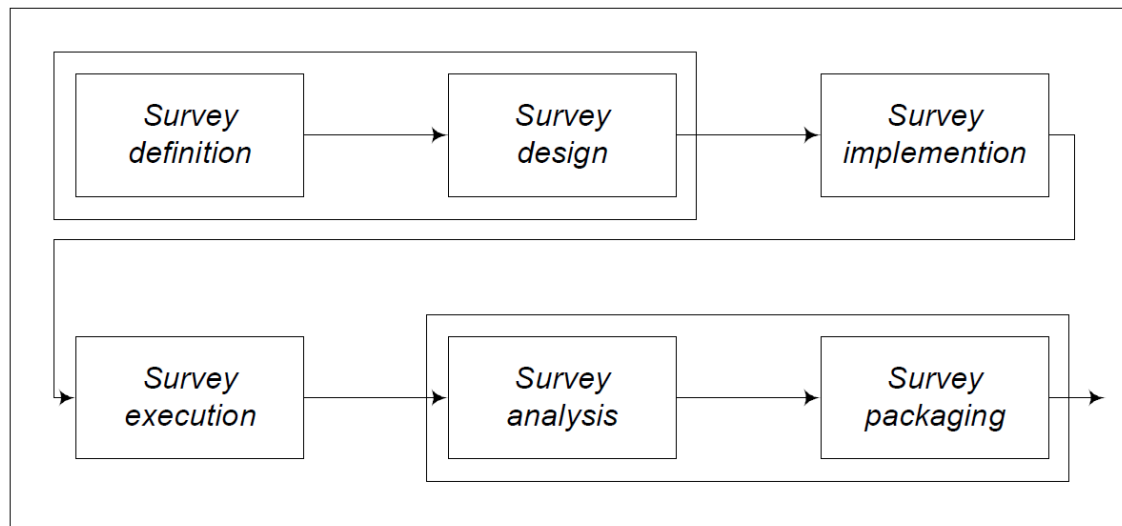
Figure 3. A method for conducting software engineering surveys [CLV+03].

1. Study definition – determining the goal of the survey;
2. Design – converting the survey goals into a set of questions;
3. Implementation –to design and to make the survey executable;
4. Execution – the actual data collection and data processing;
5. Analysis – interpretation of the data; and
6. Packaging – reporting the survey results.

2 Survey Definition

2.1 Goals

The purpose of the survey is to understand the impact of using Everis' reference architecture for designing the software architecture of an information system of a client organisation. This RA-based software architecture is the baseline to develop enterprise applications. This is a descriptive survey that measures what occurred while using reference architectures rather than why. This study is not meant to be used as a competitive product analysis.

The research questions and number of variables that are evaluated in this survey are listed in the following Section 2.1.1 and Section 3.2.

2.1.1 Research Questions

The research questions intended to answer are:

1. How does the adoption of RA-based software architectures provide observable benefits to the different involved actors?
   a) How do RA-based software architectures align business needs with information systems (sociotechnical systems)?
   b) How do RA-based software architectures provide facilities to develop (less complex) IT systems?
   c) How do RA-based software architectures reduce the time-to-market?
   d) How do RA-based software architectures increase system's quality attributes?
   e) Are there more benefits that the ones inquired above?
   f) Which parts of Everis' RA can be improved in order to provide more benefit?
   g) Are Everis' SAs based on j-everis?
   h) How has the contact been between Everis and the client since the origin of the project?
2. What practices are followed by the industry for requirements engineering?
   a) How are requirements elicited and negotiated?
   b) How are requirements documented?
   c) How are requirements validated?
   d) Which facts about requirements' types may be observed?
   e) Do requirements' types influence any of the activities inquired above?
3. What practices are followed by the industry for architectural design?
   a) How are architectural design decisions taken and documented?
   b) Which activities are currently (or could be) automated?
   c) How aware are developers of the global architecture?
4. What methodologies are currently being used for enterprise architectures?
   a) Which type of methodology is used and how is it being applied?
   b) How do they consider continuous integration?
   c) Are they model driven oriented?
   d) How is testing being done?
   e) How is documentation being done?
5. Which tools and technologies are currently being used by the industry in the context of enterprise architectures?

a) Which tools are currently being used by the industry?

b) Which technologies are currently being used by the industry?

To check that the research questions achieve a sense of specificity and focus, the following issues need to be well defined [Gra09]:

- Time frame of the survey. All the projects were started in the past, although some of them are still on going.
- Geographical location of the research. The projects have been carried out in different countries, mainly in Spain.
- The focus of the research. It is broad and general, covering enterprises from several domains (e.g., banking, industry, insurance and utilities) that use RA-based software architectures.
- Interesting aspect of the topic. The research issue is reference architectures for designing software architectures. We are interested in its impact, requirements engineering, software architectural decisions, business qualities, architectural competence, software methodologies, tools, and technologies.
- Abstraction of the research interest. The main focus is reveal about general enterprise experiences in using RA-based software architectures.

2.1.2 Need for a survey

Before deciding to launch an RA-based SA project (or improving an RA), it is needed to understand RA's characteristics, as well as its potential benefits and limitations. Assessing previous RA-based SA projects is a feasible way to start gaining such an understanding. This survey is needed to understand the impact of using an RA in RA-based SA projects in the client organisations.

We will use exploratory surveys with personalised semi-fixed questionnaires applied to relevant stakeholders (e.g., leader, architect, developer) to gather qualitative data about their perceptions and needs.

As a result, we expect to get an understanding of the impact and suitability of the RA for the elaboration of RA-based SA projects. Improvement insights can also be identified from different stakeholders.

Stakeholders

The presented empirical survey is currently being applied at the Architecture Centre of Excellence (ARCHEX) of Everis. The main motivation of ARCHEX for conducting the survey is twofold:

1) technical: identifying strengths and weaknesses for their reference architecture;

2) strategic: providing evidence to their clients about the potential benefits of applying their RA.

This survey protocol aims to serve as a point of reference for ARCHEX and GESSI in order to assess Everis' reference architecture.

3 Survey Design

3.1 Definition of the target population and the survey sample

The target population are projects in which a software architecture has been designed by using a reference architecture (we call them RA-based SA projects), and projects in which enterprise applications have been developed with the help of the aforementioned RA-based software architecture (SA-based enterprise application projects). Figure 1 shows these kind of projects. A representative sample has been selected from this population. This sample consists of nine projects.

