



Leveraging eID in the Private Sector

D7.2 Report on Cost Benefit Assessment

Document Identification			
Status	Final	Due Date	01/10/2018
Version	1.025	Submission Date	30/11/2018

Related WP	WP7	Document Reference	D7.2
Related Deliverable(s)	7.1, 7.3	Dissemination Level (*)	PU
Lead Participant	UAegean	Lead Author	Petros Kavassalis, UAegean
Contributors	UAegean ATOS ATHEX ELTA CORREOS	Reviewers	John Balafas, ATHEX
			Adrian Fernandez, Correos

Keywords:
eIDAS, eIDAS ID, eIDAS Network, Customer Identity Management, Service Providers, eIDAS API Connectors, CIAM, Costs Benefit Assessment, SP Cost Model, LTV

This document is issued within the frame and for the purpose of the *LEPS* project. This project has received funding from the European Union's Innovation and Networks Executive Agency – Connecting Europe Facility (CEF) under Grant Agreement No. INEA/CEF/ICT/A2016/1271348; Action No 2016-EU-IA-0059. The opinions expressed and arguments employed herein do not necessarily reflect the official views of the European Commission.

This document and its content are the property of the *LEPS* Consortium. All rights relevant to this document are determined by the applicable laws. Access to this document does not grant any right or license on the document or its contents. This document or its contents are not to be used or treated in any manner inconsistent with the rights or interests of the *LEPS* Consortium or the Partners detriment and are not to be disclosed externally without prior written consent from the *LEPS* Partners.

Each *LEPS* Partner may use this document in conformity with the *LEPS* Consortium Grant Agreement provisions.

(*) Dissemination level. -**PU**: Public, fully open, e.g. web; **CO**: Confidential, restricted under conditions set out in Model Grant Agreement; **CI**: Classified, **Int** = Internal Working Document, information as referred to in Commission Decision 2001/844/EC

Document Information

List of Contributors	
Name	Partner
Petros Kavassalis	UAegean
Kostas Panou (LTV approach)	UAegean
Maria Lekakou (Data Collection & Analysis)	UAegean
Anastasia Konstantelou (Data Analysis)	UAegean
Nikos Triantafyllou (Annex)	UAegean
Katerina Ksystra (Annex)	UAegean
Alberto Crespo	ATOS
Aljosa Pasic	ATOS
Juan Perez Baun	ATOS
Petros Stefaneas (Annex)	NTUA
Thodoris Mitsikas (Annex)	NTUA
Javier Salazar Gomez	Correos
John Balafas	ATHEX
Aris Maragkakakis	ELTA
Thomas Macheras	ELTA

Document History			
Version	Date	Change editors	Changes
0.1	05/01/2018	ATOS	Table of content
0.2	10/09/2018	ATOS	Draft with Atos contributions
0.3	1/10/2017	UAegean	Initial Draft (SP Cost Model)
0.4	8/10//2018	UAegean	Update with input from IMG Committee and Correos
0.5	18./10/2018	UAegean	Update with input received from ATOS and ATHEX (SP Cost Model)
0.6	26/10/2018	UAegean	Update with input received from ELTA (SO Cost Model)
0.7	15/11/2018	UAegean	Update with data regarding SP benefit analysis
0.8	27/11/2018	UAegean	Update to include SP Benefit Model
0;9	29/11/2018	UAegean	Update to include comments from ATOS

Document name:	D7.2 Report on Cost Benefit Assessment					Page:	2 of 74
Reference:	D7.2	Dissemination:	PU	Version:	1.025	Status:	Final

1.023	30/11/2018		Update to include input from Reviewers (Correos, ATHEX)
1.024	30/11/2018		Quality Review
1.025	30/11/2018		FINAL VERSION TO BE SUBMITTED

Document name:	D7.2 Report on Cost Benefit Assessment				Page:	3 of 74
Reference:	D7.2	Dissemination:	PU	Version:	1.025	Status: Final

Table of Contents

Document Information.....	2
Table of Contents.....	4
List of Tables	6
List of Figures.....	7
List of Acronyms	8
Executive Summary	9
1 Introduction	10
1.1 Purpose of the document	10
1.2 Relation to other project work	10
1.3 Structure of the document.....	11
2 Overall analysis framework, methodology and value proposition	12
2.1 Analysis framework and methodology	12
2.2 Value proposition	13
3 SP integration with the eIDAS Network: A Cost Model.....	15
3.1 SP-eIDAS Network interconnection architecture.....	15
3.2 SP Integration with the eIDAS Network: Task Analysis	18
3.3 Principal Cost Categories: Fixed Costs (Upfront Investments).....	20
3.4 CAPEX: Cost Model	21
3.4.1 Architecture Option 1 – A SP uses its own custom software to connect to an eIDAS Network Node	21
3.4.2 Architecture Option 2 – A SP uses the CEF Demo SP module (eIDAS Node v1.x) to connect to an eIDAS Network Node	24
3.4.3 Architecture 3 – A SP uses off-the-shelf software to connect to an eIDAS Network Node (LEPS API Connectors)	26
3.4.4 Cost model CAPEX Results: Summary	33
3.5 Principal Cost Categories: Operational Expenses (Dynamic Costs)	33
3.6 OPEX: Cost Model	35
3.6.1 Architecture Option 1 – A SP uses its own custom software to connect to an eIDAS Network Node	35
3.6.2 Architecture Option 2 – A SP uses the CEF Demo SP module (eIDAS Node v1.x) to connect to an eIDAS Network Node	36
3.6.3 Scenario 3 – A SP uses off-the-shelf software to connect to an eIDAS Network Node (LEPS API Connectors)	36

Document name:	D7.2 Report on Cost Benefit Assessment				Page:	4 of 74	
Reference:	D7.2	Dissemination:	PU	Version:	1.025	Status:	Final

3.7	Cost Model: CAPEX and OPEX summary	37
4	SP integration with the eIDAS Network: A Cost-Benefit Analysis	38
4.1	Introduction	38
4.2	Costs and Gains from a “CIAM integrated with the eIDAS Network”” solution: Model data preparation	39
4.3	SP Benefit Analysis: Methodological Considerations	41
4.4	LTV definition and metrics	42
4.5	Model Methodological Specifications	44
4.6	Financial Viability Assessment	45
4.6.1	User acquisition	46
4.6.2	UP/SIP-to-eIDAS eID conversion	47
4.6.3	User retention.....	1
4.6.4	Cashflow analysis	1
4.6.5	Lifetime value calculation.....	1
5	Conclusions	5
6	Annexes	7
6.1	Annex 1: Improve the security of the integration of the SP integration with the eIDAS Network via a formal methods-based verification of eIDAS API Connectors	7
6.1.1	LEPS API Connector Architecture	7
6.1.2	LEPS API Connector Architecture Formal Model	8
6.1.3	Redesigned Architecture	13
6.1.4	Summary	16
	References	17

Document name:	D7.2 Report on Cost Benefit Assessment					Page:	5 of 74
Reference:	D7.2	Dissemination:	PU	Version:	1.025	Status:	Final

List of Tables

Table 1: Functional difference between eIDAS integration architecture options	18
Table 2: SP eIDAS Integration Activities and Tasks	18
Table 3: Architecture Option 1 – eIDAS Integration Up-front Costs	21
Table 4: Architecture Option 2 – eIDAS Integration Up-front Costs	24
Table 5: Architecture Option 3 – eIDAS Integration Up-front Costs	26
Table 6: Architecture Option 3b – eIDAS Integration Up-front Costs with Learning Effects	30
Table 7: SP eIDAS Integration model Up-front Costs - Summary of Architecture Options	33
Table 8: SP eIDAS Integration Architecture Options – Comparison Metrics	33
Table 9: Description of Activities related to eIDAS Integration operation	34
Table 10: SP Integration Architecture Option 1 – Operational Expenses	35
Table 11: SP Integration Architecture Option 2 – Operational Expenses	36
Table 12: SP Integration Architecture Option 3 – Operational Expenses	36
Table 13: SP eIDAS Integration model Up-front Costs - Summary of Architecture Options	37
Table 14: SP eIDAS integration costs as input to estimate benefits	39
Table 15: Reference SP Cost Savings Sources	40
Table 16: Media buying matrix	47
Table 17: Setup parameters for user funnel and virality	48
Table 18: User funnel and virality	1
Table 19: eIDAS eID user rétention matrix	1
Table 20: Conv, CIAM (UP/SIP only) user retention matrix	1
Table 21: Total user (UP/SIP+eIDAS eID) retention matrix	3
Table 22: Cost structure	1
Table 23: Estimation of quarterly cost of service per user	1
Table 24: Cash flow	1
Table 25: eIDAS eID users	1
Table 26: Conv CIAM (UP/SIP only)	2
Table 27: Total user (UP/SIP+eIDAS)	3

Document name:	D7.2 Report on Cost Benefit Assessment					Page:	6 of 74
Reference:	D7.2	Dissemination:	PU	Version:	1.025	Status:	Final

List of Figures

Figure 1: Structure and organization of the eIDAS Network	15
Figure 2: LEPS API Connectors – Generic Interconnection Architecture	16
Figure 3: ATHEX interconnection architecture with the Greek eIDAS Node	17
Figure 4: Correos interconnection architecture with the Spanish eIDAS Node	17
Figure 5: Functional Decomposition of the eIDAS integration workload into Activities and Tasks	20
Figure 6: LEPS API Connector Architecture	7
Figure 7: LEPS API Connector Redesigned Architecture	15

Document name:	D7.2 Report on Cost Benefit Assessment				Page:	7 of 74
Reference:	D7.2	Dissemination:	PU	Version:	1.025	Status: Final

List of Acronyms

Abbreviation / acronym	Description
ATO	Account Takeover
CIAM	Consumer Identity and Access Management
eIDAS	Electronic Identification and Signature
eIDAS eID	eIDAS-based electronic Identification
IAM	Identity and Access Management
IdM	Identity Management
LTV	LongTime Value (Analysis)
SAML	Security Assertion Markup Language
SIP	Socoal Identity Providers
SP	Service provider
UP	User Pool

Document name:	D7.2 Report on Cost Benefit Assessment				Page:	8 of 74
Reference:	D7.2	Dissemination:	PU	Version:	1.025	Status: Final

Executive Summary

Online Service Providers (S)s), such as e-commerce retailers, financial institutions, telecom companies etc., must manage customers' access to their ICT applications and databases and they need to do so as effectively as possible (at both levels, technical and economic). Traditionally, these SPs carry out local user identification processes, and very recently, they are increasingly refer to third-party Identity Providers, such as Social Networks and Internet mega-providers (Google, Microsoft etc.), for user authentication and service login. They now have the possibility of using the eIDAS Network to provide a more secure login option to their customers. This report and the accompanying tool may help SPs to understand and quantify the induced cost and the expected benefits from the use of eIDAS eID. The report includes a cost models for SPs aiming at integrating with the eIDAS Network. The model is used to gain insight into an SP's present costs and to quantify the impact of these costs on the future benefits, Towards this, it introduces techniques known as Customer Lifetime Value Analysis (LTV) and applies them to quantify and assess the possible benefits and return on investment of a reference Service Provider (SP) who decides to offer eIDAS eID services in e-commerce transactions.

Document name:	D7.2 Report on Cost Benefit Assessment				Page:	9 of 74
Reference:	D7.2	Dissemination:	PU	Version:	1.025	Status: Final

1 Introduction

The objective of this Deliverable is to provide a Cost-Benefit Assessment Report of eIDAS services uptake by the private sector's Service Providers. This Report is based on: a) SP cost data that have been meticulously collected during the integration of CEF eID with the LEPS partners (Correos, ATHEX, ELTA) – under the responsibility of UAegean and ATOS and in close collaboration with these LEPS partners and, b) a benefit analysis for an SP aiming of integrating with the eIDAS Network, based on data collected from the related literature and from structured interviews with the LEPS partners' personnel that has participated in the project – specifically with reference to the perception they have of the expected tangible and intangible benefits. UAegean and ATOS also drew from previous experience, insight, and research through advisory and inquiry discussions with end-users, vendors, and regulators across industry sectors, and of course with the participants in LEPS Industrial Monitoring Group (IMG). The discussion with the IMG members took place in several occasions, and certainly during an IMG event organized in the context of the LEPS Final Technical Meeting (Murcia, Spain, 3.10.2018). Finally, this Report builds upon and extends previous work undertaken within LEPS Activity 7, as reported in LEPS Deliverable 7.1¹.

1.1 Purpose of the document

This report and the accompanying tool helps Service Providers (SP) executives understand and quantify the costs and benefits of integrating the eIDAS Network under different architecture options and determine which one eventually provides the most benefits. It summarized the work performed within Task 7.2 (Cost-benefit assessment of CEF eID uptake by private sector), which mainly delivered, as defined in the DoA (GA): a) a framework between LEPS partners to enable the collection of different categories of costs related to the integration with CEF eID, ii) the qualitative / quantitative assessment of the corresponding benefits and, iii) the definition of different eIDAS Network integration architectures to cover different SP technical strategies and organizational cultures and, eventually, differences among different Member States.

1.2 Relation to other project work

As already explained, this Deliverable has as input the work performed within Task 7.1 (Market Research and Feasibility Analysis of eIDAS services uptake by the private sector) and builds and extends the findings reported in Deliverable 7.1. It provides a major input to the conclusions of the project, as elaborated in the context of Task 7.3 (Roadmap & recommendations for long-term sustainability).

¹ LEPS Deliverable D7.1, "Report on Market Research and Feasibility Analysis"

Document name:	D7.2 Report on Cost Benefit Assessment					Page:	10 of 74
Reference:	D7.2	Dissemination:	PU	Version:	1.025	Status:	Final

1.3 Structure of the document

This document is structured in 4 major chapters:

Chapter 2 presents the overall analysis framework and methodology used in Task 7.2 and, consequently, in the definition of the structure of this Report.

Chapter 3 presents a Cost Model of SP integrating the eIDAS Network. The model is used to gain insight into an SP's present technical and non-technical costs. The model considers in detail several fixed and dynamic cost parameters (CAPEX and OPEX factors) for three different architecture options: a) An SP uses custom software to connect to an eIDAS Network, b) An SP uses a generic software (such as CEF provided Demo SP Connector) to connect to an eIDAS Network Node, b) an SP uses commercial off-the-shelf software to connect to an eIDAS Network Node, such as eIDAS APIs provided by LEPS project. The model is used to identify the costs of connectivity to eIDAS Network based on an exhaustive analysis of the operations and tasks a SP should enact in order to integrate with the eIDAS Network (work functional decomposition).

Once the SP costs are described, a Cost Benefit Assessment is conducted in **Chapter 4**. The analysis uses the results of the previously conducted cost analysis, as well data collected through inquiry and research and input parameters, to estimate expected benefits over a period of 3 years, in the specific context of a reference SP activating in the e-commerce industry and possessing already an CIAM system² (assuming 100.000 users with 10% "eIDAS eID customers"). eIDAS Network adoption-specific benefits are mostly related to cost savings and to potential user-base enlargement due to an increase of the cross-border transactions.

Chapter 5 summarizes the conclusions of this Report.

² CIAM: Customer Identity Management Systems; for a quick presentation of the different options, see: The Forrester Wave™: Customer Identity and Access Management, Q2 2017, available at <https://www.janrain.com/resources/industry-research/forrester-wavetm-customer-identity-and-access-management-q2-2017>

Document name:	D7.2 Report on Cost Benefit Assessment				Page:	11 of 74
Reference:	D7.2	Dissemination:	PU	Version:	1.025	Status: Final

2 Overall analysis framework, methodology and value proposition

2.1 Analysis framework and methodology

In order to make a cost benefit assessment, we have used a number of sources:

- Results and data from previous pilots, including Stork and Stork 2.0 projects, FutureID, FIDES, EGOV (Greece, funded by CEF) and others – in the objective to estimate effort dedicated to different phases of software development and integration with the eIDAS infrastructure.
- The LEPS' team own experience and data collected from the integration of LEPS industrial partners' services with the eIDAS Network, mostly quantitative and fine-grained assessment of costs based on the systematic reporting of the invested efforts through worksheets developed specifically for the needs of this project.
- Reported and estimated cost savings and expected benefits from Services Providers regarding eIDAS eID based authentication and the related procedures and rules (such as the existence of a higher level of assurance). Similar data were collected from several sources including other CEF projects or experiences from members of Industrial Monitoring Group, as well as from the related literature on Identity Management Systems (IAM) and Customer Identity Access Management (CIAM) Systems.
- Studies and Reports exploring the capital and operational costs for Service Providers as well as the benefits and savings for an SP adopting a CIAM perspective and the practice of authentication based on the use of third-party Identity Providers (IdPs).

The cost model we have developed has focused on the investigation of three (3) different architectural options for SPs:

1. An SP uses custom software to connect to an eIDAS Network Node
2. An SP uses the CEF Demo SP module (eIDAS Node v1.x) to connect to an eIDAS Network Node
3. An SP uses off-the-shelf software to connect to an eIDAS Network Node, such as LEPS API Connectors.

The cost model compares the results related to each architectural option while specifically exploring architectural option 3.

Regarding benefit analysis, we should recognize that this will vary depending on the type of industry and market sector, the type of Service Provider, the volume of cross-border activity, compliance needs, risk appetite and many other factors. However, we build a reference case based on the assumption of an SP operating in the e-commerce industry. We have defined tangible and intangible benefits and make an approximation for tangible benefits, starting from collecting data from public sources and industry reports and using assumptions that have been validated by LEPS industrial partners.