Stakeholders need to be clearly defined for reference architecture assessment purposes [ATG08]. In Everis' projects, there are four kinds of stakeholders in both Everis and client organisation teams: project business leader, project technological leader, software architect and developer. Each of these stakeholders has a vested interest in different architectural aspects, which are important to analyse and reason about the appropriateness and the quality of the three kinds of projects [Gal00]. This survey covers the following roles:

- Everis team. Four kinds of roles will be contacted:
  - **Project Technical Leader.** His/her aim is to manage the RA-based software architecture project.
  - **Software Architect**. He/she is responsible of any decision over the RA-based software architecture designed for the client's organisation.
  - **Architecture Developer**. His/her aim is to develop the RA-based software architecture that is designed by the Software Architect.
  - **Application Developer**. He/she develops enterprise applications for the client organisation by using the RA-based software architecture of the client organisation.
- Client organisation team. One kind of role will be contacted:
  - **Client organisation's Project Business Leader**. He/she is the project manager of the client that asked for creating or improving the software architecture of his/her organisation.

Table 1 indicates with an 'S' the roles that will be interviewed in each project.

Table 1. Stakeholders of the survey.

Project[a]	Everis Team				Client Organization Team			
	PBL	**PTL**	**Arc**	**Dev**	**PBL**	**PTL**	**Arc**	**Dev**
RA	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
SA	n/a	S	S	S	S	n/a	n/a	n/a
Application	n/a	n/a	n/a	S	n/a	n/a	n/a	n/a

a. Legend: Project Business Leader (PBL), Project Technological Leader (PTL), Software Architect (Arc), Developer (Dev), Survey (S).

The customer name of the interviewee will be provided by ARCHEX.

3.2 Conceptual model of the objects and variables of the survey

The variables that are defined during a survey should be strongly related to the research goal. The conceptual model follows from the definition of goals, questions and hypotheses [CLV+03].

We identified six relevant aspects of which we wanted to collect data [MAA+12]:

1. Overview: functionalities, origin, utility and adaptation.
2. Requirements analysis, also called quality attributes.
3. Architectural knowledge and decisions.
4. Business qualities and architecture competence.
5. Software development methodology.
6. Technologies and tools.

Aspect 1 refers to the need of having an overview of the RA. It includes an analysis of its generic functionalities, its domain [ATG08], its origin and motivation, its correctness and utility, and its support for efficient adaptation and instantiation [GA11].

Falesi et al. [FAC+10] and other studies such as [Gal00] highlight the importance of requirements analysis and quality attributes, as well as decision-making and architectural evaluation for the SA design process. These two aspects should also be considered for the RA assessment because, as we said, SAs and RAs have to be assessed for the same aspects [ATG08]. Thus, we considered them as Aspects 2 and 3 respectively. However, since an RA has to address more architectural qualities than an SA (e.g., applicability) [ATG08], this analysis could be wider for RAs in this sense.

SAs also address business qualities [ATG08] (e.g., cost, time-to-market) that are business goals that affect their competence [BCK+08]. It is also applicable to RAs, so it is considered as Aspect 4.

To improve the SA design process, there also exist supportive technologies such as methods, and techniques and tools [FAC+10][NAB11]. Thus, it is not only important for an RA to collect data to assess its design process, but also its supportive technologies, which are assessed by Aspects 5 and 6.

3.3 Approach for data collection

There are six different types of questionnaires [Gra09]:

- Self-administered
    - Postal questionnaire
    - Online questionnaire
    - Delivery and collection questionnaire
- Interviewer-administered
    - Interview
    - Focus group
    - Telephone questionnaire

In this survey, three types will be used. On the one hand, **semi-structured interviews** will be used for *Project Technological Leaders and Software Architects*, and *Client's Project Business Leaders*. The reason of using interviews is that these roles have higher knowledge than the other roles about the architectural aspects of the Section 3.2, or another perspective in the case of Client's Project Business Leaders, so we want to collect as much information as possible from them. Prior to the interviews, **delivery and collection questionnaires** might be delivered to collect personal information about the interviewee and to inform him/her about the interview. On the other hand, **online questionnaires** will be used for *RA-based SA Developers* and *SA-based enterprise application Developers*, since most of their questions are about supportive technologies and their responses can be previously listed, simplifying the data collection process.

3.4 Question design

We have four personalised questionnaires for the four different kinds of stakeholders that will be contacted:

1. Interview for projects technical leaders and software architects.
2. Online questionnaire for RA-based SA developers.
3. Online questionnaire for SA-based enterprise applications developers.
4. Interview for client project business leaders.

These questionnaires are divided into different sections that include questions to collect data about the relevant aspects to understand reference architectures of Section 3.2. Since each of these stakeholders has a vested interest in different architectural aspects, the approach for data collection, as it is explained in the Section 3.3, is not the same for all of them.

These four questionnaires are being conducted in Spanish.

3.4.1 Interview for projects technical leaders and software architects

Step I: Sending the interview script

Prior to the face-to-face interview, a questionnaire will be delivered to collect personal information about the interviewee and to inform him/her about the interview. This questionnaire includes: a template of short questions that must be answered in the form sent (Table 2), and the script with the questions that will take place during the interview.

Table 2. Delivery and collection questionnaire for projects technical leaders and software architects.

ID	Question	Mandatory	Scale
	PERSONAL DATA		
1.1	Name and Surname	Yes	Text
1.2	Email	Yes	Text (Email)
1.3	Phone	No	Number
1.4	Level of education	Yes	List of levels
1.5	Education Area	Yes	List of areas
1.6	Certificates	Yes	List of certificates
	ABOUT THE PROJECT		
2.1	Project and SA of the project	Yes	List of projects and their SA
2.2	Role(s) in the project	Yes	List of roles
2.3	Number and role of participants	Yes	Numbers and list of roles
2.4	Project duration	Yes	2 dates
2.5	Project's budget (approximately)	Yes	Number and currency
2.6	How many participants of the project had experience in SAs?	Yes	Number
2.7	Did you have previous experience in SAs before the project?	Yes	Text
2.8	Total effort of the project (people/month)	Yes	Number
	EXPERIENCE IN EVERIS		
2.10	Job position in the IT consulting firm (when you participated in this project)	No	List of job positions
2.11	Years in this job position (when you participated in this project)	No	Number
2.12	Years in the IT consulting firm (when you participated in this project)	No	Number
2.13	Experience in project management (when you participated in this project)	No	Free
2.14	Experience in SAs (when you participated in this project)	No	Free

Step II: Interview

- The duration of the interview will be approximately 1 hour and 15 minutes.
- Unless explicitly agreed, the interview will take place in the Everis building.
- The interview will be recorded (in audio) for later transcription.