Document name:	D7.2 Report on Cost Benefit Assessment					Page:	12 of 74
Reference:	D7.2	Dissemination:	PU	Version:	1.025	Status:	Final

Therefore, our approach to the analysis of costs and benefits related to market adoption of eIDAS enabled eID based solutions is at the same time:

- A qualitative approach focused on the analysis of a number of different elements intrinsically involved and contributing to cost benefit structure and evolution.
- A quantitative analysis that delivers a Cost Benefit Assessment, where we provide:
 - i. A detailed cost analysis decomposed in a number of relevant cost categories that SPs would need to face when integrating with eIDAS Network = with the clustering of costs into one time and continuous costs. These two clusters basically correspond to capital (CAPEX) and operational (OPEX) cost. Capital, fixed costs (also known as CAPEX) require a one-time investment in order to understand and set-up the needed IT solution, adapting existing services to operate in a cross-border user-base, technically interfacing a country Node of the eIDAS Network, etc. Operational costs (or OPEX), are usually referring to the dynamic costs needed to run the infrastructure that makes the needed IT solution for integration with the eIDAS Nwtwork, fully operational and sustainable in a period of three (3) years.
 - ii. An SP benefit assessment, based on a Customer Lifetime Value Analysis approach (LTV), to estimate cost savings and pure gains for an SP integrating its services with the eIDAS Network.

The advantages of using a quantified approach for assessing SPs costs and benefits for integrating with the eIDAS Network, are:

- Transparency: detailed cost data allows potential errors to be investigated and their impact tested, both in Greece and Spain. This facilitates the quality assurance process and learning from each other's lessons.
- Granularity: detailed cost data can highlight variations in cost data and enable SP's technical staff to explore alternative choices.
- Versatility: the methodology enables a Service Provider to forecast how benefits may change as a result of an increase in service usage.

2.2 Value proposition

LEPS project results have been listed and described in detail in previous project Deliverables. The aim of this Deliverable is to take a business perspective of the SP integration with the eIDAS Network, provide a cost model and benefit quantified assessment, and bring these into a unique value proposition for LEPS results, which can be summarised as follows “Use of LEPS API Connectors cuts SP costs for service integration with the eIDAS and enables the realization of a large part of the expected benefits – SP benefits are mostly related to cost savings and eIDAS eID based authentication shows a considerably higher profit margin as compared to the more traditional user logins methods, such as User Pool (UP)³”. We finally notice that the value proposition from D7.1 that is applied in this Deliverable will be further enhanced with the conclusions from this Report, to provide valuable input to D7.3, where a set of

³ A User Pool (UP) is a local (i.e., on-premises) user directory in an enterprise IT environment.

Document name:	D7.2 Report on Cost Benefit Assessment					Page:	13 of 74
Reference:	D7.2	Dissemination:	PU	Version:	1.025	Status:	Final

recommendations and a roadmap for the further adoption of the eIDAS Network by the private sector are proposed.

Document name:	D7.2 Report on Cost Benefit Assessment				Page:	14 of 74
Reference:	D7.2	Dissemination:	PU	Version:	1.025	Status: Final

3 SP integration with the eIDAS Network: A Cost Model

A cost model of Service Providers integrating with the eIDAS Network has been developed by the LEPS project in the context of Task 7.2 “Cost-benefit assessment of CEF eID uptake by private sector”. The model quantifies the impact on an SP’s revenues of the adoption of the eIDAS Network as a “third-party service” for customer authentication. Three options are modeled on the basis of the type of the integration architecture an SP deploys to connect to an eIDAS Node:

1. An SP uses its own custom software to connect to an eIDAS Network Node
2. An SP uses the CEF Demo SP module (eIDAS Node v1.x) to connect to an eIDAS Network Node
3. An SP uses off-the-shelf software to connect to an eIDAS Network Node, such as LEPS API Connectors.

3.1 SP-eIDAS Network interconnection architecture

The eIDAS SP cost model presented here has many input parameters. Each input parameter will be explained in this document, starting with the key assumption of how an SP integrates with the eIDAS Network. SPs may come in all shapes and sizes, we assume however that in all cases, an SP Connector is needed, and this Connector can serve many SP services that are integrated with an eIDAS Node. In fact, an SP effective connection to an eIDAS Node requires the use of a specific software that is able to prepare an authentication request that is forwarded to the eIDAS Node and, a bit later, receive and process the authentication response delivered by the eIDAS Node.

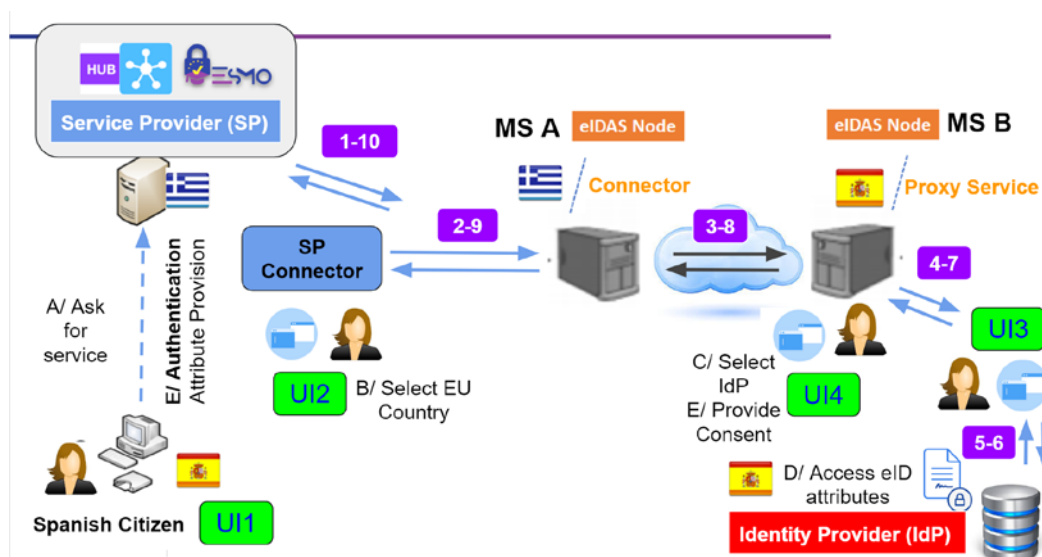


Figure 1: Structure and organization of the eIDAS Network

Document name:	D7.2 Report on Cost Benefit Assessment					Page:	15 of 74
Reference:	D7.2	Dissemination:	PU	Version:	1.025	Status:	Final

The type of this Connector explains the differences between the above mentioned three architectural options. The software for this Connector may be built by an SP from scratch or, eventually, by using software that is available to SPs as a “reference connector” to an eIDAS Node. A simple version of such a software is included in CEF eID Building Block (CEF eID BB), under the name “Demo SP module”. Besides, LEPS has developed a complete API Connector for the needs of the SPs participating in the project, in two product versions, one from ATOS and another from UAegean. The ATOS eIDAS Connector has been used to create the bridge between Correos IT premises and the Spanish eIDAS Node, while UAegean API Connectors have been deployed within ATHEX and ELTA IT premises, to enable the interconnection of these SP with the Greek eIDAS Node (UAegean LEPS eIDAS API Connectors are provided as “off-the-shelf software” under EUPL license, in different options, depending on the conditions of use⁴). Generally speaking, the use of LEPS API connectors provides the following SP interconnection topology:

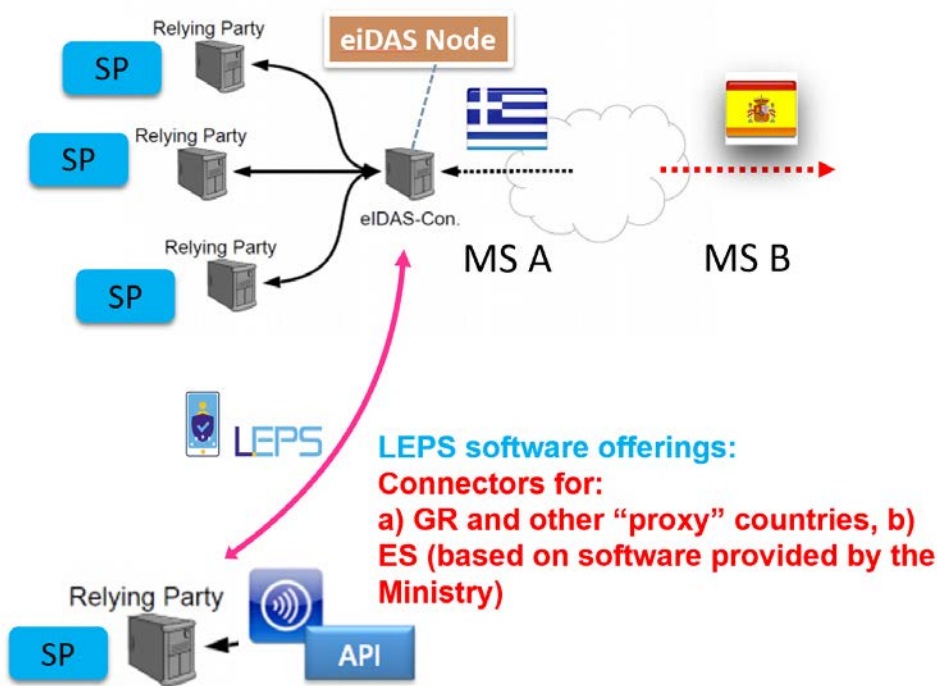


Figure 2: LEPS API Connectors – Generic Interconnection Architecture

The application of this topology in the specific cases of ATHEX and Correos has as follows:

⁴ For more details, see: LEPS Deliverable D4.2/5.2: “eIDAS Interconnection Supporting Service”

Document name:	D7.2 Report on Cost Benefit Assessment				Page:	16 of 74	
Reference:	D7.2	Dissemination:	PU	Version:	1.025	Status:	Final

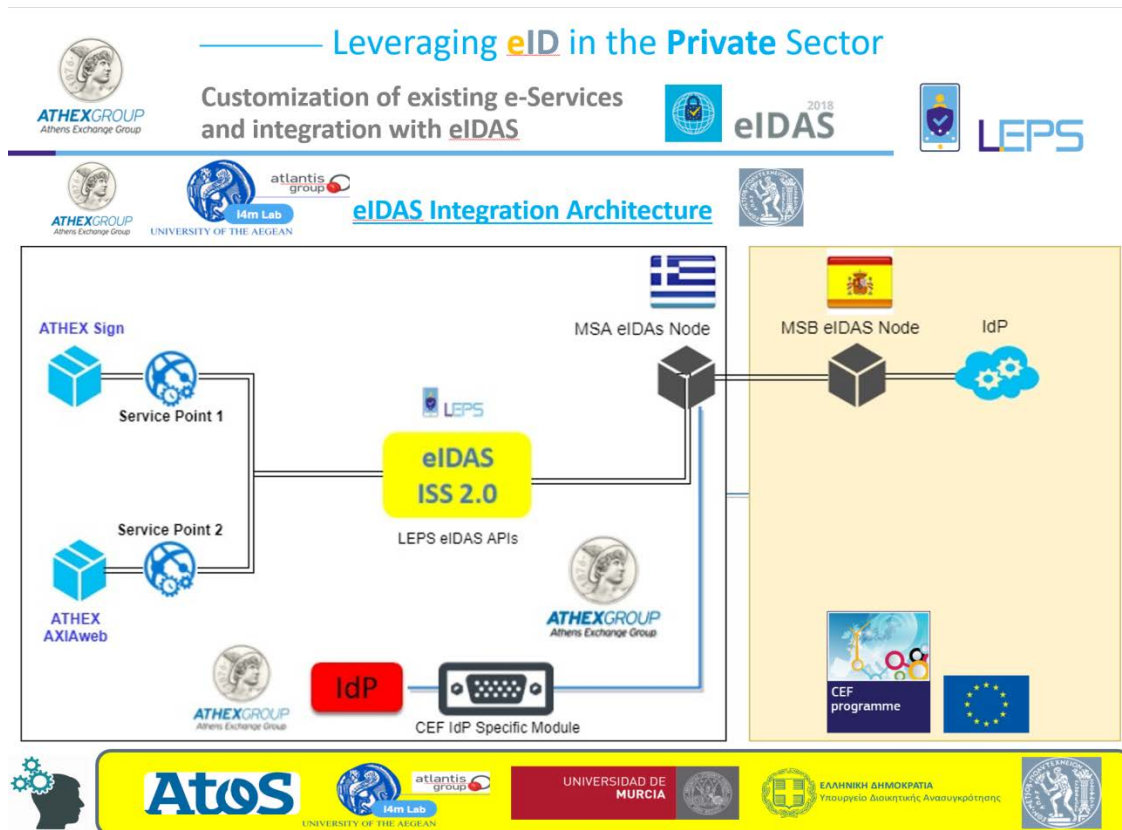


Figure 3: ATHEX interconnection architecture with the Greek eIDAS Node

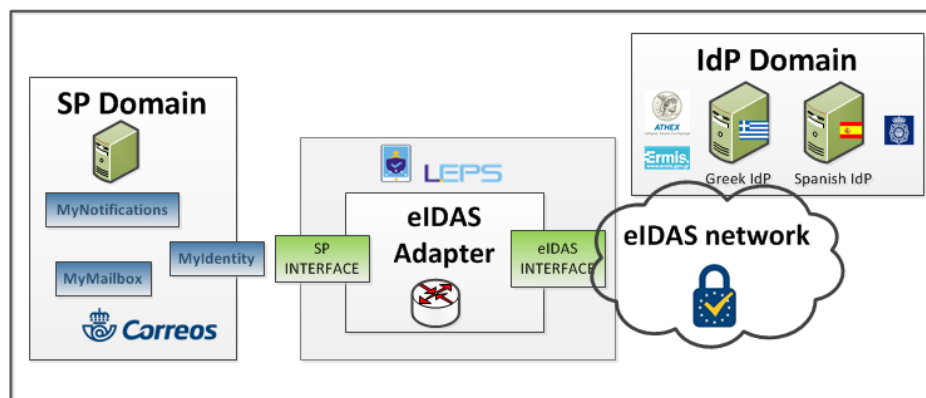


Figure 4: Correos interconnection architecture with the Spanish eIDAS Node

Since LEPS API Connectors have effectively deployed in the premises of LEPS industrial partners, LEPS team is in the position to effectively estimate the necessary effort that an SP should invest in order to integrate the eIDAS Network by using LEPS API Connectors (Architecture Option 3: An SP uses off-the-shelf software to connect to an eIDAS Network Node, such as LEPS API Connectors). But also, UAegean, from previous experience with other CEF projects and STORK, has also the capacity to estimate the necessary SP effort when this SP uses the other two possible interconnection architecture options: a) Option 1: An SP uses its own custom software to connect to an eIDAS Network Node and,

Document name:	D7.2 Report on Cost Benefit Assessment	Page:	17 of 74
Reference:	D7.2	Dissemination:	PU
	Version:	1.025	Status:
			Final

b) Scenario 2: An SP uses the CEF Demo SP module (eIDAS Node v1.x) to connect to an eIDAS Network Node.

We should finally notice that these three integration architecture options may have a apparent architectural similarity (i.e., in all cases a software connector bridges SP and eIDAS Node infrastructures). Despite this similarity, in practice, the three possible architectural solutions have different standardization degree and a different intrinsic capacity of re-usability in different SP environments⁵.

Table 1: Functional difference between eIDAS integration architecture options

	Build from scratch (Option 1)	Build by using CEF Demo SP (Option 2)	LEPS eIDAS API Connectors (Option 3)
Standardization Degree	Low	Medium	High
Re-usability in different SP environments	Low	Medium	High

These differences will essentially matter when an SP uses these different software Connectors to implement the specific Tasks that are necessary to integrate the eIDAS Network. As a result, the cost model described in this Deliverable depends on the used architecture option for interconnection with the eIDAS Node.

3.2 SP Integration with the eIDAS Network: Task Analysis

From the LEPS experience, as well from the knowledge accumulated in LEPS partners from previous similar projects, we understand that the implementation of the interconnection of an SP with an eIDAS Node includes several activities that are functionally detailed in fine-grained Tasks. Consequently, the model will proceed by breaking down the costs into these Activities and Task categories.

The eIDAS integration Activities and Tasks for a Service Provider (SP) have as follows (in time order):

Table 2: SP eIDAS Integration Activities and Tasks

a/a	eIDAS Integration Activities/Tasks		Task Classification
A1	Requirement Analysis and Choice		Technical
		Problem Understanding	

⁵ The discussion of the proper technical differences between the three available architecture solutions is not directly related to the theme of this Deliverable. We should notice however, the dual internal architecture of the LEPS eIDAS API Connectors (ISS 2.0 and WebApp) allow for more resilience and adaptivity in the specific IT environment of a SP, as a previous Deliverable explains in detail (D4.2 eIDAS Interconnection Supporting Service,).