- It is required that the respondent has had the role of software architect and has participated as a project technical leader (or who has the knowledge to respond as such).

Questions of the face-to-face interview are shown in Table 3.

Table 3. Interview for projects technical leaders and software architects.

ID	Question
	OVERVIEW OF THE ARCHITECTURE
3.1	What do you understand by SA?
3.2	Could you give a short description of the functionalities of the project?
3.3	Which was the client's problematic that motivated the project?
3.4	What was the objective of the project and the relationship with the client during the design and implementation of the SA?
3.5	How was the contact with the client after the first release of the SA?
4.1	Does your SA take into account client's business processes?
4.2	What artefacts or deliverables have been produced in the project? How did they help the client?
4.3	Is your SA general or specific for a domain? Could it be used for other domains?
4.4	During the design of the SA, ¿have you reused some existing architectural knowledge or software component?
4.5	Does your SA offer reusable modules for transversal services?
	REQUIREMENTS ANALYSIS
5.1	Which were the main functional requirements to cover for by your SA?
5.2	Which were the main non-functional requirements to cover for by your SA? Could you give an example that was important for this project?
5.3	Which were the main non-technical requirements to cover for by your SA? Could you give an example that was important for this project?
5.4	How were requirements elicited in this project?
5.5	How were requirements documented in this project?
5.6	How were requirements validated in this project?
	ARCHITECTURAL KNOWLEDGE AND DECISIONS
6.1	How did you decide the architecture design?
6.2	How much freedom did you have while taking architectural decisions?
6.3	Did you have to use mandatorily some technology?
6.4	What was chosen before in this project: architecture design or technological framework?
6.5	Could you give us an example of an architectural decision and its relation to quality attributes?
6.6	Were architectural decisions documented?
6.7	Were these architectural decisions predefined?
6.8	Do you think that some part of the architectural design could be automated?
	SOFTWARE DEVELOPMENT METHODOLOGY
7.1	Describe the used methodology and processes for this project. Explain their stages.
7.2	Which practices or methods were followed in this project in relation to testing?
7.3	Besides the possible documentation of requirements and architectural decisions, which documentation was done in this project?
	TECHNOLOGIES AND TOOLS
8.1	Which integrated development environments (IDEs) were used in this project?
8.2	What tools were used for project management?

8.3	How was continuous integration performed? Have you used some tool for that?
8.4	Does your SA include a monitoring tool for enterprise applications?
8.5	Have you used any tool to generate code automatically?
8.6	Do you think that any development or coding task can be done automatically (totally or partially)?
8.7	Have you used any other important tool in this project?
	BUSINESS QUALITIES AND ARCHITECTURE COMPETENCE
	Benefits for the client organisation
9.1	To develop new SA-based enterprise applications, is recommended any development methodology?
9.2	To develop new SA-based enterprise applications, is recommended any method in relation to testing?
9.3	To develop new SA-based enterprise applications, are recommended good documentation practices?
9.4	How was conducted the training for the client organisation in order to them use your SA?
9.5	Did the use of your SA cause any organizational change in the client organisation?
9.6	How does the use of your SA reduce the *time-to-market* of SA-based enterprise applications in the client organisation?
9.7	What types of non-functional requirements are reinforced because of using your SA in enterprise applications?
9.8	Which other benefits or problems developers might experience while using your SA?
9.9	To sum up, what conclusions do you draw from the facilities provided by your SA for the client organisation?
	Benefits for the IT consulting firm
10.1	How is your SA based on an RA and any other existing architectural knowledge and software components in your company?
10.2	What do you think should be replaced, included or updated in prospective versions of the RA?
10.3	To sum up, what conclusions do you draw from the facilities provided by the RA for the IT consulting firm?

Matching with the Research Questions

Table 4 shows the relationship of the questions of the interview for projects technical leaders and software architects with the research questions (RQ) of Section 2.1.1. An 'X' indicates that the question of that row collects data to answer the research question of that column. On the other hand, a 'v' shows that the response of a question of that row validates the information collected (which is indicated by an 'X') to answer the research question of that column.

Table 4. Matching of interview for projects technical leaders and software architects with the research questions.

	RQ1								RQ2					RQ3			RQ4					RQ5	
Q	1a	1b	1c	1d	1e	1f	1g	1h	2a	2b	2c	2d	2e	3a	3b	3c	4a	4b	4c	4d	4e	5a	5b
3.1	X																						
3.2								v															
3.3								X															
3.4								X															
3.5								X															
4.1	X																						

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
4.2		X																					
4.3		X																					
4.4							X																
4.5		X																					
5.1												X	v										
5.2												X	v										
5.3												X	v										
5.4									X			X	X										
5.5										X		X	X										
5.6											X	X	X										
6.1														X									
6.2														X	v								
6.3																							X
6.4														X	v								
6.5														X	v								
6.6														X									
6.7														X									
6.8															X								
7.1																	X						
7.2																				X			
7.3																					X		
8.1																						X	
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8.3																		X					
8.4																						X	
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9.5	X																						
9.6			X																				
9.7				X																			
9.8					X																		
9.9					X																		
10.1							X																
10.2						X																	
10.3					X																		

3.4.2 Online questionnaire for RA-based SA developers

RA-based SA developers will be contacted by an online questionnaire. This questionnaire is divided into two parts. First, there are questions about personal information (see Table 5). Second, the questions to answer the research questions will be conducted (see Table 6).

The questions that are also asked to the project technical leaders and software architects share the same identifier. When it is more appropriate to split one question up in several sub questions in order to previously list the possible responses, another number between brackets is added to the identifier (e.g., x.y (n)). New questions for developers are characterised for a 'd' at the end of the identifier code (e.g., x.yd).

Table 5. First part of the online questionnaire for RA-based SA developers.