Document name:	D7.2 Report on Cost Benefit Assessment					Page:	18 of 74
Reference:	D7.2	Dissemination:	PU	Version:	1.025	Status:	Final

		Information Collection	
		Option Analysis	
A2	Service Customization eIDAS Integration Design		Technical
		Process Design	
		Technical Design Document	
A3	e-IDAS Integration: init Tasks		Technical
		Familiarization with eIDAS specs	
		Preparatory Actions (SAML or OIDC message, encryption, configuration, code modifications etc.)*	
		Connection with the eIDAS Node	
A4	Service Customization/Re-design		Technical
		Add of new components (in the case of a major re-design)	
		Customization development (DB and back-end modifications, eIDAS login signs and front-end modifications etc.)	
		English version	
		"How to Use" text writing	
A5	Service Integration with the eIDAS Network		Technical
		UI Layer (country form, auth-failure pages, other Uis)	
		Mobile Responsiveness	
		Help Pages	
A6	Pre-production Deployment		Technical
		Pre-production Deployment	
A7	Identities Consolidation (local, eIDAS, other)		Technical
		Solution Design	
		Deployment	
		Testing	
A8	Main Testing		Technical
		Functional Testing (integration with the eIDAS Network/ pre-production and production)	
		Usability Testing	
		User Acceptance Testing	
A9	Service Update after Identities Consolidation and Testing		Technical
		Production Version (20% FC3+FC4)	
A10	Production Deployment		Technical

Document name:	D7.2 Report on Cost Benefit Assessment					Page:	19 of 74
Reference:	D7.2	Dissemination:	PU	Version:	1.025	Status:	Final

		Security Analysis (Verification)	
		Peak-load and Performance Testing	
		Final Deployment Testing	
A11	Internal Support		Management/Technical
		Dev/Support Teams Training	50-50%
		Documentation	
		Other	
A12	Technical Management		Management
		Technical Management	
A13	Project Management		Management
		Project Management	

A more graphical presentation of these Tasks follows:

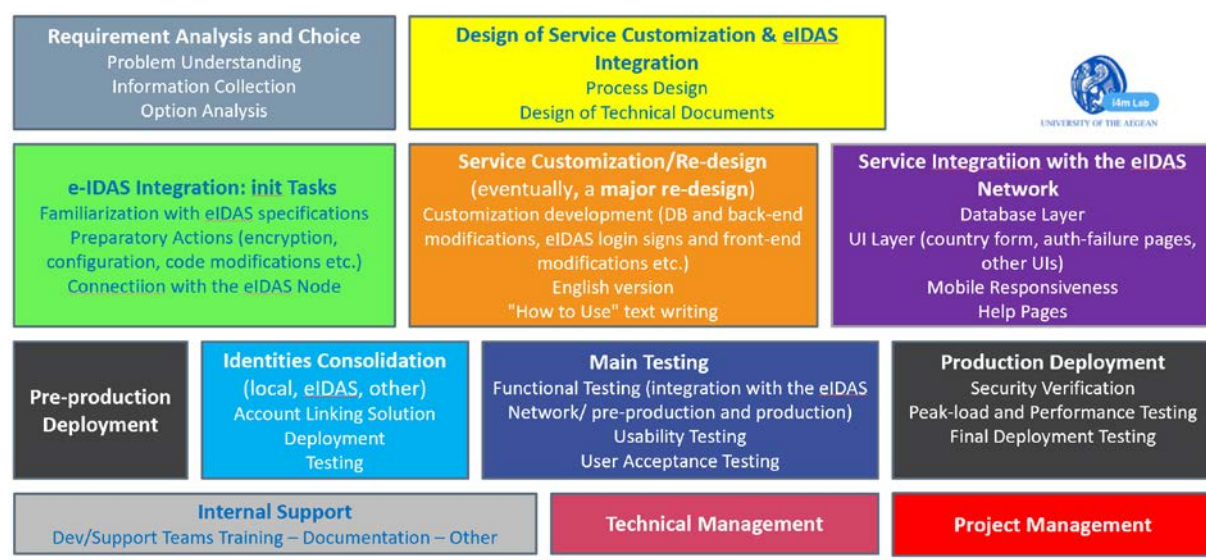


Figure 5: Functional Decomposition of the eIDAS integration workload into Activities and Tasks

3.3 Principal Cost Categories: Fixed Costs (Upfront Investments)

The integration of an SP with the eIDAS Network requires the completion of all Activities and Tasks described in the previous section. Therefore, the SP costs are separated into these Activities categories.

1. Requirement Analysis and Choice
2. Service Customization | eIDAS Integration Design
3. e-IDAS Integration: init Tasks
4. Service Customization/Re-design
5. Service Integration with the eIDAS Network
6. Pre-production Deployment

Document name:	D7.2 Report on Cost Benefit Assessment					Page:	20 of 74
Reference:	D7.2	Dissemination:	PU	Version:	1.025	Status:	Final

7. Identities Consolidation (local, eIDAS eID, other)
8. Main Testing
9. Service Update after Identities Consolidation and Testing
10. Production Deployment
11. Internal Support
12. Technical Management
13. Project Management

These are fixed (up-front) costs, payed once by an SP, in the beginning of an eIDAS integration project. They are calculated on the basis of the working days needed to successfully accomplish the integration project. Since activities are classified in terms of the necessary competences (technical or managerial), one can calculate the cost of each activity based on the cost of the labor participating in this activity. A calculation of the costs for ICT labor is provided based on data obtained from Eurostat and other resources, with reference to labor costs applied in the Eurozone^{6,7}.

3.4 CAPEX: Cost Model

Obviously, the cost model shows essential differences between the three (3) scenarios since they have different requirements in terms of the labor needed to effectively implement the integration with the eIDAS Network. The results obtained for the different models have as follows:

3.4.1 Architecture Option 1 – A SP uses its own custom software to connect to an eIDAS Network Node

Description: An SP “builds from scratch” software to interconnect with an eIDAS Node

Method of Calculation: Estimations based on UAegean experience with the development of eIDAS Connectors – cross-verification with SPs having a similar experience.

Table 3: Architecture Option 1 – eIDAS Integration Up-front Costs

a/a	eIDAS Integration Activities/Tasks	Task Classification	Work day (EUR)	working days	Cost (EUR)
FC1	Requirement Analysis and Choice	Technical	216.96	9	1,952.64

⁶ The exact calculation of ICT labor cost is shown on the spreadsheet: URL <https://docs.google.com/spreadsheets/d/1zVCcjgLEdVyGEaT1Gd3II98-v1kMeDW9PxpNQ14msAc/edit?usp=sharing>

Sheet: ICTlaborCosts

⁷ We have included data only from the Eurozone countries to avoid the large differences between the values representing labor cost in the different EU countries. However, the cost model can accept input parameter values from any specific country or SP company.

Document name:	D7.2 Report on Cost Benefit Assessment					Page:	21 of 74
Reference:	D7.2	Dissemination:	PU	Version:	1.025	Status:	Final

		Problem Understanding			3	
		Information Collection			3	
		Option Analysis			3	
FC2	Service Customization eIDAS Integration Design		Technical	216.96	6	1,301.76
		Process Design			4	
		Technical Design Document			2	
FC3	e-IDAS Integration: init Tasks		Technical	216.96	29	6,291.84
		Familiarization with eIDAS specs			4	
		Preparatory Actions (SAML or OIDC message, encryption, configuration, code modifications etc.)*			20	
		Connection with the eIDAS Node			5	
FC4	Service Customization/Re-design		Technical	216.96	23	4,990.08
		Add of new components (in the case of a major re-design)			8	
		Customization development (DB and back-end modifications, eIDAS login signs and front-end modifications etc.)			12	
		English version			2	
		"How to Use" text writing			1	
FC5	Service Integration with the eIDAS Network		Technical	216.96	6	1,301.76

Document name:	D7.2 Report on Cost Benefit Assessment					Page:	22 of 74
Reference:	D7.2	Dissemination:	PU	Version:	1.025	Status:	Final

		UI Layer (country form, auth-failure pages, other Uis)			3	
		Mobile Responsiveness			2	
		Help Pages			1	
FC6	Pre-production Deployment		Technical	216.96	5	1,084.80
		Pre-production Deployment			5	
FC7	Identities Consolidation (local, eIDAS, other)		Technical	216.96	13	2,820.48
		Solution Design			5	
		Deployment			4	
		Testing			4	
FC8	Main Testing		Technical	216.96	9	1,952.64
		Functional Testing (integration with the eIDAS Network/ pre-production and production)			5	
		Usability Testing			2	
		User Acceptance Testing			2	
FC9	Service Update after Identities Consolidation and Testing		Technical	216.96	10	2,169.60
		Production Version (20% FC3+FC4)			10.4	
FC10	Production Deployment		Technical	216.96	15	3,254.40
		Security Analysis (Verification)			10	
		Peak-load and Performance Testing			2	
		Final Deployment Testing			3	
FC11	Internal Support		Management/Technical	216.96	14	3,702.16
		Dev/Support Teams Training	50-50%	311.92	10	
		Documentation			3	

Document name:	D7.2 Report on Cost Benefit Assessment					Page:	23 of 74
Reference:	D7.2	Dissemination:	PU	Version:	1.025	Status:	Final

		Other			1	
FC12	Technical Management		Management	311.92	20	6,238.40
		Technical Management			20	
FC13	Project Management		Management	311.92	15	4,678.80
		Project Management			15	
SUM FC	SUM FC				174	41,739.36

3.4.2 Architecture Option 2 – A SP uses the CEF Demo SP module (eIDAS Node v1.x) to connect to an eIDAS Network Node

Description: An SP builds a Connector based on a Demo SP software delivered in the context of CEF eID BB

Method of Calculation: Estimations based on UAegean experience with the development of eIDAS Connectors – cross-verification with SPs having a similar experience.

Table 4: Architecture Option 2 – eIDAS Integration Up-front Costs

eIDAS Integration Activities/Tasks		Task Classification	Work day (EUR)	working days	Cost (EUR)
Requirement Analysis and Choice		Technical	216.96	8	1,735.68
	Problem Understanding			3	
	Information Collection			3	
	Option Analysis			2	
Service Customization eIDAS Integration Design		Technical	216.96	5	1,084.80
	Process Design			3	
	Technical Design Document			2	
e-IDAS Integration: init Tasks		Technical	216.96	17	3,688.32
	Familiarization with eIDAS specs			3	
	Preparatory Actions (SAML or OIDC message, encryption, configuration,			12	

Document name:	D7.2 Report on Cost Benefit Assessment				Page:	24 of 74
Reference:	D7.2	Dissemination:	PU	Version:	1.025	Status: Final

	code modifications etc.)*				
	Connection with the eIDAS Node			3	
Service Customization/Re-design		Technical	216.96	21	4,556.16
	Add of new components (in the case of a major re-design)			8	
	Customization development (DB and back-end modifications, eIDAS login signs and front-end modifications etc.)			10	
	English version			2	
	"How to Use" text writing			1	
Service Integration with the eIDAS Network		Technical	216.96	6	1,301.76
	UI Layer (country form, auth-failure pages, other Uis)			3	
	Mobile Responsiveness			2	
	Help Pages			1	
Pre-production Deployment		Technical	216.96	4	867.84
	Pre-production Deployment			4	
Identities Consolidation (local, eIDAS, other)		Technical	216.96	13	2,820.48
	Solution Design			5	
	Deployment			4	
	Testing			4	
Main Testing		Technical	216.96	7	1,518.72
	Functional Testing (integration with the eIDAS Network/ pre-production and production)			3	
	Usability Testing			2	

Document name:	D7.2 Report on Cost Benefit Assessment					Page:	25 of 74
Reference:	D7.2	Dissemination:	PU	Version:	1.025	Status:	Final

	User Acceptance Testing			2	
Service Update after Identities Consolidation and Testing		Technical	216.96	7	1,518.72
	Production Version (20% FC3+FC4)			7.6	
Production Deployment		Technical	216.96	10	2,169.60
	Security Analysis (Verification)			5	
	Peak-load and Performance Testing			2	
	Final Deployment Testing			3	
Internal Support		Management/Technical	216.96	12	3,173.28
	Dev/Support Teams Training	50-50%	311.92	8	
	Documentation			3	
	Other			1	
Technical Management		Management	311.92	15	4,678.80
	Technical Management			15	
Project Management		Management	311.92	15	4,678.80
	Project Management			15	
SUM FC				140	33,792.96

3.4.3 Architecture 3 – A SP uses off-the-shelf software to connect to an eIDAS Network Node (LEPS API Connectors)

Description: A SP uses LEPS API

Method of Calculation: Login of real invested work-hours during the deployment of LEPS API Connectors within LEPS industrial SP partners (based on a specific monitoring) | Two versions ATOS and UAegean | AVG calculation - cross-verification with SPs having a similar experience.

Table 5: Architecture Option 3 – eIDAS Integration Up-front Costs

a/a	eIDAS Integration Activities/Tasks	Task Classification	Work day (EUR)	working days (no) UAegean	working days (no) ATOS	working days (AVG)	Cost (EUR)
-----	------------------------------------	---------------------	----------------	---------------------------	------------------------	--------------------	------------

Document name:	D7.2 Report on Cost Benefit Assessment				Page:	26 of 74	
Reference:	D7.2	Dissemination:	PU	Version:	1.025	Status:	Final

FC1	Requirement Analysis and Choice		Technical	216.96	5	7	6	1,301.76
		Problem Understanding			2	3	2.5	
		Information Collection			2	3	2.5	
		Option Analysis			1	1	1	
FC2	Service Customization eIDAS Integration Design		Technical	216.96	5	6	5.5	1,193.28
		Process Design			3	4	3.5	
		Technical Design Document			2	2	2	
FC3	e-IDAS Integration: init Tasks		Technical	216.96	12	15	13.5	2,928.96
		Familiarization with eIDAS specs			3	5	4	
		Preparatory Actions (SAML or OIDC message, encryption, configuration, code modifications etc.)*			5	5	5	
		Connection with the eIDAS Node			3	5	4	
FC4	Service Customization/ Re-design		Technical	216.96	17	20	18.5	4,013.76
		Add of new components (in the case of a major re-design)			8	8	8	

Document name:	D7.2 Report on Cost Benefit Assessment				Page:	27 of 74	
Reference:	D7.2	Dissemination:	PU	Version:	1.025	Status:	Final

		Customization development (DB and back-end modifications, eIDAS login signs and front-end modifications etc.)			6	8	7	
		English version			2	2	2	
		"How to Use" text writing			1	2	1.5	
FC5	Service Integration with the eIDAS Network		Technical	216.96	3	4	3.5	759.36
		UI Layer (country form, auth-failure pages, other Uis)			1	1	1	
		Mobile Responsiveness			1	1	1	
		Help Pages			1	2	1.5	
FC6	Pre-production Deployment		Technical	216.96	3	5	4	867.84
		Pre-production Deployment			3	5	4	
FC7	Identities Consolidation (local, eIDAS, other)		Technical	216.96	6	7	6.5	1,410.24
		Solution Design			3	2	2.5	
		Deployment			1	3	2	
		Testing			2	2	2	
FC8	Main Testing		Technical	216.96	6	6	6	1,301.76
		Functional Testing (integration			2	3	2.5	

Document name:	D7.2 Report on Cost Benefit Assessment				Page:	28 of 74	
Reference:	D7.2	Dissemination:	PU	Version:	1.025	Status:	Final

		with the eIDAS Network/ pre-production and production)						
		Usability Testing			2	2	2	
		User Acceptance Testing			2	1	1.5	
FC9	Service Update after Identities Consolidation and Testing		Technical	216.96	5	na	5	1,084.80
		Production Version (20% FC3+FC4)			5.8	na	5.8	
FC10	Production Deployment		Technical	216.96	8	0	8	1,735.68
		Security Analysis (Verification)			3	na	3	
		Peak-load and Performance Testing			2	na	2	
		Final Deployment Testing			3	na	3	
FC11	Internal Support		Management/Technical	216.96	12	17	14.5	3,834.38
		Dev/Support Teams Training	50-50%	311.92	8	12	10	
		Documentation			3	5	4	
		Other			1	0	0.5	
FC12	Technical Management		Management	311.92	8	10	9	2,807.28
		Technical Management			8	10	9	
FC13	Project Management		Management	311.92	8	8	8	2,495.36

Document name:	D7.2 Report on Cost Benefit Assessment				Page:	29 of 74	
Reference:	D7.2	Dissemination:	PU	Version:	1.025	Status:	Final

		Project Management			8	8	8	
SUM M FC	SUM FC				98	105	108	25,734.46

Note: A variation of the AVG cost model has been also created (Scenario 3B) which includes estimations of UAegean on further reduction of working days, to the accumulation of Learning Effects. The results of this cost model are shown below.

Table 6: Architecture Option 3b – eIDAS Integration Up-front Costs with Learning Effects

a/a	eIDAS Integration Activities/Tasks	Task Classification	Work day (EUR)	working days	Cost (EUR)
FC1	Requirement Analysis and Choice	Technical	216.96	5	1,084.80
		Problem Understanding		2	
		Information Collection		2	
		Option Analysis		1	
FC2	Service Customization eIDAS Integration Design	Technical	216.96	5	1,084.80
		Process Design		3	
		Technical Design Document		2	
FC3	e-IDAS Integration: init Tasks	Technical	216.96	10	2,169.60
		Familiarization with eIDAS specs		3	
		Preparatory Actions (SAML or OIDC message, encryption, configuration, code		4	

Document name:	D7.2 Report on Cost Benefit Assessment					Page:	30 of 74
Reference:	D7.2	Dissemination:	PU	Version:	1.025	Status:	Final

		modifications etc.)*				
		Connection with the eIDAS Node			3	
FC4	Service Customization/Re-design		Technical	216.96	18	3,905.28
		Add of new components (in the case of a major re-design)			8	
		Customization development (DB and back-end modifications, eIDAS login signs and front-end modifications etc.)			7	
		English version			2	
		"How to Use" text writing			1	
FC5	Service Integration with the eIDAS Network		Technical	216.96	3	650.88
		UI Layer (country form, auth-failure pages, other Uis)			1	
		Mobile Responsiveness			1	
		Help Pages			1	
FC6	Pre-production Deployment		Technical	216.96	4	867.84
		Pre-production Deployment			4	
FC7	Identities Consolidation (local, eIDAS, other)		Technical	216.96	6	1,301.76
		Solution Design			3	
		Deployment			1	

Document name:	D7.2 Report on Cost Benefit Assessment				Page:	31 of 74
Reference:	D7.2	Dissemination:	PU	Version:	1.025	Status: Final

		Testing			2	
FC8	Main Testing		Technical	216.96	5	1,084.80
		Functional Testing (integration with the eIDAS Network/ pre-production and production)			2	
		Usability Testing			2	
		User Acceptance Testing			1	
FC9	Service Update after Identities Consolidation and Testing		Technical	216.96	4	867.84
		Production Version (20% FC3+FC4)			4	
FC10	Production Deployment		Technical	216.96	5	1,084.80
		Security Analysis (Verification)			1	
		Peak-load and Performance Testing			2	
		Final Deployment Testing			2	
FC11	Internal Support		Management/Technical	216.96	14	3,702.16
		Dev/Support Teams Training	50-50%	311.92	10	
		Documentation			3	
		Other			1	
FC12	Technical Management		Management	311.92	9	2,807.28
		Technical Management			9	
FC13	Project Management		Management	311.92	8	2,495.36
		Project Management			8	
SUM FC	SUM FC				96	23,107.20

Document name:	D7.2 Report on Cost Benefit Assessment				Page:	32 of 74
Reference:	D7.2	Dissemination:	PU	Version:	1.025	Status: Final

3.4.4 Cost model CAPEX Results: Summary

Table 7: SP eIDAS Integration model Up-front Costs - Summary of Architecture Options

SP Integration Scenario	Working Days needed	Cost (in EUR)
Build from scratch (Scenario 1)	174	41,739.36
Build by using CEF Demo SP (Scenario 2)	140	33,792.96
LEPS eIDAS API Connectors (Scenario 3)	108	25,734.46
LEPS eIDAS Connectors with Learning Effects (Scenario 3B)	96	23,107.20

It is clear that in all cases, the use of LEPS eIDAS API Connectors reduce the necessary up-front investment in a percentage between 20 and 25%.