ID	Question	Mandatory	Scale
	PERSONAL DATA		
1.1	Name and Surname	Yes	Text
1.2	Email	Yes	Text (Email)
1.3	Phone	No	Number
1.4	Level of education	Yes	List of levels
1.5	Education Area	Yes	List of areas
1.6	Certificates	Yes	List of certificates
	ABOUT THE PROJECT		
2.1	Project and SA of the project. Describe briefly this SA project.	Yes	List of projects and their SA
2.2	Role(s) in the project	Yes	List of roles
2.3	With how many participants did you interact during the development of the product?	Yes	Number
2.4	Duration of the development period (if it existed) of the SA project.	Yes	Numbers and list of roles
2.5	Duration of the maintenance period (if it existed) of the SA project.	Yes	Number of months
2.8	Did you have previous experience in SAs development before this project?	Yes	Yes or no
	EXPERIENCE IN EVERIS		
2.10	Job position (developer) in the IT consulting firm (when you participated in this project)	No	List of job positions
2.11	Years in this job position (when you participated in this project)	No	Number
2.12	Years in the IT consulting firm (when you participated in this project)	No	Number
2.13	Experience in SAs (when you participated in this project)	No	Likert scale

Table 6. Main part of the online questionnaire for RA-based SA developers.

ID	Question	Mandatory	Scale
	OVERVIEW OF THE ARCHITECTURE		
3.1	Which of the following definitions express best for	Yes	List of definitions

	you an SA?		
4.3	Is your SA general or specific for a domain? Could it be used for other domains?	Yes	Yes or no. Comment field
4.5	Which of the following reusable modules for transversal services are offered by your SA?	Yes	List of modules
REQUIREMENTS ANALYSIS			
	None		
ARCHITECTURAL KNOWLEDGE AND DECISIONS			
6.9d	How much do you know the global architecture of the SA?	Yes	Likert scale
SOFTWARE DEVELOPMENT METHODOLOGY			
7.1	What kind of methodology was used in the project?	Yes	List of kind of methodologies
7.2	Which practices or methods were followed in this project in relation to testing?	Yes	List of testing practices
7.3	Which documentation was done in this project?	Yes	List of documentation practices
7.4d	Why have you used the software development methodology, the testing methods and the documentation aforementioned?	Yes	List of reasons
7.5d	Which input documentation have you received to start coding?	Yes	List of documentation deliverables
7.6d	What liberty grade (restrictions about technologies, libraries, way of coding…) while coding?	Yes	List of different grades of restriction
7.7d	Have you used some of the following practices?	Yes	List of practices
TECHNOLOGIES AND TOOLS			
8.1	What integrated development environments (IDEs) were used?	Yes	List of IDEs
8.3	How was continuous integration performed? Have you used some tool for that?	Yes	List of tools for continuous integration
8.4	Does your SA include a monitoring tool for enterprise applications?	Yes	List of monitoring tools
8.5	Have you used any tool to generate code automatically?	Yes	Yes or no. Comment field
8.6	Do you think that any development or coding task can be done automatically (totally or partially)?	Yes	Yes or no. Comment field
8.8d	Which programming languages did you use in this project?	Yes	List of programming languages
8.9d	Which technologies were used for presentation in this project?	Yes	List of technologies
8.10d	Which technologies were used for the development of services in this project?	Yes	List of technologies
8.11d	Which technologies were used for the development of business processes in this project?	Yes	List of technologies
8.12d	Which technologies were used for interoperability and integration in this project?	Yes	List of technologies

8.13d	Which technologies were used for the management of data in this project?	Yes	List of technologies
8.14d	Which database management systems were used in this project?	Yes	List of database management systems
8.15d	Which application servers were used in this project?	Yes	List of application servers
8.16d	Why have you used the aforementioned tools and technologies?	Yes	List of reasons
8.7	Have you used any other important tool in this project?	Yes	Yes or no. Comment field
8.17d	Do you consider that the usage of some technologies and tools have caused any limitation?	Yes	Yes or no. Comment field
BUSINESS QUALITIES AND ARCHITECTURE COMPETENCE			
Benefits for the client organisation			
9.7	What types of non-functional requirements are reinforced because of using your SA in enterprise applications?	Yes	List of non-functional requirements
9.8	Which benefits does the client organization might experience while using your SA?	Yes	List of benefits
9.8 (2)	Which problems does the client organization might experience while using your SA?	Yes	List of problems
9.4	How long was the training for the client organisation in order to them use your SA?	Yes	List of training periods
9.9	To sum up, what conclusions do you draw from the facilities provided by your SA for the client organisation?		
Benefits for the IT consulting firm			
10.4d	Do you think that a common repository for all SA for reusing services would be useful for the IT consulting firm?	Yes	Yes or no. Comment field
10.1	How is your SA based on an RA and any other existing architectural knowledge and software components in your company?	Yes	Free text
10.2	What do you think should be replaced, included or updated in prospective versions of the RA?	Yes	Free text
10.3	To sum up, what conclusions do you draw from the facilities provided by the RA for the IT consulting firm?	Yes	Free text

Matching with the Research Questions

Table 7 shows the relationship of the questions of the online questionnaire for RA-based SA developers with the research questions (RQ) of Section 2.1.1. An 'X' indicates that the question of that row collects data to answer the research question of that column. On the other hand, a 'v' shows that the response of a question of that row validates the information collected (which is indicated by an 'X') to answer the research question of that column.

Table 7. Matching of the online questionnaire for RA-based SA developers with the research questions.

Q	RQ1								RQ2					RQ3			RQ4					RQ5	
	1a	1b	1c	1d	1e	1f	1g	1h	2a	2b	2c	2d	2e	3a	3b	3c	4a	4b	4c	4d	4e	5a	5b
3.1	X																						
4.1	X															v							
4.3		X														v							
4.5		X														v							
6.9d																X							
7.1																	X						
7.2																				X			
7.3																					X		
7.4d																	v		v	v			
7.5d																					X		
7.6d																		X					
7.7d																		X					
8.1																						X	
8.3																		X					
8.4																						X	
8.5																			X				
8.6																			X				
8.7																							X
8.8d																							X
8.9d																							X
8.10d																							X
8.11d																							X
8.12d																							X
8.13d																							X
8.14d																							X
8.15d																							X
8.16d																						v	v
8.17d																						v	v
9.4			X																				
9.7				X																			
9.8					X																		
9.8 (2)					X																		
9.9					X											v							
10.1							X																
10.2						X																	
10.3					X											v							
10.4d						X																	

3.4.3 Online questionnaire for SA-based enterprise applications developers

SA-based enterprise applications developers will be contacted by an online questionnaire. This questionnaire is divided into two parts. First, there are questions about personal information (see Table 8). Second, the questions to answer the research questions will be conducted (see Table 9).