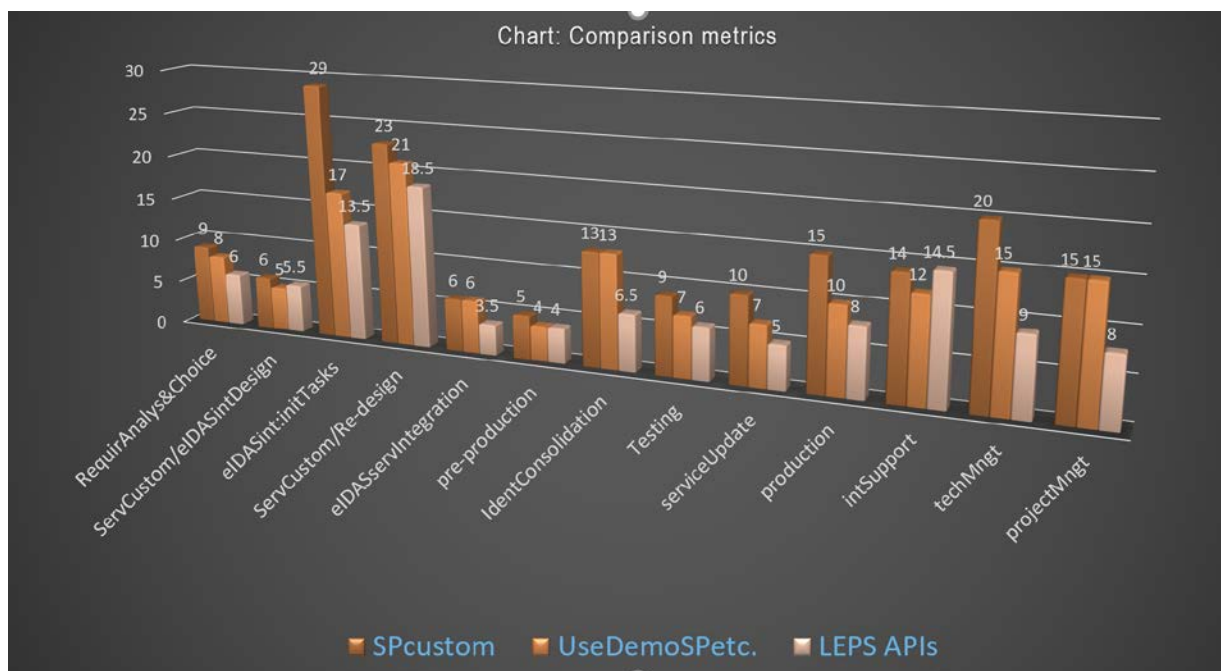


Table 8: SP eIDAS Integration Architecture Options – Comparison Metrics

3.5 Principal Cost Categories: Operational Expenses (Dynamic Costs)

Similar to fixed (up-front) costs, the costs related to the operation of the integration with the eIDAS Network, are decomposed into the following categories:

Document name:	D7.2 Report on Cost Benefit Assessment					Page:	33 of 74
Reference:	D7.2	Dissemination:	PU	Version:	1.025	Status:	Final

1. Hosting Hardware Acquisition (in EUR - depreciation in 3Y)
2. Hosting Services (EUR per year)
3. SSL certificates (EUR per year)
4. Other Hosting Costs (EUR per year)
5. eIDAS Network Integration Software Update (EUR per year)
6. Cost of sustaining eIDAS eID based profiles (EUR per year)
7. Project Management (EUR per year)
8. Other Operational Costs (EUR per year)

We have also considered the following estimation of Operational (Expenditure) Costs, (as already mentioned, in this case costs can be considered to be per year of operation):

Table 9: Description of Activities related to eIDAS Integration operation

a/a	Type of Operational Expenses	Description Details
DC1	Hosting Hardware Acquisition (in EUR - depreciation in 3Y)	Number of required Servers: 3 - 1Y contract: 3.000EUR 3Y 7.200EUR
DC2	Hosting Services (in EUR)	20% of DC1
DC3	SSL certificates (in EUR)	Number of required SSLs: 2 - 1Y contract 1.200 3Y 2.520 per certificate
DC4	Other Hosting Costs (in EUR)	5% of (DC1+DC2+DC3)
SUM DC1-4	SUM DC1-4 (EUR) – over 3Y	EUR
DC5	eIDAS Network Integration Software Update (in EUR)	$C_{update}=0.1*initialCost+0.1*X_{26}+0.3*X_{33}+0.5*X_{38}+0.3*X_{42}+0.2*(X_{46}+X_{48})$
DC6	Cost of sustaining eIDAS eID based profiles (in EUR, see below)	Assumption: 100.000 customers - 10% eIDAS eID 0,.10 EUR per profile
DC7	Project Management (in EUR)	10% of (DC5+DC6)
DC8	Other Operational Costs (in EUR)	5% of (DC5+DC6+DC7)
SUM DC5-8	SUM DC5-8 (in EUR) - annually	EUR
SUM DC	SUM DC - annually	EUR

The above Table explains in detail the estimation strategy for the Operations Costs, we should however define in more detail two types of expenses:

- eIDAS Network Integration Software Update

It is the annual cost of software update (i.e. deploying a new software release) to cover security and other fixed costs and eventually adaptations to not-significant changes of the technical structure of eIDAS Network. It is estimated as part of the initial costs, according to the following formula:

$C_{update}=0.10*Initial\ Cost+0.1*X_{26}+0.3*X_{33}+0.5*X_{38}+0.3*X_{42}+0.2*(X_{46}+X_{48})$, where:

X26: Pre-production Deployment

Document name:	D7.2 Report on Cost Benefit Assessment					Page:	34 of 74
Reference:	D7.2	Dissemination:	PU	Version:	1.025	Status:	Final

X33: Main Testing / Functional Testing (integration with the eIDAS Network/ pre-production and production)

X38: Production Deployment

X42: Internal Support

X46: Technical Management

X48: Project Management.

- Cost of sustaining eIDAS eID based profiles

It is the additional cost for sustaining customer profiles, for eIDAS users who sign in through SAML (or OIDC), such as the eIDAS Network⁸.

Cost per unit in EUR (per eIDAS eID-based User Account)	0.10
Compare between:	
(I) A CIAM ⁹ with Users who sign in directly with their User Pool credentials or with Social Identity Providers (per user per month)	0.0055
Yearly	€0.06
(II) A CIAM with Users who sign in through SAML or OIDC federation, such as the eIDAS Network (per user per month)	0.0150
Yearly	€0.16
Cost of sustaining eIDAS eID based profiles (per user per year): II-I	€0.10

3.6 OPEX: Cost Model

The cost model shows again differences between the 3 scenarios. The results obtained for the different model have as follows:

3.6.1 Architecture Option 1 – A SP uses its own custom software to connect to an eIDAS Network Node

Table 10: SP Integration Architecture Option 1 – Operational Expenses

a/a	Type of Operational Expense	cost in EUR
DC1	Hosting Hardware Acquisition (in EUR - depreciation in 3Y)	21,600.00
DC2	Hosting Services (in EUR)	4,320.00
DC3	SSL certificates (in EUR)	5,040.00
DC4	Other Hosting Costs (in EUR)	1,548.00
SUM DC1-4	SUM DC1-4 (EUR) - over 3Y	32,508.00

⁸ Source - <https://aws.amazon.com/cognito/>

⁹ CIAM: Customer Identity Access Management Software, used for creating and supporting customer profiles.

Document name:	D7.2 Report on Cost Benefit Assessment					Page:	35 of 74
Reference:	D7.2	Dissemination:	PU	Version:	1.025	Status:	Final

DC5	eIDAS Network Integration Software Update (in EUR)	8,665.01
DC6	Cost of sustaining eIDAS eID based profiles (in EUR, see below)	12,038.40
DC7	Project Management (in EUR)	2,070.34
DC8	Other Operational Costs (in EUR)	1,138.69
SUM DC5-8	SUM DC5-8 (in EUR) - annually	23,912.44
SUM DC	SUM DC – annuallyAVG (SUM DC5-8 plus 1/3SUM DC1-4)	34,748.44

3.6.2 Architecture Option 2 – A SP uses the CEF Demo SP module (eIDAS Node v1.x) to connect to an eIDAS Network Node

Table 11: SP Integration Architecture Option 2 – Operational Expenses

a/a	Type of Operational Expense	cost in EUR
DC1	Hosting Hardware Acquisition (in EUR - depreciation in 3Y)	21,600.00
DC2	Hosting Services (in EUR)	4,320.00
DC3	SSL certificates (in EUR)	5,040.00
DC4	Other Hosting Costs (in EUR)	1,548.00
SUM DC1-4	SUM DC1-4 (EUR) - over 3Y	32,508.00
DC5	eIDAS Network Integration Software Update (in EUR)	6,828.96
DC6	Cost of sustaining eIDAS eID based profiles (in EUR, see below)	12,038.40
DC7	Project Management (in EUR)	1,886.74
DC8	Other Operational Costs (in EUR)	1,037.70
SUM DC5-8	SUM DC5-8 (in EUR) - annually	21,791.80
SUM DC	SUM DC – annuallyAVG (SUM DC5-8 plus 1/3SUM DC1-4)	32,627.80

3.6.3 Scenario 3 – A SP uses off-the-shelf software to connect to an eIDAS Network Node (LEPS API Connectors)

Table 12: SP Integration Architecture Option 3 – Operational Expenses

a/a	Type of Operational Expense	cost in EUR
DC1	Hosting Hardware Acquisition (in EUR - depreciation in 3Y)	21,600.00
DC2	Hosting Services (in EUR)	4,320.00
DC3	SSL certificates (in EUR)	5,040.00
DC4	Other Hosting Costs (in EUR)	1,548.00
SUM DC1-4	SUM DC1-4 (EUR) - over 3Y	32,508.00
DC5	eIDAS Network Integration Software Update (in EUR)	5,372.23
DC6	Cost of sustaining eIDAS eID based profiles (in EUR, see below)	12,038.40
DC7	Project Management (in EUR)	1,741.06
DC8	Other Operational Costs (in EUR)	957.58
SUM DC5-8	SUM DC5-8 (in EUR) - annually	20,109.28
SUM DC	SUM DC – annuallyAVG (SUM DC5-8 plus 1/3SUM DC1-4)	30,945.28

Document name:	D7.2 Report on Cost Benefit Assessment					Page:	36 of 74
Reference:	D7.2	Dissemination:	PU	Version:	1.025	Status:	Final

3.7 Cost Model: CAPEX and OPEX summary

Table 13: SP eIDAS Integration model Up-front Costs - Summary of Architecture Options

Integration Scenario	CAPEX Cost (in EUR)	OPEX Cost (in EUR)
Build from scratch (Scenario 1)	41,739.36	34,748.44
Build by using CEF Demo SP (Scenario 2)	33,792.96	32,627.80
LEPS eIDAS API Connectors (Scenario 3)	25,734.46	30,945.28
LEPS eIDAS Connectors with Learning Effects (Scenario 3B)	23,107.20	30,190.77

Document name:	D7.2 Report on Cost Benefit Assessment				Page:	37 of 74
Reference:	D7.2	Dissemination:	PU	Version:	1.025	Status: Final

4 SP integration with the eIDAS Network: A Cost-Benefit Analysis

4.1 Introduction

To help Service Providers to build the business case for the integration of their services to eIDAS Network, we develop a Service Provider (SP) benefit model. The aim of this model is to assess the possible benefits and return on investment of a (reference) Service Provider (SP) who decides to offer eIDAS eID-based services in e-Commerce transactions. The model is based on the cost analysis of the previous section, but it also incorporates a number of key assumptions on how the effective use of the eIDAS eID for user authentication may introduce non-negligible cost savings, thus reducing SP's expenses for customer identity management. These assumptions and parameters are based on inquiries and desktop research, similar models for IAM investments costs-benefits assessment¹⁰, conversations with online service providers and policy makers, and other sources. The accompanying tool helps SP's executives customize and quantify benefits from integrating with the eIDAS Network, building their own benefit model.

Download the accompanying tool from:

https://drive.google.com/drive/folders/1_L6Y16X671tCG9wx8KfHdB17clydYJrW

Essentially, the model synthesizes progressively the potential benefit of a SP integrating with the eIDAS Network for a reference medium-sized e-commerce company, i.e. an Internet Retailer, while showing the procedures taken to gather information for each of the calculation steps. The model runs on MATLAB but it is also provided as a spreadsheet-based tool that can be downloaded and customized to the specific context and dataset of a any other reference of real SP. The reference Internet Retailer considered here, has the following profile:

Reference e-commerce SP (Internet Retailer)
Area of activity: e-commerce
of Customers: 100.000
Average # of transactions per Year per customer: $18.4^{11} \cdot 0.005 = 0.09$
Average Amount Spent per Transaction (EUR): 166.03 ¹²
Annual Turnover Rate (Churn): 5%
Model Timespan: 3 Years

¹⁰ Forrester, 2012, Use Commercial IAM Solutions To Achieve More Than 100% ROI Over Manual Processes, available at

https://www.servicecontrol.com/wp-content/uploads/2014/07/Forrester_Whitepaper_IAM_Solution_ROI.pdf

E. Heino, 2011, Evaluating financial benefits of an identity management solution: the CASE Logica, Master's, Aalto University, School of Economics, available at <https://aaltodoc.aalto.fi/handle/123456789/632>

¹¹ Source: KPMG, 2017, The truth about online consumers, Global Online Consumer Report, available at <https://assets.kpmg.com/content/dam/kpmg/xx/pdf/2017/01/the-truth-about-online-consumers.pdf>

¹² ibid.

Document name:	D7.2 Report on Cost Benefit Assessment					Page:	38 of 74
Reference:	D7.2	Dissemination:	PU	Version:	1.025	Status:	Final

In our model, we assume that the reference SP company has already implemented a Customer Identity Access Management Solution (CIAM) for both identity management and marketing purposes. SP CIAM allows SP's web and mobile users to sign in with local credentials (User Pool – UP) and, also, through a third-party Social Identity Provider (SIP). By integrating its services and IT infrastructure with the eIDAS Network, the SP offers its users, additionally to UP and SIP authentication modes, the option to sign in through eIDAS eID. This report compares the following two customer identity management scenarios:

1. **Conventional CIAM (Conv. CIAM):** Users sign in with directly with their UP credentials and through a Social Identity Provider (SIC)
2. **CIAM integrated with the eIDAS Network:** Offers Users the additional option to sign in with their eIDAS eID credentials

to quantify the benefit a SP receives from adopting Scenario 2, i.e. the profit obtained because of the eIDAS eID adoption (user authentication via the eIDAS Network), essentially created by cost savings and ARPU increase.