Table 8. First part of the online questionnaire for SA-based enterprise applications developers.

ID	Question	Mandatory	Scale
	PERSONAL DATA		
1.1	Name and Surname	Yes	Text
1.2	Email	Yes	Text (Email)
1.3	Phone	No	Number
1.4	Level of education	Yes	List of levels
1.5	Education Area	Yes	List of areas
1.6	Certificates	Yes	List of certificates
	ABOUT THE PROJECT		
2.1	Project and SA of the project. Describe briefly this SA-based enterprise application project.	Yes	List of projects and their SA
2.2	Role(s) in the project	Yes	List of roles
2.3	With how many participants did you interact during the development of the product?	Yes	Number
2.8	Did you have previous experience in SA-based enterprise applications development before this project?	Yes	Yes or no
	EXPERIENCE IN EVERIS		
2.10	Job position (developer) in the IT consulting firm (when you participated in this project)	No	List of job positions
2.11	Years in this job position (when you participated in this project)	No	Number
2.12	Years in the IT consulting firm (when you participated in this project)	No	Number
2.13	Experience in SAs (when you participated in this project)	No	Likert scale

Table 9. Main part of the questionnaire for SA-based enterprise applications developers.

ID	Question	Mandatory	Scale
	OVERVIEW OF THE ARCHITECTURE		
3.1	Which of the following definitions express best for you an SA?	Yes	List of definitions
4.3	Is the SA general or specific for a domain? Could it be used for other domains?	Yes	Yes or no. Comment field
4.5	Which of the following reusable modules for transversal services are offered by the SA?	Yes	List of modules
	REQUIREMENTS ANALYSIS		
	None		
	ARCHITECTURAL KNOWLEDGE AND DECISIONS		
6.9d	How much do you know the global architecture of the SA?	Yes	Likert scale

	SOFTWARE DEVELOPMENT METHODOLOGY		
7.1	What kind of methodology was used in the project?	Yes	List of kind of methodologies
7.2	Which practices or methods were followed in this project in relation to testing?	Yes	List of testing practices
7.3	Which documentation was done in this project?	Yes	List of documentation practices
7.4d	Why have you used the software development methodology, the testing methods and the documentation aforementioned?	Yes	List of reasons
7.5d	Which input documentation have you received to start coding?	Yes	List of documentation deliverables
7.6d	What liberty grade (restrictions about technologies, libraries, way of coding…) while coding?	Yes	List of different grades of restriction
7.7d	Have you used some of the following practices?	Yes	List of practices
	TECHNOLOGIES AND TOOLS		
8.1	What integrated development environments (IDEs) were used?	Yes	List of IDEs
8.3	How was continuous integration performed? Have you used some tool for that?	Yes	List of tools for continuous integration
8.4	Does the SA include a monitoring tool for enterprise applications?	Yes	List of monitoring tools
8.5	Have you used any tool to generate code automatically?	Yes	Yes or no. Comment field
8.6	Do you think that any development or coding task can be done automatically (totally or partially)?	Yes	Yes or no. Comment field
8.8d	Which programming languages did you use in this project?	Yes	List of programming languages
8.9d	Which technologies were used for presentation in this project?	Yes	List of technologies
8.10d	Which technologies were used for the development of services in this project?	Yes	List of technologies
8.11d	Which technologies were used for the development of business processes in this project?	Yes	List of technologies
8.12d	Which technologies were used for interoperability and integration in this project?	Yes	List of technologies
8.13d	Which technologies were used for the management of data in this project?	Yes	List of technologies
8.14d	Which database management systems were used in this project?	Yes	List of database management systems
8.15d	Which application servers were used in this project?	Yes	List of application servers
8.16d	Why have you used the aforementioned tools and technologies?	Yes	List of reasons
8.7	Have you used any other important tool in this	Yes	Yes or no.

	project?		Comment field
8.17d	Do you consider that the usage of some technologies and tools have caused any limitation?	Yes	Yes or no. Comment field
BUSINESS QUALITIES AND ARCHITECTURE COMPETENCE			
Benefits for the client organisation			
9.7	What types of non-functional requirements are reinforced because of using the SA in enterprise applications?	Yes	List of non-functional requirements
9.8	Which benefits do you experience while using an RA-based SA?	Yes	List of benefits
9.8 (2)	Which problems do you experience while using an RA-based SA?	Yes	List of problems
9.4	How long was your training process in order to use the SA?	Yes	List of training periods
10.2	What do you think should be replaced, included or updated in prospective versions of the RA?	Yes	Free text
9.9	To sum up, what conclusions do you draw from the facilities provided by your SA for the client organisation?	Yes	Free text

Matching with the Research Questions

Table 10 shows the relationship of the questions of the interview for online questionnaire for SA-based enterprise applications developers with the research questions (RQ) of Section 2.1.1. An 'X' indicates that the question of that row collects data to answer the research question of that column. On the other hand, a 'v' shows that the response of a question of that row validates the information collected (which is indicated by an 'X') to answer the research question of that column.

Table 10. Matching of the online questionnaire for SA-based enterprise applications developers with the RQs.

Q	RQ1								RQ2					RQ3			RQ4					RQ5	
	1a	1b	1c	1d	1e	1f	1g	1h	2a	2b	2c	2d	2e	3a	3b	3c	4a	4b	4c	4d	4e	5a	5b
3.1	X																						
4.1	X															v							
4.3		X														v							
4.5		X														v							
6.9d																X							
7.1																	X						
7.2																				X			
7.3																					X		
7.4d																	v			v	v		
7.5d																					X		
7.6d																		X					
7.7d																		X					
8.1																						X	
8.3																		X					

8.4																		X		
8.5																X				
8.6																X				
8.7																				X
8.8d																				X
8.9d																				X
8.10 d																				X
8.11 d																				X
8.12 d																				X
8.13 d																				X
8.14 d																				X
8.15 d																				X
8.16 d																			v	v
8.17 d																			v	v
9.4		X																		
9.7			X																	
9.8				X																
9.8 (2)				X																
9.9				X								v								
10.2					X															

3.4.4 Interview for client organisation's project business leaders

Client organisations project business leaders will be interviewed to mainly check how they were involved in the requirements analysis and to analyse business qualities of RA-based software architectures as well as architecture competence of Everis. This interview should not take more that twenty five minutes to finish. It is divided into two parts. First, there are questions about personal information (see Table 11).

The questions that are also asked to the project technical leaders and software architects share the same identifier. When it is more appropriate to split one question up in several sub questions, another number between brackets is added to the identifier (e.g., x.y (n)). New questions for client organisation's project business leaders are characterised for a 'c' at the end of the identifier code (e.g., x.yc).

Table 11. Initial part of the interview for client organisation's project business leaders.

ID	Question	Mandatory	Scale
	PERSONAL DATA		
1.1	Name and Surname	Yes	Text
1.2	Email	Yes	Text (Email)
1.3	Phone	No	Number
1.4	Level of education	Yes	List of levels
1.5	Education Area	Yes	List of areas
	ABOUT THE PROJECT		
2.1	Project and SA of the project	Yes	List of projects and their SA
2.4	Project duration	Yes	2 dates
2.5	Project's budget (approximately)	Yes	Number and currency

Second, the questions to answer the research questions will be conducted. The face-to-face interview consists of the questions below (see Table 12). These questions must be valued from 1 to 5, where 1 means strongly disagree and 5 strongly agree. In addition, whenever necessary, the interviewee can add comments. Especially when the given value is low (less than or equal to 2), it is important to the interviewer to investigate the reasons. Besides, questions marked with an asterisk (*) require a response or comment. Finally, the response of the question 5.1 has to be greater than 2 in order to conduct the questions 5.1 (2), 5.4, 5.5, and 5.6.

Table 12. Main part of the interview for client organisation's project business leaders.

ID	Question
	OVERVIEW OF THE ARCHITECTURE
4.1	SA-based enterprise applications are aligned with business need
4.2	The quality of the SA deliverables is good
4.6c	The integration has been performed easily
	REQUIREMENTS ANALYSIS
5.1	You (or someone for the client organisation) defined the requirements
5.1 (2)*	Can you give an example of requirement?
5.4	You followed some pattern for defining the requirements
5.5	Requirements were expressed in sufficient detail to discern their satisfaction.
5.6	The requirements were met successfully
	ARCHITECTURAL KNOWLEDGE AND DECISIONS

	None
	SOFTWARE DEVELOPMENT METHODOLOGY
	None
	TECHNOLOGIES AND TOOLS
	None
	BUSINESS QUALITIES AND ARCHITECTURE COMPETENCE
	Benefits for the client organisation
9.5	The RA-based SA has been made easier the collaboration between IT and business teams
9.6	The development time has been reduced because of using an RA (comparing to other projects)
9.7	The RA-based SA has improved the quality of the SA-based enterprise applications
9.10c	SA-based enterprise applications' price been has reduced because of using an RA-based SA (comparing to other projects)
9.8*	How many incidences have you experienced with the enterprise applications?
9.9*	Which is the most relevant benefit from using an RA-based SA?
10.2	You would like to change something in future versions of the RA-based SA
9.11c	Indicate your overall satisfaction with the RA-based SA and the functioning of this project
9.12c	Indicate if you have met all expectations regarding the use of the RA-based SA (e.g., time-to-market, cost ...).
9.13c	You consider successful the use of the RA-based SA and you would use it again in the future

Matching with the Research Questions

Table 13 shows the relationship of the questions of the interview for client organisations project business leaders with the research questions (RQ) of Section 2.1.1. An 'X' indicates that the question of that row collects data to answer the research question of that column. On the other hand, a 'v' shows that the response of a question of that row validates the information collected (which is indicated by an 'X') to answer the research question of that column.

Table 13. Matching of the interview for client organisation's project business leaders with the RQs.

	RQ1								RQ2					RQ3			RQ4					RQ5	
Q	1a	1b	1c	1d	1e	1f	1g	1h	2a	2b	2c	2d	2e	3a	3b	3c	4a	4b	4c	4d	4e	5a	5b
4.1	X																						
4.2		X																					
4.6c		X																					
5.1												X	v										
5.1 (2)												X	v										
5.4									X			X	X										

5.5									X		X	X									
5.6										X	X	X									
9.5	X																				
9.6			X																		
9.7					X																
9.8					X																
9.9					X																
9.10c					X																
9.11c					X																
9.12c					X																
9.13c					X																
10.2						X															

3.4.5 Matching with the research questions

Table 14 shows how the research questions of the survey (Section 2.1.1), which are placed in the rows, are covered by the different stakeholders, which are located in the columns. As we can see in the column "Total", all the research questions are covered.

Table 14. Matching of all four kinds of questionnaires with the research questions.

| | | Everis | | | | | | Client Organisation | | Total | |
| | | SA PTL & SA Arc | | SA Dev | | Application Dev | | SA PBL | | | |
		Rep (X)	Val (v)	Rep (X)	Val (v)	Rep (X)	Val (v)	Rep (X)	Val (v)	Rep (X)	Val (v)
RQ1	1.a	3	0	2	0	2	0	2	0	9	0
	1.b	3	0	2	0	2	0	2	0	9	0
	1.c	2	0	1	0	1	0	1	0	5	0
	1.d	1	0	1	0	1	0	0	0	3	0
	1.e	3	0	4	0	3	0	7	0	17	0
	1.f	1	0	2	0	1	0	0	0	4	0
	1.g	2	0	1	0	0	0	1	0	4	0
	1.h	3	1	0	0	0	0	0	0	3	1
RQ2	2.a	1	0	0	0	0	0	1	0	2	0
	2.b	1	0	0	0	0	0	1	0	2	0
	2.c	1	0	0	0	0	0	1	0	2	0
	2.d	6	0	0	0	0	0	5	0	11	0
	2.e	3	3	0	0	0	0	3	2	6	5
RQ3	3.a	6	3	0	0	0	0	0	0	6	3
	3.b	1	0	0	5	0	4	0	0	1	9
	3.c	0	0	1	1	1	1	0	0	2	2
RQ4	4.a	2	0	2	0	2	0	0	0	6	0
	4.b	1	0	2	0	2	0	0	0	5	0
	4.c	2	0	2	0	2	0	0	0	6	0
	4.d	2	0	2	1	2	1	0	0	6	2
	4.e	2	0	1	1	1	1	0	0	4	2
RQ5	5.a	3	0	2	2	2	2	0	0	7	4
	5.b	2	0	9	2	9	2	0	0	20	4

Legend: Project Business Leader (PBL), Project Technological Leader (PTL), Software Architect (Arc), Developer (Dev), Reply (Rep), Validate (Val).