4.2 Costs and Gains from a “CIAM integrated with the eIDAS Network” solution: Model data preparation

In order to provide its Users the additional option of eIDAS eID-based authentication, the reference SP should make the up-front investment presented in the previous section, and cover the necessary operational costs, also explained in detail in the previous section. We assume that the reference SP integrates the eIDAS Network via **Architectural Option 3 – “SP uses off-the-shelf software to connect to an eIDAS Network Node, such as LEPS API Connectors”**. In this case, the induced costs have as the following Table shows (calculated on an annual basis):

Table 14: SP eIDAS integration costs as input to estimate benefits

	Description (EUR per year*)	Arch. 3 (AVG)
Development Integration	Up-front Costs	8,578.15
	Total	8,578.15
Up-front & Operational Costs	Hosting Hardware Acquisition	7,200.00
	Hosting Services	1,440.00
	SSL certificates	1,680.00
	Other Hosting Costs	516.00
	Total	10,836.00
	eIDAS Network Integration Software Update	5,372.23
	Cost of sustaining eIDAS eID based profiles	12,038.40
	Project Management	1,741.06
	Other Operational Costs	957.58
	Total	20,109.28
Grand Total		39,523.43

Document name:	D7.2 Report on Cost Benefit Assessment					Page:	39 of 74
Reference:	D7.2	Dissemination:	PU	Version:	1.025	Status:	Final

We also assume that the SP integration with the eIDAS Network induces two categories of benefits, tangible and intangible ones¹³. Tangible benefits are measurable and easier to implement into the model, while intangible benefits are harder to estimate and conclude in financial terms. According to the literature, intangible benefits are mostly related to business agility (more business opportunities, efficiency etc.) and growth of user demand (because users receive more utility from the service), and mostly relate to an increase of revenues¹⁴. Source of tangible benefits is usually a process of automation and/or service improvement that introduces a cost decrease. In this model, we assume the following sources of cost savings because of SP integration with the eIDAS Network (cost savings are marginal benefits of sign in with eIDAS eID, compared with authentication via Pool User or a Social Identity Provider). Based on the related literature and information collection through the Web, sources of cost saving are considered the following ones:

- Relatively Safety (S1)
 - Reduce Identity Data Monitoring Costs
 - Reduce E-commerce Risk
- Simplified User Management (S2)
 - Labor Costs (S2.1)
 - Identity Administration Costs
 - Security Costs
 - Auditing-Compliance Costs

Table 15: Reference SP Cost Savings Sources

SP Cost Savings Sources	
Relative Safety - S1 (Cost Savings) [S1.1+S1.2]	3,626.12
Decrease Costs compared to a Conventional CIAM solution	
A CIAM with Users who sign in directly with their User Pool credentials or with Social Identity Providers	
Reduce Identity Data Monitoring Costs (S1.1)	3,094.53
Comment: With eIDAS eID, part of the administrative burden of user profiling is moved from the SP to the IdP; as a result, redundancy and information inconsistencies in identity information can be avoided, and the processing of user's identity information can be optimized	
Operations Expenses - eIDAS users (EUR)	30,945.28
Percentage of operational expenses directly related to bad data (20-30%)	0.20
Savings related to the reduction of operational expenses because of the use of eIDAS eID (5%) (EUR)	3,094.53
Reduce E-commerce Risk (S1.2)	531.59
Comment: Ecommerce fraud (or purchase fraud) is one of the biggest threats to online retail and it is increasing	
Online Retailers lose a percentage of revenue to fraud (%)	1.50

¹³ See also:

¹⁴ In this regard, see in particular: PwC, 2018, Study on a marketing plan to stimulate the take-up of eID and trust service for the Digital Single Market, A study prepared for the European Commission DG Communications Networks, Content & Technology, available at

https://ec.europa.eu/futurium/en/system/files/ged/study_on_marketing_plan_takeupeidas_final_report.pdf

Document name:	D7.2 Report on Cost Benefit Assessment			Page:	40 of 74
Reference:	D7.2	Dissemination:	PU	Version:	1.025
				Status:	Final

Revenue from eIDAS eID users	177,196.12
Savings related to the reduction of losses related to fraud because of the use of eIDAS eID (0.3% of revenue) (EUR)	531.59
Simplified User Management - S2 (Cost Savings) [S2.1+S2.2+S2.3+S2.4]	15,459.09
Decrease Costs compared to a Conventional CIAM solution	
A CIAM with Users who sign in directly with their User Pool credentials or with Social Identity Providers	
Labor Costs (S2.1)	446.78
Comment: Benefiting from reducing CIAM maintenance personnel	
Cost of CIAM maintenance (a ICT technician's 1Y salary) (EUR)	44,678.40
Savings related to the use of eIDAS eID (10% reduction of maintenance costs for eIDAS users) (EUR)	446.78
Identity Administration Costs (S2.2)	2,935.54
Comment: Benefiting from reducing Help Desk costs, essentially the costs related with password reset	
Help Desk cost per call (password reset etc) (EUR)	2.64
Requests per Year (CIAM)	1
Concerned population (%)	0.2
Savings related to the use of eIDAS eID (smaller concerned population / 10%) (EUR)	2,935.54
Security Costs (S2.3)	11,076.77
Comment: Benefiting from reducing the probability of Account Takeover (ATO)	
Probability of account takeover 1% < 6.6% / average (increases at 8% per year)	0.01
Cost per successful takeover (the cost of an online purchase with an overhead of 20%) (EUR)	199.232
ATO Risk Realizing (eIDAS users) (EUR)	22,153.53
Savings related to # of eIDAS eID Users (50% lower probability of account takeover)	11,076.77
Auditing-Compliance Costs (S2.4)	1,000.00
Comments: Benefiting from reducing the cost of auditing personnel	
Auditing Costs (total number of users) (EUR)	20,000.00
Savings related to the use of eIDAS eID (50% reduction of auditing costs)	1,000.00

4.3 SP Benefit Analysis: Methodological Considerations

As already explained, the aim of this study is to assess the possible benefits and return on investment of a reference Service Provider (SP) offering eIDAS eID services in e-commerce transactions.

Internet retailers today, and many other Online Service Providers, have numerous visitors, user accounts and daily transactions that make that kind of analysis highly challenging. Cost-benefit analysis (CBA) and other partial equilibrium models imply that the analysis only considers the effects of a given action in the market(s) that are directly affected; that is, the analysis does not account for the economic interactions between the various segments in a given framework.

Document name:	D7.2 Report on Cost Benefit Assessment					Page:	41 of 74
Reference:	D7.2	Dissemination:	PU	Version:	1.025	Status:	Final

As discussed before, in an online business, like our reference SP, there are costs generated by the introduction of eIDAS eID-based authentication functionality, but also benefits that result from a possible increase in user demand and/or cost savings that can only take effect if the eIDAS eID value is actually appreciated by the users (or customers). In modern economics terms, this means that the benefits should be measured to the consumer and the costs to the firm. This is where customer LifeTime Value (LTV) analysis comes in.

In business lingo, “customer lifetime value is a prediction of the net profit attributed to the entire future relationship with a customer.” There are various methods of calculating customer lifetime value. These models take into account the expected benefits that the customer might bring and also the burden on the company in acquiring, retaining, and serving that customer. These would include costs related to development of the functionality, maintenance costs, service costs, and so on. Additionally, indirect benefits like the effect of word-of-mouth, social media referrals, reviews, etc. (of top importance in the e-commerce business), can also be considered.

The three main advantages of using customer lifetime value analysis in this study are:

- Know where each user stands and spend appropriately

The first step is to group users based on their profitability and retention proclivity. This will give a fair idea of where users stand. The aim is to identify why the top users are loyal and use those insights in our case to capture and retain the “eIDAS eID” users. LTV can help the SPs to define an eIDAS eID user-specific communication strategy with better segmentation of users.

- Know the upper limit of spending on acquiring new users

The advantage of LTV is that it gives a money figure for each user. One can predict how much each user will cost you and how much profit they might generate. This will also provide a clear picture of how much money an SP can spend on acquiring, retaining and serving those users. LTV calculations can help allocate the right budgets for different types of users in the value chain. Moreover, LTV calculations might also help identify which channels of user acquisition are bringing in the best value users. This will enable SPs to invest more on channels that work and reduce their spending on the channels that are bringing low-value users.

- Forecast future revenues

Customer lifetime value calculations can help focus on the long-term profits instead of acquiring cheap users today. The “lifetime” of a user varies for different businesses. For instance, an e-commerce (SP) retailer might consider customer lifetime to be 2-4 years. By using an LTV model, one can calculate the proportion of purchase, the probability of purchase and repurchase, purchase frequency and sequence for individual customers and this might give a clearer picture of the probable revenue that one can expect from their current customer base.

4.4 LTV definition and metrics

There is an abundant literature relating to the measurement of LTV. A cursory review has revealed two major approaches, namely the aggregate and the disaggregate approach. In the aggregate approach, the lifetime value of a customer is derived as an average of the lifetime values of a cohort or the entire

Document name:	D7.2 Report on Cost Benefit Assessment					Page:	42 of 74
Reference:	D7.2	Dissemination:	PU	Version:	1.025	Status:	Final

customer base of a company. In the disaggregate approach the customer lifetime value is calculated as the sum of the cash flows (discounted to present values) generated by a customer over his lifetime with a company.

The most typical example of an aggregate model is given by Venkatesan and Kumar (2004)¹⁵. They propose a model that calculates ‘customer equity’ (another form for customer value) as the averaged sum of lifetime values of all the customers of a company (Eq. 1):

$$CE = \sum_{i=1}^I \sum_{t=1}^T CM_{it} \left(\frac{1}{1+d} \right)^t \quad (1)$$

where, CE is the customer equity in monetary terms (sum of individual lifetime values); CM is the contribution margin¹⁶ in time period t ; d is the discount rate; i is the customer index; t is the time period; and T is the number of time periods for which CE is being estimated.

Average LTV can be derived by dividing CE by the number of customers.

Likewise, a textbook example of a disaggregate approach, is the model presented by Bayòn et al. (2002) for assessing individual customer lifetime (Eq. 2):

$$LTVc = [Cc + WOMc] * Wc \quad (2)$$

where $LTVc$ is the lifetime value of customer c ; Cc is the sum of cashflows (discounted to present values) of customer c over his lifetime with the company; $WOMc$ is the revenue from customers acquired via word-of-mouth recommendations of customer c ; and Wc is a weighting factor depending on the product’s potential value and the characteristics of the lead customer c .

To assess LTV Bayòn et al. (op. cit) calculate customer acquisition probability and retention periods based on observations from past customers. Their model does not take explicit account of factors that

¹⁵ References on the subject of LTV:

Bayòn, T., Gutsche, J. and Bauer, H. (2002) ‘Customer equity marketing: touching the intangible’, European Management Journal, Vol. 20 No. 3, pp.213-222.

Breslow, N.E. (1975) Analysis of Survival Data under the Proportional Hazards Model, International Statistical Review / Revue Internationale de Statistique, Vol.43, No.1, pp.45–57.

Cox, D.R. (1972) Regression models and life tables, Journal of the Royal Statistical Society, Vol. B, No.34, pp.187–220.

Hale, K. (2009) ‘On converting free users to paid users’, in Proceedings of the Future of Web Apps International Conference, Miami, USA.

Morecroft, J. (1985) Rationality in the analysis of behavioral simulation models, Management Science, Vol. 31, No.7, pp.900–916.

Novo, J. (2006). [online] Maximizing marketing ROI with customer behavior analysis, <http://www.drilling-down.com> (Accessed May 8, 2013)

Simon, H. (1982) Models of Bounded Rationality, MIT Press, Cambridge, MA, USA.

Stahl, H.K., Matzler, K. and Hinterhuber, H.H. (2003) ‘Linking customer lifetime value with shareholder value’, Industrial Marketing Management, Vol. 32 No. 4, pp.267-279.

Venkatesan, R. and Kumar, V. (2004) ‘A customer lifetime value framework for customer selection and optimal resource allocation strategy’, Journal of Marketing, Vol. 68 No. 4, pp.106-125.

¹⁶ The contribution margin is the marginal profit per unit of sale

Document name:	D7.2 Report on Cost Benefit Assessment					Page:	43 of 74
Reference:	D7.2	Dissemination:	PU	Version:	1.025	Status:	Final

can affect a customer's LTV, for instance, the customer's individual characteristics, the customer service performance, service quality and/or customer satisfaction. Rather, it captures the possible effect such factors may have, holistically—inferred from the observed customer data.

In a nutshell, there is a range of LTV models of varying structural and computational complexity that could be used for the purposes of this research. This range spans from the very simplistic approaches, ignoring completely the different factors that can affect LTV, to complex proportional hazards model (Cox, 1972; Breslow, 1975) using numerous customer and service properties as predictors. Although simplistic approaches may result in trivializing reality, too complex and elaborate models may turn out to be of less practical use, because they are modeling 'local' effects relevant only for the present, or simply because there is not enough data to estimate them properly (Novo, 2006). So to build practical and useful LTV models a balance must be stroked between complexity and effective use of available resources. Our approach, presented in section 2, employs a model that uses holistic estimates of LTV predictors to capture business and customer decision heuristics. This is done for reasons of simplicity and better intuitive understanding.

It should be noted that the accuracy of a generic model such as LTV depends on the quality of input data which, for the needs of this study, has been delivered by other LEPS project activities. Analytical discussion on how this data was prepared has been already presented in subsection 4.2.

4.5 Model Methodological Specifications

As stressed above, there are several models to estimate customer's worth to a company but their inherent difficulty to predict future purchase behaviours has resulted in increased complexity and made their real-world application problematic. Also, the benefits of using a complex model are relatively small as compared to the effort required to implement the model (Stahl et al., 2003). For these reasons we suggest the following approach in order to assess the customer lifetime value of an eIDAS-based CIAM strategy.

The starting point of our approach is this principle: for such a strategy to become profitable, the following simple equation (Eq. 3) must hold true:

$$\text{Lifetime value} > \text{Cost per acquisition} + \text{Cost of service (conventional CIAM* \& eIDAS eID-based)} \quad (3)$$

**Users who sign in directly with their User Pool (UP) or Social Identity Providers (SIP) credentials; hereafter UP/SIP users*

This means that the lifetime value of the eIDAS eID user needs to be greater than the cost it took to acquire them, plus, the cost of servicing all users (Conv or eIDAS eID).

Building on this principle, our approach also takes account of the following requirements:

Document name:	D7.2 Report on Cost Benefit Assessment					Page:	44 of 74
Reference:	D7.2	Dissemination:	PU	Version:	1.025	Status:	Final

Base Potential: addressing cashflow from services that form the core of the business-customer relationship. Cost of acquisition, development and retention are assessed over the duration of the relationship's lifetime.

Networking potential: it includes cashflow from new users acquired through customer's word-of-mouth referrals. Referrals have a double effect: (a) they may lead to additional sales and lower acquisition costs as new customers are attracted through word-of-mouth advertising; and (b) they can increase the effectiveness of advertising and promotion to the extent customers develop a more favourable attitude towards the seller's communication strategies.

Learning potential: it includes cashflow from knowledge created by interaction within the seller-customer relationship. Such knowledge can be, for instance, about market conditions (competitors, customers, channels, suppliers, etc), technologies and business processes or future trends. The learning potential can be factored in the LTV conversion rates and retention assumptions to reflect the impact on customers' future purchase behaviour.

Based on these requirements and in accordance with the eIDAS structural and technical characteristics, the customer value of an eIDAS-based CIAM strategy can be assessed in five consecutive steps:

User acquisition: includes making decisions on how new users are acquired, what are the primary advertising suggestions and how they are paid for;

UP/SIP-to-eIDAS eID conversion: deals with the assessment of the number of acquired users, and estimates the proportion of UP/SIP users converting to eIDAS eID customers by taking account of possible viral effects and learning potential;

User retention: adjusts the resulting user funnel through time by introducing churn rates and building user retention matrixes;

Cashflow analysis: Calculates the flow of costs and revenue over time.

LTV calculation: Estimates the revenue that users will generate over their lifetime with the reference e-Commerce company.

4.6 Financial Viability Assessment

With the eIDAS-eID based CIAM strategy being the offering designed to deliver value via an e-commerce business example the LTV model is applied with the aim of assessing the viability of the strategy. Based on the methodology outlined in section 2 this is done in five consecutive steps:

- User acquisition
- UP/SIP-to-eIDAS conversion
- User retention
- Cashflow analysis
- LTV calculation

Document name:	D7.2 Report on Cost Benefit Assessment					Page:	45 of 74
Reference:	D7.2	Dissemination:	PU	Version:	1.025	Status:	Final

4.6.1 User acquisition

To grow their share of the market, the reference e-Commerce business strives to retain and expand their user base. This may require: (a) focusing on current market differences, which leads to greater tailoring of offerings to better meet user preferences and/or; (b) building on commonalities in what users value, which allows the promoters to reach beyond the current market and to unlock the mass of nonusers.

Here we take up the first of these points, while the second (attempts to capture tiered levels of nonusers) is an area that remains for future investigative research.

In the current market there are two (2) categories of users, namely the old users and the new users. The new users correspond predominantly (but not exclusively) to cross-border customers who benefit most from our SP, through achieving better economies, as well as better transactions' security and higher LoA resulting from the SP's eIDAS eID capabilities. But, to attract those new users SPs should make themselves known through online marketing and digital advertisement. There is little likelihood that any international audience will be overwhelmed by the eIDAS eID value and beat their way to the door of the SP, unless there is a running advertising campaign to communicate that value. It is therefore safe to assume that the majority of new users will be either ad or virally acquired users; with the first entailing significant acquisition costs.

Whether a user will remain in the funnel and bring additional value to the company depends little on the employed CIAM strategy. Instead, it is dependent on a number of factors linked to the user characteristics and the overall value deliverance of the e-Commerce business, i.e.: performance, servicing, quality, eco-value and emotional satisfiers. At present, these factors are addressed by the model holistically to capture business and customer decision heuristics. The rationale behind this approach is the following: The e-Commerce business managers monitor user funnel conditions including conversion and retention rates, and adjust their customer service performance accordingly. But their rationality is bounded: in the tradition of Simon (1982) and Morecroft (1985), the business managers make decisions using routines and heuristics because the complexity of the decision environment often exceeds their ability to optimize even with respect to the limited information available to them. Here we draw on the literature cited above and the well-established tradition of bounded rationality and assume that our reference managers make business decisions based on customer value with intendedly rational decision heuristics. This 'local' rationality of managers has been built in our model in such a way so that the model generates different results when service and marketing options exist that allow the business value to be adjusted in a sufficiently quick manner relative to the dynamics of demand, such that the forecasts and estimates of the user acquisition plans remain reasonably accurate. Thus, in our model, user acquisition and churn are modelled with realistic boundedly heuristics reflected by the conversion and retention rates¹⁷. This is obviously a second-best solution which along with the fact that no inclusion measure for chance users is employed, may limit the accuracy of the model.

¹⁷ Apparently those heuristics are linked to very good knowledge of the eIDAS advantages, such as higher LoA, more privacy, trust in government as IdP etc—for a more detailed discussion on the conversion rate see section 5.2 and for the retention rate section 5.3 below.

Document name:	D7.2 Report on Cost Benefit Assessment					Page:	46 of 74
Reference:	D7.2	Dissemination:	PU	Version:	1.025	Status:	Final

To assess the number of old users and ad-user acquisitions our model uses the following assumptions:

The reference company has a user base of nearly 100,000 (100 thousand) users;

As many online businesses do, the reference firm will rely on AdWords and ad network buys in order to acquire users. The following decisions have to be made:

- How advertisement is to be paid for? (CPM/CPA/CPC¹⁸)
What do the intermediate metrics look like? (impressions/CTR¹⁹/etc.)
- How does the signup funnel perform?

Then the media buying matrix of the following Table 16 can be filled which includes Google and Facebook as primary advertising suggestions. Note that the selected costs per unit of traffic are indicative of an e-Commerce SME ad campaign.

Table 16: Media buying matrix

Category	Source	CPC ²⁰	Impressions / month	CTR ²¹	Clicks / month	Signup ²² %	Registered users / month	Monthly Cost ²³	CPA
New Users	Google ads	1,00 €	500.000	1,06%	5.275	1,4%	76	5.275 €	69,69 €
	Facebook ads	1,70 €	250.000	1,00%	2.500	9,2%	230	4.250 €	18,48 €
Total			750.000	1,04%	7.775	3,9%	306	9.525 €	31,16 €

4.6.2 UP/SIP-to-eIDAS eID conversion

Once the users are willing to signup for the service, there is the question of how many will convert to eIDAS customers, and whether there are any word-of-mouth or viral effects. At a high level what is happening at this stage is the following:

- Each time period (12 time periods are used, corresponding to 3 calendar months, i.e. a quarter), a group of newly registered users come in (acquired through ads and/or viral marketing);
- Some % of these users convert into eIDAS eID users (they are calculated using the UP/SIP-to-eIDAS eID conversion factor of the Table 17);

¹⁸ CPM: Cost Per thousand impressions, CPA: Cost Per Acquisition, CPC: Cost Per Click.

¹⁹ CTR: Click Through Rate. It is obtained by dividing the number of users who clicked on an ad by the number of times the ad was delivered (impressions).

²⁰ Source: <https://www.wordstream.com/blog/ws/2015/05/21/how-much-does-adwords-cost>

²¹ Source: <https://www.wordstream.com/average-ctr>

²² Source: <https://searchenginewatch.com/2016/03/15/google-adwords-average-conversion-rates-by-industry-study/> and <https://www.quora.com/On-average-what-is-the-conversion-rate-of-Facebook-CPM-ads>

²³ Source: <https://www.smartinsights.com/managing-digital-marketing/planning-budgeting/much-budget-ecommerce-seo-ppc/>

Document name:	D7.2 Report on Cost Benefit Assessment				Page:	47 of 74	
Reference:	D7.2	Dissemination:	PU	Version:	1.025	Status:	Final

- Some % of these users then send off viral invitations (calculated using the invite conversion rate of the Table 7);
- Revenue is generated by building up a base of paying users;
- Cost is generated through building up a base of active users (paying or not).

The Table 17 shows the setup parameters for the user funnel and the virality effect. The UP/SIP-to-eIDAS conversion rates were selected as indicative of good-to-excellent quality services based on e-Commerce business heuristics. The conversion rate for the new users is greater than that of the old users as it factors in the quarterly equivalent of a 4.0% yearly average increase of cross-border trade (a model assumption), which is very likely that it will be mainly capitalized by sellers offering eIDAS eID-based CIAM capabilities.

The ad spend increase corresponds to a yearly increase of 15.8%²⁴. The cost per acquisition and the number of registered users are copied from Table 16. Further, the viral growth factor is estimated by multiplying the invite conversion factor (i.e. the % of users that send off viral invitations) by the number of invitations sent by the users.

Table 17: Setup parameters for user funnel and virality

Funel and Virality parameters		
Setup parameters	New user UP/SIP-to-eIDAS conversion rate	11%
	Old user UP/SIP-to-eIDAS conversion rate	10%
	CPA - Cost Per Acquisition (unadjusted for virality and STL)	31,16 €
	New registered users per quarter	917
	Ad spend increase %	5,3%
	Viral growth kicker	1
	Invite conversion rate %	20%
	Avg invites per quarter	5,00

Based on the above setup parameters the user funnel and virality matrices of Table 18 can be calculated. The virally acquired users are estimated by multiplying the total new users who registered in the preceding period by the viral growth factor. The eIDAS eID users are calculated as a percentage (UP/SIP-to-eIDAS eID conversion rate) of the total new users per period. Note that the adjusted CPA is the ratio of ad spend to total new users and that the ad acquired users increase with increasing ad spends.

²⁴ Source: <https://www.emarketer.com/content/emarketer-total-media-ad-spending-worldwide-will-rise-7-4-in-2018>

Document name:	D7.2 Report on Cost Benefit Assessment					Page:	48 of 74
Reference:	D7.2	Dissemination:	PU	Version:	1.025	Status:	Final

Table 18: User funnel and virality

Quarter	Old users	Ad acq users	Viral acq users	Ad spend	Total new users	Cumulative users	eIDAS users	Cum. eIDAS users	Adj CPA	Cumulative ad spend	Average adj CPA
Y1-Q1	100.000	917		28.575,00 €	917	100.917	10.101	10.101	31,16 €	28.575	5,29 €
Y1-Q2		965	917	30.079,95 €	1.882	102.800	207	10.308	15,98 €	58.655	
Y1-Q3		1.016	1.882	31.664,16 €	2.899	105.698	319	10.627	10,92 €	90.319	
Y1-Q4		1.070	2.899	33.331,81 €	3.968	109.667	437	11.063	8,40 €	123.651	
Y2-Q1		1.126	3.968	35.087,28 €	5.095	114.761	560	11.624	6,89 €	158.738	
Y2-Q2		1.185	5.095	36.935,21 €	6.280	121.041	691	12.315	5,88 €	195.673	
Y2-Q3		1.248	6.280	38.880,47 €	7.528	128.569	828	13.143	5,16 €	234.554	
Y2-Q4		1.314	7.528	40.928,17 €	8.841	137.410	973	14.115	4,63 €	275.482	
Y3-Q1		1.383	8.841	43.083,72 €	10.224	147.634	1.125	15.240	4,21 €	318.566	
Y3-Q2		1.456	10.224	45.352,80 €	11.680	159.314	1.285	16.525	3,88 €	363.919	
Y3-Q3		1.532	11.680	47.741,38 €	13.212	172.526	1.453	17.978	3,61 €	411.660	
Y3-Q4		1.613	13.212	50.255,76 €	14.825	187.351	1.631	19.609	3,39 €	461.916	

Document name:	D7.2 Report on Cost Benefit Assessment				Page:	1 of 74	
Reference:	D7.2	Dissemination:	PU	Version:	1.025	Status:	Final

4.6.3 User retention

For the reference company to be viable it is not enough only to acquire eIDAS eID users, there is need to retain them. That is crucial for every business as low retention might lead to a very high churn rate, which drives the business into a revenue treadmill with a lot of effort involved but flat revenue and no profitability. At worse, it is easy to end up with big losses if the CPA exceeds the LTV.

The most important factors affecting retention can be summarized in the following three:

- Service design
- Customer service quality
- In success cases, saturation effects.

The question that apparently arises is how sensitive is lifetime value on retention numbers? The literature says that by increasing the retention rate by half, revenue (thus LTV) is actually doubled (Hale, 2009).

It should be noted that retention rates are generally not fixed numbers—they usually increase the longer a cohort of users stays with the service and trust is built. In our case, however, we use a fixed retention number to set a lower bound, and for mathematical simplicity.

Assuming an average retention rate of 95%, which is an attainable figure for good-to-excellent quality services, the retention matrices of Table 19 (eIDAS eID users), Table 20 (UP/SIP users) and Table 21 (total users) can be calculated. Note that the values on the diagonal of these Tables represent new (eIDAS, UP/SIP or total) users that come in each time period (they are copied from columns ‘eIDAS users’ and ‘Total New Users’ of Table 18). By applying the retention factor on the new users the retained users are calculated for each reference period.

Table 19: eIDAS eID user rétention matrix

	Y1-Q1	Y1-Q2	Y1-Q3	Y1-Q4	Y2-Q1	Y2-Q2	Y2-Q3	Y2-Q4	Y3-Q1	Y3-Q2	Y3-Q3	Y3-Q4
Y1-Q1	10.101	9.596	9.116	8.660	8.227	7.816	7.425	7.054	6.701	6.366	6.048	5.745
Y1-Q2		207	197	187	178	169	160	152	145	137	131	124
Y1-Q3			319	303	288	273	260	247	234	223	212	201
Y1-Q4				437	415	394	374	356	338	321	305	290
Y2-Q1					560	532	506	480	456	434	412	391
Y2-Q2						691	656	623	592	563	535	508
Y2-Q3							828	787	747	710	674	641
Y2-Q4								973	924	878	834	792
Y3-Q1									1.125	1.068	1.015	964
Y3-Q2										1.285	1.221	1.159
Y3-Q3											1.453	1.381
Y3-Q4												1.631
eIDAS users only	10.101	9.803	9.632	9.587	9.668	9.875	10.209	10.671	11.263	11.984	12.838	13.827

Table 20: Conv, CIAM (UP/SIP only) user retention matrix[illegible]

UP/SIP users	90.816	87.951	86.133	85.358	85.625	86.933	89.286	92.690	97.155	102.692	109.316	117.044
--------------	--------	--------	--------	--------	--------	--------	--------	--------	--------	---------	---------	---------

Table 21: Total user (UP/SIP+eIDAS eID) retention matrix

	Y1-Q1	Y1-Q2	Y1-Q3	Y1-Q4	Y2-Q1	Y2-Q2	Y2-Q3	Y2-Q4	Y3-Q1	Y3-Q2	Y3-Q3	Y3-Q4
Y1-Q1	100.917	95.871	91.078	86.524	82.198	78.088	74.183	70.474	66.950	63.603	60.423	57.402
Y1-Q2		1.882	1.788	1.699	1.614	1.533	1.457	1.384	1.315	1.249	1.186	1.127
Y1-Q3			2.899	2.754	2.616	2.485	2.361	2.243	2.131	2.024	1.923	1.827
Y1-Q4				3.968	3.770	3.582	3.402	3.232	3.071	2.917	2.771	2.633
Y2-Q1					5.095	4.840	4.598	4.368	4.150	3.942	3.745	3.558
Y2-Q2						6.280	5.966	5.668	5.384	5.115	4.859	4.616
Y2-Q3							7.528	7.151	6.794	6.454	6.131	5.825
Y2-Q4								8.841	8.399	7.979	7.580	7.201
Y3-Q1									10.224	9.713	9.227	8.766
Y3-Q2										11.680	11.096	10.541
Y3-Q3											13.212	12.551
Y3-Q4												14.825
Total users (UP/SIP+eIDAS eID)	100.917	97.754	95.765	94.945	95.292	96.808	99.495	103.362	108.418	114.676	122.154	130.871

4.6.4 Cashflow analysis

Following the estimation of retention matrices, the cashflow analysis is performed to yield the flow of costs and revenue over time. The analysis considers three types of costs:

- *Development / Integration Costs*: they are labor costs.
- *Upstream & Support Costs*: they are capacity and support provision costs, calculated on a quarterly basis by assuming a range of total users; additional (incremental) users add incremental costs.
- *Total Costs*: the sum of development and capacity/support costs.

The development and capacity/support faced by the ref. SP company (Integration Architecture Option 3) are tabulated below.

Table 22: Cost structure

	Description (EUR per year*)	Arch. 1	Arch. 2	Arch. 3 (AVG)	Arch. 3 (LE)
Development/ Integration	Labour costs	13.913,12	11.264,32	8.578,15	7.702,40
	Total	13.913,12	11.264,32	8.578,15	7.702,40
Upstream & Support Costs	Hosting Hardware Acquisition	7.200,00	7.200,00	7.200,00	7.200,00
	Hosting Services	1.440,00	1.440,00	1.440,00	1.440,00
	SSL certificates	1.680,00	1.680,00	1.680,00	1.680,00
	Other Hosting Costs	516,00	516,00	516,00	516,00
	Total	10.836,00	10.836,00	10.836,00	10.836,00
	eIDAS Network Integration Software Update (in EUR)	8.665,01	6.828,96	5.372,23	4.718,98
	Cost of sustaining eIDAS eID based profiles (in EUR, see below)	12.038,40	12.038,40	12.038,40	12.038,40
	Project Management	2.070,34	1.886,74	1.741,06	1.675,74
	Other Operational Costs	1.138,69	1.037,70	957,58	921,66
	Total	23.912,44	21.791,80	20.109,28	19.354,77
Grand Total		48.661,56	48.661,56	43.892,12	39.523,43

Using the above cost structure, the quarterly cost of service per user for Arch. 3 (AVG) is determined in the following Table 23.

Table 23: Estimation of quarterly cost of service per user

Description	eIDAS eID-based	UP/SIP-based	Total (UP/SIP + eIDAS)
Avg # of users in a quarter-year period	1.634	13.979	15.613
Total quarterly cost (factoring in cost savings for eIDAS users)	6.813 €	13.174 €	12.509 €
Quarterly cost of service per user*	0,44 €	0,84 €	0,80 €
*corresponding to Arch. 1			

The next Table (Table 24) illustrates the variation of the cashflow in the 12-quarter reference period. In this Table, the 'eIDAS eID users', the 'UP/SIP users' and the 'total users' are copied from previous Tables (Tables 19, 20 and 21, respectively). The 'Revenue' is calculated by multiplying the 'Total Users' by the 'Avg quarterly revenue per user' and by factoring in (from Quarter 5 and onwards) the avg e-commerce ARPU increase rate in the calculations of the eIDAS eID users' revenue. The 'Ad spend' is obtained from the respective column of Table 16. The 'Cost of service' is determined by multiplying the 'Total Users' by the 'Quarterly cost of service' corresponding to the total (UP/SIP + eIDAS) users. The 'Total Cost' sums up the 'Ad spend' and the 'Cost of service'.

Table 24: Cash flow

Time period	Y1-Q1	Y1-Q2	Y1-Q3	Y1-Q4	Y2-Q1	Y2-Q2	Y2-Q3	Y2-Q4	Y3-Q1	Y3-Q2	Y3-Q3	Y3-Q4
eIDAS eID users	10.101	9.803	9.632	9.587	9.668	9.875	10.209	10.671	11.263	11.984	12.838	13.827
Conv CIAM users (UP/SIP only)	90.816	87.951	86.133	85.358	85.625	86.933	89.286	92.690	97.155	102.692	109.316	117.044
Total users (UP/SIP + eIDAS eID)	100.917	97.754	95.765	94.945	95.292	96.808	99.495	103.362	108.418	114.676	122.154	130.871
Revenue	4.624.360 €	4.479.404 €	4.388.262 €	4.350.697 €	4.371.042 €	4.440.576 €	4.563.875 €	4.741.267 €	4.978.433 €	5.265.895 €	5.609.351 €	6.009.706 €
Ad spend	28.575 €	30.080 €	31.664 €	33.332 €	35.087 €	36.935 €	38.880 €	40.928 €	43.084 €	45.353 €	47.741 €	50.256 €
Cost of service	80.854 €	78.319 €	76.726 €	76.069 €	76.347 €	77.561 €	79.715 €	82.812 €	86.863 €	91.878 €	97.869 €	104.853 €
Total cost	109.429 €	108.399 €	108.390 €	109.401 €	111.435 €	114.497 €	118.595 €	123.741 €	129.947 €	137.230 €	145.610 €	155.109 €

4.6.5 Lifetime value calculation

In this step the number of payments that a user will generate over their lifetime is estimated, referred to in Table 25, Table 26 and Table 27 ‘user periods’ (quarters). This is then multiplied by revenue per user, to get the ‘aggregate LTV’ generated.

Table 25, Table 26 and Table 27 show the LTV results for eIDAS, UP/SIP and total users. In these Tables the new paying users and total new users are obtained from the respective column of Table 19, Table 20 and Table 21. The total user periods (corresponding to the total number of accounts sold—eIDAS and UP/SIP) are calculated by summing from the rows of the Tables 19, 20, 21 for each reference period. The aggregate LTV is determined by multiplying the ‘paying user periods’ by the ‘revenue per paying user’ of Table 23. The ‘LTV for eIDAS users’ is calculated by dividing the sum of ‘aggregate LTV’ in 3-year period, by the respective sum of ‘eIDAS eID users’. In a similar way the LTV for UP/SIP or total users is determined by dividing the corresponding sum of aggregate LTV by the sum of UP/SIP or total users in 3-year period.