4 Survey Implementation

As we said in Section 3.3, two types of questionnaires will be used: interviews and online questionnaires.

4.1 Interviews

4.1.1 Structure of the interview for projects technical leaders and software architects

In this interview, the interviewers are members of GESSI. The two following subsections explain how the interview process is implemented, and the tools which were needed.

Structure

This interview consists of two parts:

- Delivery and collection questionnaires. It is the initial part with questions about the interviewee and the project in which he/she has worked. This part of the interview consists of a questionnaire with short questions that is filled electronically.

- Semi-structured interview. It is the main part which consists of questions about RA-based software architectures and its currently used practices. It is done "face-to-face".

These two parts are the two initial steps of the interview process:

1. Step I: Sending the interview script
   - Prior to the face-to-face interview, a questionnaire will be delivered to collect personal information about the interviewee and to inform him/her about the interview. This questionnaire includes: a template of short questions that must be answered in the form sent, and the script with the questions that will take place during the interview.

2. Step II: Interview
   - The duration of the interview will be approximately 1 hour and 15 minutes for project technical leaders and software architects.
   - Unless explicitly agreed, the interview will take place in the Everis building.
   - The interview will be recorded (in audio) for later transcription.
   - It is required that the respondent has had the role of software architect and has participated as a project technical leader (or who has the knowledge to respond as such). Hence, the interviewee needs to have both roles.

3. Step III: Depuration
   - The transcript will be validated by the interviewee, being able to complete it or even change the parts that he/she considers inaccurate or misleading.

4. Step IV: Analysis
   - During the analysis process, it may be necessary to contact again with the interviewee to ask for more details on any specific issue.

   Other Comments:
   - All information provided will be treated strictly confidential.

Tools

Delivery and collection questionnaires will be made by Adobe Acrobat X Pro forms. On the other hand, interviews questions have been written in a text editor.

For the interview, a voice recorder is also used.

4.1.2 Structure of the interview for client organisation's projects business leaders

In this interview, the interviewers are members of ARCHEX. The two following subsections explain how the interview process is implemented, and the tools which were needed.

Structure

This interview consists of one part which is divided in two sections:

- The initial part with questions about the interviewee and the project in which he/she has worked. This part of the interview consists of a questionnaire with short questions that is filled prior to the interview.

- Structured interview. It is the main part which consists of questions about RA-based software architecture, mainly about requirements analysis, business qualities and architectural competence. It is done "face-to-face".

The interview process is described as follows:

1. Step I: Interview
   - The duration of the interview will be approximately 25 minutes for project business leaders.
   - Unless explicitly agreed, the interview will take place in the Everis building.
   - It is required that the interviewee has participated as a project business leader (or who has the knowledge to respond as such).
   - The interviewer should fill the template of Table 15.
2. Step II: Analysis
   - During the analysis process, it may be necessary to contact again with the interviewee to ask for more details on any specific issue.
   Other Comments:
   - All information provided will be treated strictly confidential.

Table 15. Template to fill by the interviewer for the interview for client organisation's project business leaders.

Question	1	2	3	4	5	Comments
4.1						
4.2						
4.6c						
5.1						
5.1 (2)*						

5.4						
5.5						
5.6						
9.5						
9.6						
9.7						
9.10c						
9.8*						
9.9*						
10.2						
9.11c						
9.12c						
9.13c						

Tools

Interviews questions and the template of Table 15 have been written in a text editor.

4.2 Online questionnaires for developers

Both kinds of developers (i.e., RA-based SA developers and SA-based enterprise applications developers) are contacted through an online questionnaire. Although the online questionnaires contain different questions, they share the same structure and have been implemented with the same tool.

Structure

The online questionnaires are divided into the following sections:

- Personal data.
- About the project.
- Experience in Everis.
- Overview of the architecture.
- Architectural knowledge and decisions.
- Software development methodology.
- Technologies and tools.
- Business qualities and architecture competence.

The interview process has been implemented as follows:

1. Step I: Sending the online questionnaire link
    - An email is sent to the interviewee by GESSI. This email contains the instructions to perform the online questionnaire.
2. Step II: Online questionnaire
    - The duration of the interview will be approximately 1 hour for developers.
    - It is required that the interviewee has participated as a developer in the project (or who has the knowledge to respond as such).
3. Step III: Analysis
    - During the analysis process, it may be necessary to contact again with the interviewee to ask for more details on any specific issue.
    Other Comments:
    - All information provided will be treated strictly confidential.

Tool

Online questionnaires were implemented with the help of Lime Survey, which is an open source online survey application.

4.3 Protocol Review Plan

Prior to the survey execution and its final implementation, it needs to be validated.

4.3.1 Pilot Surveys

This stage involves the testing or piloting of elements such as the sampling frame, survey questions and data collection tools. It is likely that several drafts on such elements will have to be tested before a satisfactory version is reached.

Two projects have been used as beta-testers.

First Pilot Survey

Interview for project technical leaders and software architects

In the first pilot survey, the main problem was the confusion between RA-based SA projects and SA-based enterprise applications. It was due to the wrong idea that an RA-based SA was the baseline of only a huge enterprise application. However, we found out that an RA-based SA provides a baseline that facilitates standardization and interoperability as well as the attainment of business goals during several (and to only one) enterprise applications' development and maintenance. Then, all questions were redesigned defining clearly the kind of project that they target. Besides, in order to better understand this context, we add some questions to the interview for project technical leaders and software architects to cover one new area of the first relevant aspect (i.e., overview of the architecture) to assess RAs: origin and motivation of RA-based SA.

Another major change was selecting new names for the projects. We were using "j-everis", which is the name of the reference architecture of Everis, to refer to reference architectures. We consider more proper to use the generic name of reference architectures, since some

stakeholders do not know what j-everis is, since it is the new name of the reference architecture of Everis. Moreover, we renamed the architectures derived from the reference architecture. In the beginning we were calling them "enterprise architectures". This term was a little bit ambitious because we found out that these architectures are mainly technological. Therefore, we call them "RA-based software architectures". Finally, we explicitly called the enterprise applications, which are derived from RA-based SAs, as "SA-based enterprise applications".

Furthermore, we noticed that asking for several kinds of requirements (e.g., functional and non-functional requirements) in the same question was confusing. We made changes asking in the first question for each kind of requirement: functional, non-functional and technical. Then, we ask for three relevant activities of requirements engineering: elicitation, documentation and validation.

In addition, the name of the section of "other kinds of knowledge" was changed to technologies and tools. We moved some questions that were asked in the section of software development methodology to this section. Also, questions about technologies were removed for the interviews, since developers have a higher knowledge in this field.

Moreover, the last section of business qualities was split up in two parts that have different targets. In the first place, we focus on the benefits of using RA-based software architectures for the client organisations whereas we focus on the benefits for Everis in the second part. With the help of this division, it is easier to understand and reply properly the questions for the interviewee.

Finally, some minor changes were applied in some questions to make then clearer. For instance, we swap the order of the sections "about the project" and "experience in Everis" of the initial delivery and collection questionnaire. Since we are interested on the experience in Everis that the interviewee had had when he worked on the project, we consider that with the new order it was easier to reply these questions.

Online questionnaire for RA-based SA developers
The main feedback of the developer was also that some questions target SA-based enterprise applications, and he was not able to reply them. Due to this problem, we performed a major change. In the beginning, only three questionnaires were intended to be conducted:

1. Interview for projects technical leaders and software architects.
2. Online questionnaire for RA-based SA developers.
3. Interview for client project business leaders.

Since these three questionnaires only cover RA-based SA projects, we also designed and implemented a new questionnaire for the second pilot survey: the online questionnaire for SA-based enterprise applications developers. This way, SA-based enterprise applications were covered too. In both online questionnaires for developers, questions were adapted to their contexts.

On the other hand, he commented that it would be useful to have a button to go to the previous section during the execution of the online questionnaire. During this process, he

wanted to make some changes in previous questions and he needed to start again the questionnaire again to change it.

Finally, some minor changes were applied in some questions to make then clearer.

Interview for client project business leaders
It was adapted from the feedback that we received in the two previous questionnaires.

Second Pilot Survey
All questionnaires of the second pilot survey (except the interview for client organisation project business leaders that has not been conducted yet) were satisfactory. Hence, we will use this second pilot survey in the analysis.

Only minor changes will be made in online questionnaires, in which we have added some "non-applicable" options in some questions.

4.3.2 External reviewers
Everis reviewed and provided feedback to the survey and questionnaires, but GESSI maintained editorial control over the study and its findings and did not accept changes to the study that contradicted findings or obscured the meaning of the study.

5 Survey Execution

The survey execution consists of the actual data collection and data processing. Questionnaires will be executed as we explained in the previous section.

In total, thirty six questionnaires will be conducted: four for each project. Our representative sample includes the nine projects of Table 16.

Table 16. Total amount of questionnaires to be executed.

N	Client	Interviews		Online questionnaires		Total
		SA PTL & SA Arc	Client SA PBL	SA Dev	Application Dev	
1	Client 1	1	1	1	1	4
2	Client 2	1	1	1	1	4
3	Client 3	1	1	1	1	4
4	Client 4	1	1	1	1	4
5	Client 5	1	1	1	1	4
6	Client 6	1	1	1	1	4
7	Client 7	1	1	1	1	4
8	Client 8	1	1	1	1	4
9	Client 9	1	1	1	1	4
Total		9	9	9	9	36

On the one hand, ARCHEX will conduct the interviews for client organisation's project business leaders. On the other hand, GESSI will conduct the other three questionnaires. To this end, the contact information (including his/her e-mail address) of the interviewee will be provided by ARCHEX.

Schedule

Table 17 shows the schedule of the steps of the protocol and the current status. These steps were explained in Figure 3.

Table 17. Schedule of the steps of the survey protocol.

Steps	Status	Schedule
Survey definition	Finished	Sep-Oct 2011
Survey design	Finished	Nov 2011-Apr 2012
Survey implementation	Finished	Nov 2011-Apr 2012
Survey execution	Ongoing	Apr-Jul 2012
Survey analysis	Pending	Jul-Nov 2012
Survey packaging	Pending	Sep 2012-Feb 2013

The next step of the survey is the survey execution (i.e., the actual data collection and data processing). For this ongoing step we have the following schedule:

Table 18. Schedule of the survey execution step.

Survey execution activity	Schedule
Planning the questionnaires with the interviewees	First half of May 2012
Conducting the questionnaires	May–Jun 2012
Data processing (e.g., transcription of the interviews)	Jul 2012

Glossary

Term	Definition
Enterprise application	"An enterprise application is a big business application. Enterprise applications are complex, scalable, distributed, component-based, and mission-critical. They may be deployed on a variety of platforms across corporate networks, intranets, or the Internet. They are data-centric, user-friendly, and must meet stringent requirements for security, administration, and maintenance. In short, they are highly complex systems" [MSD12]. Several enterprise applications of an information system of an organisation can be developed over a software architecture (i.e., SA-based enterprise applications).
Information System (IS)	An information system of an organisation includes several enterprise applications which are based on a software architecture. Information systems provide information that is needed to manage organizations efficiently and effectively and cover needed functions of an organisation.
j-everis	The reference architecture of Everis.
Reference Architecture (RA)	"A Reference architecture refers to an architecture that encompasses the knowledge about how to design concrete architectures of systems of a given application domain; therefore, it must address the business rules, architectural styles (sometimes also defined as architectural patterns that address quality attributes in the reference architecture), best practices of software development (for instance, architectural decisions, domain constraints, legislation, and standards), and the software elements that support development of systems for that domain. All of this must be supported by a unified, unambiguous, and widely understood domain terminology" [NAB11].
Software Architecture (SA)	A software architecture is a "set of significant decisions about the organization of a software system: selection of structural elements and their interfaces by which a system is composed, behaviour as specified in collaborations among those elements, composition of these structural and behaviour elements into larger subsystem, and the architectural style that guide this organization software architecture also involves usage; functionality; performance; resilience; reuse; comprehensibility; economic and technology constraints and trade-offs; and aesthetic concerns" [Kru03].
Survey	Surveys are a system for collecting information to describe, compare, or explain knowledge, attitude and behaviour [Gra09]. Unlike other empirical methods, they are often performed in retrospect (for instance, to study tools or techniques that have been used in the past) and taking a sample that is representative from the population to be studied. They are then generalized to the population from which the sample was taken [WHH03].

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