Table 25: eIDAS eID users

	Y1-Q1	Y1-Q2	Y1-Q3	Y1-Q4	Y2-Q1	Y2-Q2	Y2-Q3	Y2-Q4	Y3-Q1	Y3-Q2	Y3-Q3	Y3-Q4	User periods	Aggregate LTV	LTV for eIDAS user	eIDAS user margin	
Y1-Q1	10.101	9.596	9.116	8.660	8.227	7.816	7.425	7.054	6.701	6.366	6.048	5.745	92.855	4.291.828	305,82 €	96,56%	
Y1-Q2	-	207	197	187	178	169	160	152	145	137	131	124	1.786	82.627			
Y1-Q3	-	-	319	303	288	273	260	247	234	223	212	201	2.559	118.548			
Y1-Q4	-	-	-	437	415	394	374	356	338	321	305	290	3.228	149.784			
Y2-Q1	-	-	-	-	560	532	506	480	456	434	412	391	3.772	175.376			
Y2-Q2	-	-	-	-	-	691	656	623	592	563	535	508	4.168	193.907	Cost per user (eIDAS eID + UP/SIP)		10,52 €
Y2-Q3	-	-	-	-	-	-	828	787	747	710	674	641	4.387	204.329			
Y2-Q4	-	-	-	-	-	-	-	973	924	878	834	792	4.400	205.234			
Y3-Q1	-	-	-	-	-	-	-	-	1.125	1.068	1.015	964	4.172	195.032			
Y3-Q2	-	-	-	-	-	-	-	-	-	1.285	1.221	1.159	3.665	171.308			
Y3-Q3	-	-	-	-	-	-	-	-	-	-	1.453	1.381	2.834	132.471			
Y3-Q4	-	-	-	-	-	-	-	-	-	-	-	1.631	1.631	76.227			
eIDAS users	10.101	9.803	9.632	9.587	9.668	9.875	10.209	10.671	11.263	11.984	12.838	13.827	129.457	5.996.671	VIABLE		

Table 26: Conv CIAM (UP/SIP only)

	Y1-Q1	Y1-Q2	Y1-Q3	Y1-Q4	Y2-Q1	Y2-Q2	Y2-Q3	Y2-Q4	Y3-Q1	Y3-Q2	Y3-Q3	Y3-Q4	User periods	Aggregate LTV	LTV for UP/SIP user	UP/SIP user margin	
Y1-Q1	90.816	86.275	81.962	77.864	73.970	70.272	66.758	63.420	60.249	57.237	54.375	51.656	834.855	38.255.865	308,96 €	95,01%	
Y1-Q2	-	1.675	1.592	1.512	1.436	1.365	1.296	1.232	1.170	1.111	1.056	1.003	14.449	662.087			
Y1-Q3	-	-	2.580	2.451	2.328	2.212	2.101	1.996	1.896	1.802	1.712	1.626	20.704	948.726			
Y1-Q4	-	-	-	3.532	3.355	3.188	3.028	2.877	2.733	2.596	2.466	2.343	26.119	1.196.846			
Y2-Q1	-	-	-	-	4.534	4.307	4.092	3.887	3.693	3.508	3.333	3.166	30.522	1.398.625			
Y2-Q2	-	-	-	-	-	5.589	5.310	5.044	4.792	4.552	4.325	4.109	33.721	1.545.203	Cost per user (eIDAS + UP/SIP)		
Y2-Q3	-	-	-	-	-	-	6.700	6.365	6.047	5.744	5.457	5.184	35.496	1.626.559	15,41 €		
Y2-Q4	-	-	-	-	-	-	-	7.869	7.475	7.102	6.747	6.409	35.601	1.631.378			
Y3-Q1	-	-	-	-	-	-	-	-	9.099	8.644	8.212	7.802	33.758	1.546.894			
Y3-Q2	-	-	-	-	-	-	-	-	-	10.395	9.875	9.381	29.651	1.358.726			
Y3-Q3	-	-	-	-	-	-	-	-	-	-	11.759	11.171	22.929	1.050.692			
Y3-Q4	-	-	-	-	-	-	-	-	-	-	-	13.194	13.194	604.595			
UP/SIP users	90.816	87.951	86.133	85.358	85.625	86.933	89.286	92.690	97.155	102.692	109.316	117.044	1.130.999	51.826.197	VIABLE		

Table 27: Total user (UP/SIP+eIDAS)

	Y1-Q1	Y1-Q2	Y1-Q3	Y1-Q4	Y2-Q1	Y2-Q2	Y2-Q3	Y2-Q4	Y3-Q1	Y3-Q2	Y3-Q3	Y3-Q4	User periods	Aggregate LTV	LTV for total user	Total user margin	
Y1-Q1	100.917	95.871	91.078	86.524	82.198	78.088	74.183	70.474	66.950	63.603	60.423	57.402	927.710	42.547.693	308,63 €	95,17%	
Y1-Q2	-	1.882	1.788	1.699	1.614	1.533	1.457	1.384	1.315	1.249	1.186	1.127	16.234	744.714			
Y1-Q3	-	-	2.899	2.754	2.616	2.485	2.361	2.243	2.131	2.024	1.923	1.827	23.263	1.067.275			
Y1-Q4	-	-	-	3.968	3.770	3.582	3.402	3.232	3.071	2.917	2.771	2.633	29.347	1.346.630			
Y2-Q1	-	-	-	-	5.095	4.840	4.598	4.368	4.150	3.942	3.745	3.558	34.294	1.574.001			
Y2-Q2	-	-	-	-	-	6.280	5.966	5.668	5.384	5.115	4.859	4.616	37.889	1.739.110	Cost per user (eIDAS + UP/SIP)		
Y2-Q3	-	-	-	-	-	-	7.528	7.151	6.794	6.454	6.131	5.825	39.883	1.830.888	14,90 €		
Y2-Q4	-	-	-	-	-	-	-	8.841	8.399	7.979	7.580	7.201	40.002	1.836.611			
Y3-Q1	-	-	-	-	-	-	-	-	10.224	9.713	9.227	8.766	37.930	1.741.926			
Y3-Q2	-	-	-	-	-	-	-	-	-	11.680	11.096	10.541	33.316	1.530.034			
Y3-Q3	-	-	-	-	-	-	-	-	-	-	13.212	12.551	25.763	1.183.163			
Y3-Q4	-	-	-	-	-	-	-	-	-	-	-	14.825	14.825	680.823			
Total users	100.917	97.754	95.765	94.945	95.292	96.808	99.495	103.362	108.418	114.676	122.154	130.871	1.260.457	57.822.868	VIABLE		

Finally, the viability of each CIAM strategy can be assessed by checking the truth of the condition in Eq. 3. By substituting the calculated values of LTV, 'Cost per acquisition' and 'Cost of service' in this equation, the results shown in the last line of the penultimate column of Tables 25, 26 and 27 are obtained.

It can be seen that every considered strategy is viable under the used assumptions. The eIDAS eID-based strategy shows a lower LTV but a considerably higher profit margin as compared to the UP/SIP one. In this case two things can be done to increase the eIDAS solution's LTV: ad spends should be increased, and/or the granting of eIDAS accounts should be limited to users with greater virality potential to improve the percentage of eIDAS eID users to total users—the latter requires long-term observation of the user base and targeted interventions aimed at identifying the most productive (in terms of word-of-mouth referrals) user group.

This document is issued within the frame and for the purpose of the *LEPS* project. This project has received funding from the European Union's Innovation and Networks Executive Agency – Connecting Europe Facility (CEF) under Grant Agreement No. INEA/CEF/ICT/A2016/1271348; Action No 2016-EU-IA-0059. The opinions expressed and arguments employed herein do not necessarily reflect the official views of the European Commission.

This document and its content are the property of the *LEPS* Consortium. All rights relevant to this document are determined by the applicable laws. Access to this document does not grant any right or license on the document or its contents. This document or its contents are not to be used or treated in any manner inconsistent with the rights or interests of the *LEP* Consortium or the Partners detriment and are not to be disclosed externally without prior written consent from the *LEPS* Partners.

Each *LEPS* Partner may use this document in conformity with the *LEPS* Consortium Grant Agreement provisions.

(*) Dissemination level.-**PU**: Public, fully open, e.g. web; **CO**: Confidential, restricted under conditions set out in Model Grant Agreement; **CI**: Classified, **Int** = Internal Working Document, information as referred to in Commission Decision 2001/844/EC.

5 Conclusions

The cost benefit assessment we propose in this Deliverable, based on a detailed cost analysis of the integration of an SP with the eIDAS Network, and a LTV approach for the estimation of the corresponding benefit, may help Service Providers to establish metrics for the transition from a “Conventional CIAM strategy” to a customer identity management strategy that explores the potential benefits from the adoption of eIDAS eID-based authentication mode. Key findings of the cost benefit assessment are:

1. The necessary up-front investments for SP integration with the eIDAS Network do not form a barrier-to-entry and the operational costs, even though significant, are rather reasonable (apparently, these costs are a very small part of the revenues generated by a small-medium size SP). The use of “off-the-shelf” API Connectors, such as the Connectors developed in LEPS project, reduces these CAPEX costs and provides a basis for deploying a smooth operational model for the support of this integration in time.
2. The adoption of eIDAS eID-based login brings real business opportunities: cost savings and potential benefits from capturing a part of the increasing cross-border traffic (this is really important for the e-commerce and financial sectors). In the reference SP we used here, we model cost saving and benefits based on assumptions that incorporate a significant research account and conversations with the industry players. However, a SP can customize the model to its own data regarding identity management costs and expected benefits from the increase of cross-border activity.
3. Given the high uncertainty of the consumer demand, a typical Cost-Benefit Analysis (or a Technology Acceptance Model) can’t provide the adequate material for assessing the expected SP gains from adopting an eIDAS eID strategy. With the use of a LTV model, we have been successful in evaluating how SP benefits (obtained mostly cost savings) operate over time. In fact, the model we propose reveals:
 - a. A rather positive conclusion on the economies per user, a SP can obtain through the switch of its users from using conventional CIAM login services to eIDAS eID based authentication.
 - b. A non-linearity between the growth of eIDAS eID users and the SP cost of serving these users.
 - c. The existence and calculation of a tipping point in the dynamics of cost evolution. Beyond a certain number of customers using eIDAS eID for authentication with SP services, the SP covers the initial investment and the annual operations, thus increasing significantly the gains obtained from the users switching to eIDAS eID authentication mode.
4. A last conclusion with reference to an interesting re-use of the SP benefit analysis in a technical-economic context. The Cost Benefit Assessment undertaken here, illustrated the critical importance of the security-related costs in the operation of a Service Provider in the e-commerce field, especially as far as it regards the risk of Account Takeover (ATO). In fact, Account Takeover becomes a growing flaw in the Internet economy that is costing online merchants enormous financial resources²⁵. The situation is similar in other sectors of economic activity,

Document name:	D7.2 Report on Cost Benefit Assessment				Page:	5 of 74
Reference:	D7.2	Dissemination:	PU	Version:	1.02 5	Status: Final

banks and telecom in priority. ATO-related savings is the most important component of Cost Savings an SP may have from the use of eIDAS Network. According to several industry reports that analyse data from many online retailers in Europe and in the US, ATO costs would likely be \$700 to \$1,000 per successful takeover²⁶ (it may cost at least the value of an online transaction that is, in Europe, at about 166 Euros in average). And, the probability of an account takeover attack (also called also called credential stuffing attack) increases at a significant percentage per year (about 8%). A significant number of ATO attacks is related to the password (and identity) theft. Most e-commerce retailers provide customers with accounts that store personal information, financial data and purchase history. Predators often hack into these accounts through phishing schemes. Of course, the use of eIDAS eID relatively protects an online retailer from credential stuffing attacks. But other risks should also be eliminated, such as the possibility of an intruder that could be positioned between the user and the SP and appropriate the communications between an SP and its customers. As a result, and with reference to eIDAS API Connectors architecture, we should define two important security principles that might strongly apply: a) The response received by SP should denote the actual user identified via eIDAS and, b) The user logged in at the SP is the actual user identified by the authentication attributes. In fact, when a Service Provider connects to the eIDAS network using LEPS-proposed interconnection strategy (see previous sections), it delegates its trust in the security of the system from the eIDAS network, to the Stand-alone LEPS API Connector architecture used. Consequently, it is a major requirement that the employed interconnection strategy is technically consistent and highly secure. The security of such a critical infrastructure cannot be adequately verified through testing alone²⁷. To this end, in the context of delivering stable and secure APIs and raising the level of assurance for the security of the interconnection strategies delivered by the LEPS project, a formal model of the eIDAS ISS 2.0 LEPS API connectors' architecture was developed. The verification of the model revealed security flaws, leading to the redesign of the architecture. The formal model of the new design satisfied the desired security properties and the required changes will be incorporated into a new version of LEPS API connectors. This model is provided as Annex 1 of this Report.

²⁶ <https://www.perimeterx.com/blog/cost-account-takeover/#>

²⁷

Document name:	D7.2 Report on Cost Benefit Assessment				Page:	6 of 74
Reference:	D7.2	Dissemination:	PU	Version:	1.02 5	Status: Final

6 Annexes

6.1 Annex 1: Improve the security of the integration of the SP integration with the eIDAS Network via a formal methods-based verification of eIDAS API Connectors

6.1.1 LEPS API Connector Architecture

The “proxy” service, called eIDAS Interconnection Supporting Service (ISS)²⁸ aims to facilitate eIDAS integration by the SPs. Additional goals of the LEPS Interconnection Supporting Service protocol are:

1. Privacy for the users: the protocol must guarantee the privacy of the user identification attributes.
2. Security for the Service Providers: The protocol must guarantee the authenticity and integrity of the received user attributes.
3. Safety for the Service Providers: The protocol must ensure that the user identified is the one actual using the service.

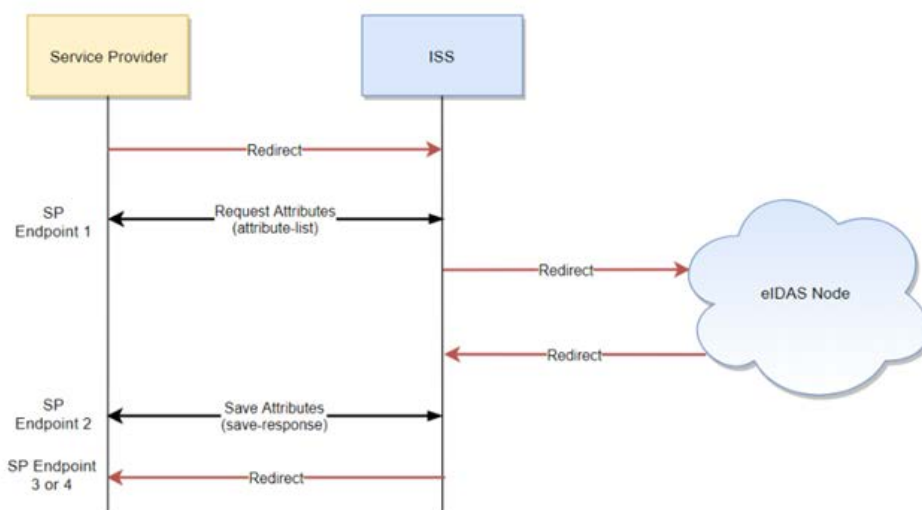


Figure 6: LEPS API Connector Architecture

The protocol defined by the LEPS API connectors, is shown in Figure 1, and can be defined as follows:

1. The user visits the SP page
2. The user's login request is redirected to ISS, this is a browser redirection. The required redirection parameters are the session identifier generated by the SP, the id of the SP on ISS and the user's country of origin.
3. ISS retrieves the list of eIDAS attributes requested by the SP based on received SP id, this is done via a back-channel API call to the SP
4. The ISS generates a suitable eIDAS SAML request and sends it to connected eIDAS node

²⁸ See LEPS Deliverable D4.2/5.2: “eIDAS Interconnection Supporting Service”

Document name:	D7.2 Report on Cost Benefit Assessment				Page:	7 of 74
Reference:	D7.2	Dissemination:	PU	Version:	1.02 5	Status: Final

- a. User Authenticates
 - b. ISS receives list of eIDAS attributes from eIDAS node
5. ISS sends list of received eIDAS attributes to the SP. This is done via a backchannel API call. The parameters of this call include the original session identifier and the received attributes as a JSON.
 - a. The SP responds with an acknowledgment
6. The ISS redirects the browser to the SP success or fail page, depending on the response from the previous step (with the session id as the redirection parameter)

6.1.2 LEPS API Connector Architecture Formal Model

Formal methods techniques (formal specification, model checking and verification) can help reveal problems and allow semi-automated reasoning about difficult design problems in critical systems that testing methodologies and informal proofs cannot successfully handle.

The main difference between formal methods and alternative system design methodologies can be summarized to the following point: when engineers build software systems they usually focus on designing the processing path of the system in which no errors occur. That code path must address the customer's needs, be efficient, and scale well in general. Once the design is completed, the engineer tries to figure out all the possible cases that can cause system's failures and tries to avoid them. In contrast, when a system is designed using formal methods the engineer begins by precisely stating what the system should do, by defining correctness properties.

There are two categories of such properties: a) safety properties which state what the system is allowed to do (e.g. at all times, all committed data is correct or equivalently at no time the system can have corrupted any committed data) and b) liveness properties which state what the system must eventually do (e.g. whenever the system receives a request, it must eventually respond to that request).

After defining correctness properties, an abstract version of the system's design along with an abstract version of its operating environment is defined. Next, with the goal of confirming that the design correctly handles all of the dynamic events in the environment, the effects of each of those possible events are specified. Next, the engineers verify that the specification of the system in its environment implements the chosen correctness properties, despite any combination or interleaving of events in the operating environment.

Security Property 1	The response received by SP should denote the actual user identified via eIDAS
Security Property 2	The user logged in at the SP is the actual user identified by the authentication attributes

Following this system design approach, we first defined the security properties that the LEPS API Connector should ensure. These properties derive from the most fundamental properties of any authorization service: secrecy, authenticity and integrity. In other words, such a service must ensure that

Document name:	D7.2 Report on Cost Benefit Assessment				Page:	8 of 74
Reference:	D7.2	Dissemination:	PU	Version:	1.02 5	Status: Final

at any time the transmitted data are not exposed, forged or corrupted. The high-level description of the derived properties can be found in table 1. Next, we defined the formal model of the protocol of the LEPS API Connector together with its operating environment (such as the possible attacks an adversary may make). Finally, we verified the formal model against the desired security properties.

More precisely, the protocol defined by the LEPS API Connector was specified as an Observation Transition System (OTS) in CafeOBJ Algebraic Specification language²⁹, using the following observers and transitions:

eidasAuth: SysUserToken → Sys	The user authenticates through eIDAS
issResponse: SysAttributesSenderToken → Sys	ISS 2.0 responds to SP by sending the requested attributes
loginUser: SysTokenClient → Sys	ISS 2.0 redirects the user to the SP success page
Observers	
issPending: Sys → TS	Requests served to ISS that have not yet been fulfilled
issReceivedAttributes: SysToken → Attributes	Attributes received by the ISS
spReceivedResponse: SysToken → Attributes	Attributes received by the SP after user authenticates with eIDAS
loggedInUser: SysToken → User	The user that SP perceives as logged in through eIDAS
authNUser: SysToken → User	The actual user that gets authenticated through eIDAS

The possible attacks against the protocol were defined by specifying an Adversary capable of performing Man in The Middle attacks (MiTM)³⁰. This Adversary was modeled using the observers and transitions presented in the table below. Please note that although the LEPS API Connector operates over a TLS

²⁹ Diaconescu, R., K. Futatsugi and K. Ogata, 2003, CafeOBJ: Logical foundations and methodologies, Computing and Informatics 22, pp. 257–283

³⁰ See <http://www.it.uu.se/edu/course/homepage/distrinfo/ht09/presentations/Group7.pdf>

Document name:	D7.2 Report on Cost Benefit Assessment				Page:	9 of 74
Reference:	D7.2	Dissemination:	PU	Version:	1.02 5	Status: Final

connection, there are still ways to perform MiTM attacks before the start of the TLS session^{31,32}. After an analysis of the system these were identified as the only type of attacks capable of compromising the protocols security.

The possible attacks against the protocol were defined by specifying an Adversary capable of performing Man in The Middle attacks (MiTM)³³. This Adversary was modeled using the observers and transitions presented in the table below. Please note that although the LEPS API Connector operates over a TLS connection, there are still ways to perform MiTM attacks before the start of the TLS session^{34,35}. After an analysis of the system these were identified as the only type of attacks capable of compromising the protocols security.

Formal syntax	Informal Description
Transitions	
issResponse: SysAttributesSenderToken → Sys	Adversary impersonates eIDAS ISS 2.0 response to SP and sends forged attributes
loginUser: SysTokenClient → Sys	Adversary intercepts Token to navigate at the SP url and gain access to the service
Observers	
loggedInUser: SysToken → User	SP gives access to Adversary, the latter identified by the SP as the user
authNUser: SysToken → User	Adversary has gained access

The security properties are formally defined as follows:

SP Security 1

³¹ <https://www.blackhat.com/presentations/bh-dc-09/Marlinspike/BlackHat-DC-09-Marlinspike-Defeating-SSL.pdf>

³² <https://avicoder.me/2016/02/22/SSLstrip-for-newbies/>

³³ <http://www.it.uu.se/edu/course/homepage/distrinfo/ht09/presentations/Group7.pdf>

³⁴ <https://www.blackhat.com/presentations/bh-dc-09/Marlinspike/BlackHat-DC-09-Marlinspike-Defeating-SSL.pdf>

³⁵ <https://avicoder.me/2016/02/22/SSLstrip-for-newbies/>

Document name:	D7.2 Report on Cost Benefit Assessment				Page:	10 of 74
Reference:	D7.2	Dissemination:	PU	Version:	1.02 5	Status: Final

$$\forall \text{States. } s, \text{Attributes. } a, \text{Token. } t: a \in \text{issReceiveAttributes}(s, t) \rightarrow \text{getUser}(a) = \text{authNUser}(s, t)$$

SP Security 2

$$\forall \text{States. } s, \text{Token. } t, \text{Users. } u: u \neq \text{nil} \wedge \text{loggedInUser}(s, t) = u \\ \rightarrow \text{getUser}(\text{spReceivedResponses}(s, t)) = u$$

In fact, as shown by the security analysis of the system both safety properties fail. The reason for this is that the system security is based on SSL only and thus state sharing between SP and ISS is necessary.

The security flaws of the system were discovered using the specification and model checking. This was performed by automatically constructing the state space of the system using its specification and checking the validity of the desired properties in each system's state.

6.1.2.1 First Security Violation

For example. for the first security violation of the system, consider the following states:

System's state	State description
$s1 = \text{startSession}(s, \text{uuid1}, \text{id1})$	Client initiates a session with ISS for eIDAS authentication
$s2 = \text{eIDASAuth}(s1, \text{usr1}, \text{uuid1})$	User $u1$ authenticates through eIDAS under ISS session uuid1
$s3 = \text{issResponse}(s2, \text{iss}, \text{uuid1}, \text{attr1})$	ISS sends attributes attr1 to SP for session uuid1
$s4 = \text{issResponse}(s3, \text{mit}, \text{uuid1}, \text{attr2})$	Adversary sends attributes attr2 to SP for session uuid1
$s5 = \text{loginUser}(s4, \text{uuid1}, c1)$	ISS redirects user browser $c1$ to the SP with token uuid1
Counterexample state: $s4$	

This means that this violation can occur after the execution of the following steps:

1. The Service Provider starts an ISS 2.0 session to authenticate a user (by generating the appropriate session id and redirecting the browser of the user)

Document name:	D7.2 Report on Cost Benefit Assessment					Page:	11 of 74
Reference:	D7.2	Dissemination:	PU	Version:	1.02 5	Status:	Final

2. The Adversary (or malicious user) gains access to session id. This can happen because the user's front-channel communications are not secure (either by an Adversary performing MiTM attack or actual user is malicious)
3. The user authenticates through eIDAS
4. The next steps may change order depending on SP implementation:
5. ISS 2.0 sends the received eIDAS identification attributes to the SP using the session id
6. Next, the Adversary sends fake attributes to the SP back end using the spoofed session id (in a sense impersonates ISS 2.0 to the SP, i.e. there exists an authenticity breach in the protocol). Depending on the SP business logic it will:
 - a. either store the first received set of attributes (in which case the adversary will try to send the fake attributes to the SP backend before the ISS)
 - b. or it will store the last set of attributes received for a session id.
7. ISS 2.0 redirects to SP success page with the session id as a redirection parameter
8. Finally, the SP following these steps has given access to a user with fake attributes received from step 5 (Integrity breach)

6.1.2.2 Second Security Violation

For the second security violation of the system, consider the following states:

System's state	State description
s1 =startSession(s,uuid1,id1)	Client initiates a session with ISS 2.0 for eIDAS authentication
s2=eIDASAuth(s1,usr1,uuid1)	User u1 authenticates through eIDAS under ISS 2.0 a session id (uuid1)
s3=issResponse(s2,iss,uuid1,attr1)	ISS 2.0 sends the received attributes (att1) to the SP under the same session id (uuid1)
s4= loginUser(s4,uuid1,c1)	ISS 2.0 redirects the user's browser (c1) to the SP success page with the session id (uuid1)
s5= loginUser(s4,uuid1,c2)	Adversary uses intercepted session id (uuid1) to navigate at the SP url and gain access to the service using his browser (c2)
Counterexample state: s5	

This violation can occur after the execution of the following steps:

1. SP starts an ISS session to authenticate a user

Document name:	D7.2 Report on Cost Benefit Assessment				Page:	12 of 74
Reference:	D7.2	Dissemination:	PU	Version:	1.02 5	Status: Final

2. Again, the user's front-channel communications are compromised by a malicious user/adversary
3. The adversary gains access to the session id
4. The actual user authenticates through eIDAS
5. ISS 2.0 sends identification attributes to the SP
6. ISS 2.0 redirects the browser to the SP success page with the same session id
7. Adversary hijacks the session by navigating to the SP success page using the valid (spoofed) session id (Authenticity breach)

6.1.3 Redesigned Architecture

In the context of LEPS the goal is to make the consumption of the offered API connectors as easy as possible to the Service Providers by requiring minimal effort by the SPs (which correlates directly to the cost of integrating eIDAS authentication to their systems) and ensuring the highest possible adoption of eIDAS e-Identification by the industry. For this reason, when deciding how we could possibly resolve the aforementioned security flaws, we decided that it was best not to rely upon solutions based on heavy cryptographic algorithms (since from the experience gained by the project even the generation of appropriate 2^{2048} keys presented problems for the service providers).

6.1.3.1 Addressing the first security violation

Thus, for addressing the first security violation of the system we propose to "Salt and Hash" the session identifier of the ISS 2.0 response back to the SP. The SP and the ISS 2.0 admin can agree on a salt/secret during the configuration of the ISS 2.0 (same as configuring endpoints).

With this change the protocol of the API Connector remains the same except from the 4th step, i.e. instead of simply sending a JSON containing the attributes received from eIDAS and the session identifier, the ISS 2.0 sends the attributes to the SP's backend the session identifier (UUID) and the salted hash of these values together (using MAC-SHA256).

This way the SP can verify the authenticity of the sent information by simply calculating the same hash (since the salt is secret, it can be certain that the attributes are indeed sent from ISS 2.0).

6.1.3.2 Addressing the second security violation

The second security violation of the system was not straightforward to address, since it depends on the way the SP handles the state. However, the Thin Web App (TWA) can streamline this process and enforce security mechanisms to prevent session hijacking.

Thus for the session hijacking attack the following alternatives were considered:

Solution 1: SSL binding (limit the "session" to the lifetime of the SSL connection)

Solution 2: IP binding

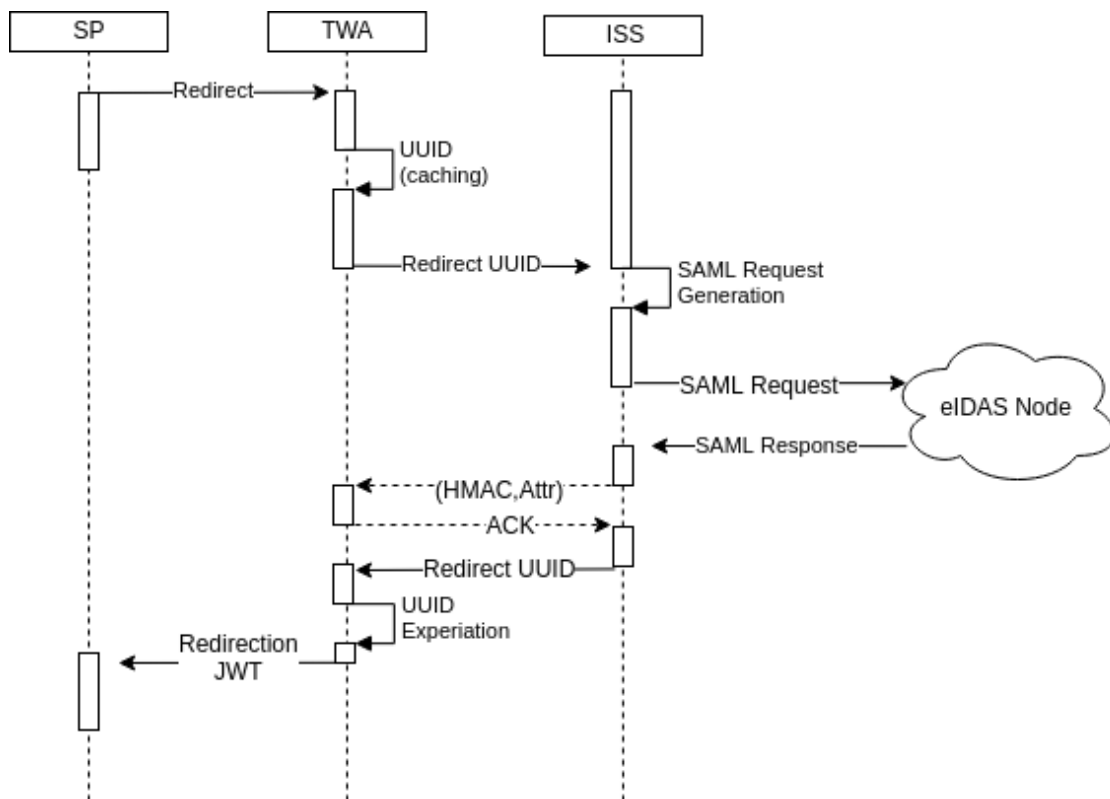
Solution 3: Homebrewed (session expiration and user notification)

Document name:	D7.2 Report on Cost Benefit Assessment					Page:	13 of 74
Reference:	D7.2	Dissemination:	PU	Version:	1.02 5	Status:	Final

The first solution was rejected due to the redirection to the eIDAS node for the authentication of the users the SSL session does not persist. The second solution is not feasible either since to the ISS 2.0 users behind the same network gateway would be indistinguishable.

6.1.3.3 The redesigned LEPS API Connector Protocol

1. For the reasons presented above the third solution was selected as the optimal. Specifically, this solution can be seen in Figure 2 and consists of the following steps:
2. The TWA caches pending generated session ids
3. Once an eIDAS authentication response is sent from ISS 2.0 to the TWA, the latter expires the session by removing it from the pending cache and then redirects the client to the SP success page.
4. If a subsequent response is received from the TWA they are rejected and a message is presented to the client.
 - a. If the client is controlled by the actual user then the user is informed that someone has hijacked the session and they can contact the SP
 - b. If the client is controlled by an adversary then they have been denied access.



Document name:	D7.2 Report on Cost Benefit Assessment				Page:	14 of 74
Reference:	D7.2	Dissemination:	PU	Version:	1.02 5	Status: Final

Figure 7: LEPS API Connector Redesigned Architecture

6.1.3.4 Verification of redesigned protocol

A new formal specification of the redesigned LEPS API Connector protocol (ISS 2.0 with TWA) was required so as to verify that this new protocol indeed satisfies the required security properties.

Also, please note that following the reasoning behind the second security violation and its solution, a rephrasing of the second security property is needed so as to verify that it has been successfully corrected. Specifically, instead of verifying the second security property presented in table 1 the security property of table 8 was verified.

Security Property 2

“The user logged in at the SP is the actual user identified by the authentication attributes or the actual user is informed”

The formal model of the redesigned protocol of the LEPS API Connector, defined as an Observation Transition System (OTS) in written in CafeOBJ terns, using the following observers and transitions is presented below:

Formal syntax	Informal Description
Transitions	
startSession : Token -> Sys	Client initiates a session with ISS for eIDAS authentication and redirects the user to ISS
eidasAuth : Sys User Token -> Sys	User Authenticates through eIDAS
issResponse : Sys Attributes Sender Token Hmac -> Sys	ISS 2.0 responds to SP by sending the requested attributes, as well as the required hash of the response
loginUser : Sys Token Client -> Sys	ISS 2.0 redirects the user to the SP
Observers	
issPending : Sys -> TS	Requests sent to ISS 2.0 that have not yet been fulfilled
issReceivedAttributes : Sys Token -> Attributes .	Attributes received by the ISS 2.0

Document name:	D7.2 Report on Cost Benefit Assessment				Page:	15 of 74
Reference:	D7.2	Dissemination:	PU	Version:	1.02 5	Status: Final

spReceivedResponse : Sys Token -> Attributes .	Attributes received by the SP after the user authenticates with eIDAS
loggedInUser : Sys Token -> User .	The user that is logged in to the SP for the specified session id
authNUser : Sys Token -> User .	The actual user that gets authenticated through eIDAS for the specified session id
Effective Condition (from state s3)	
c-issResponse: Sys Token Hmac -> Bool .	Equation defining the required conditions under which the SP will accept an issResponse

6.1.4 Summary

In order to raise the bar on the security of the offered LEPS API Connectors a formal model of the defined protocol was created. This allowed us to formally verify desired security properties against the protocol. During this process, we discovered that the original protocol of the LEPS API Connectors failed to satisfy both security properties and this resulted in the redesign of the protocol. Finally, it was proven that the new version of the LEPS API Connectors protocol successfully holds both desired security properties.

Document name:	D7.2 Report on Cost Benefit Assessment				Page:	16 of 74
Reference:	D7.2	Dissemination:	PU	Version:	1.02 5	Status: Final

References

- Bayòn, T., Gutsche, J. and Bauer, H. (2002) 'Customer equity marketing: touching the intangible', *European Management Journal*, Vol. 20 No. 3, pp.213-222.
- Breslow, N.E. (1975) Analysis of Survival Data under the Proportional Hazards Model, *International Statistical Review / Revue Internationale de Statistique*, Vol.43, No.1, pp.45-57.
- Cox, D.R. (1972) Regression models and life tables, *Journal of the Royal Statistical Society*, Vol. B, No.34, pp.187-220.
- Hale, K. (2009) 'On converting free users to paid users', in *Proceedings of the Future of Web Apps International Conference*, Miami, USA.
- Morecroft, J. (1985) Rationality in the analysis of behavioral simulation models, *Management Science*, Vol. 31, No.7, pp.900-916.
- Novo, J. (2006). [online] Maximizing marketing ROI with customer behavior analysis, <http://www.drilling-down.com> (Accessed May 8, 2013)
- Simon, H. (1982) *Models of Bounded Rationality*, MIT Press, Cambridge, MA, USA.
- Stahl, H.K., Matzler, K. and Hinterhuber, H.H. (2003) 'Linking customer lifetime value with shareholder value', *Industrial Marketing Management*, Vol. 32 No. 4, pp.267-279.
- Venkatesan, R. and Kumar, V. (2004) 'A customer lifetime value framework for customer selection and optimal resource allocation strategy', *Journal of Marketing*, Vol. 68 No. 4, pp.106-125.

Document name:	D7.2 Report on Cost Benefit Assessment					Page:	17 of 74
Reference:	D7.2	Dissemination:	PU	Version:	1.02 5	Status:	Final