Informal document GE.1 No.12 Rev.1 (2012)

Distr.: General
17 December 2012

ENGLISH ONLY

Economic Commission for Europe

Inland Transport Committee

Working Party on Customs Questions affecting Transport

Informal Ad hoc Expert Group on Conceptual and Technical Aspects of Computerization of the TIR Procedure

Cost Benefit Analysis of the eTIR system

Note by the secretariat

I. Background

1. At its forty-eighth session, further to requests from the Inland Transport Committee (ITC), WP.30 and the Informal Ad hoc Expert Group on Conceptual and Technical aspects of Computerization of the TIR Procedure (GE.1), the TIR Executive Board mandated the secretariat to conduct a Cost Benefit Analysis (CBA) of the eTIR Project (TIRExB/REP/2011/48final para. 10). Consequently, taking into account the funds available in the TIRExB consultancy budget line and the task to be undertaken, the TIR secretariat requested the relevant services of the United Nations Office at Geneva (UNOG) to issue a tender. In line with the applicable United Nations procurement principles, rules and procedures, UNOG sent out a request for quotes to five companies. Two companies submitted a bid, which were evaluated. Subsequently, the contract was awarded to the qualified bidder whose bid substantially conformed to the requirements set forth in the solicitation documents and who had been evaluated as being most cost-efficient for the United Nations.

2. At its twentieth session, GE.1 welcomed the draft CBA, presented in Informal documents GE.1 No. 6a, 6b, 6c, 6d and 6e (2012). GE.1 welcomed the summary presentation by the secretariat, but expressed its regret that the consultants had not been in a position to attend the meeting themselves in order to present the CBA and take part in the ensuing discussions. It expressed its general consent with the methodology used by the consultants, while, at the same time, raising preliminary comments with regard to various assumptions used by the consultants in the course of the CBA. Inter alia, GE.1 was of the opinion that the two scenarios described in the CBA (gradual introduction of eTIR Carnets versus the one time replacement of the paper TIR system by an electronic system, the so-called "big-bang" scenario were too optimistic and requested the "big-bang" scenario to be replaced by a more realistic one. In reply to suggestions that the scenarios used should be

based on complex forecasts on the long-term development of transport flows between TIR Contracting Parties, the secretariat recalled that the CBA had been adjudged to the consultants on the basis of a clear mandate and with a limited budget and that, therefore, it was unrealistic to expect them to undertake such complex simulation exercise, in addition to the work already accomplished. To wrap up its initial discussions on the issue, GE.1 requested additional time in order to provide the secretariat in writing with its comments on the draft CBA and proposed that eTIR focal points also be given the opportunity to submit their contributions. Further to this request, the secretariat sent an email to eTIR focal points, soliciting their considerations on the draft CBA. On the basis of all the comments received, the consultants prepared an updated version of the CBA that was presented as Informal Document No. 12 at the twenty-first session of GE.1 (ECE/TRANS/WP.30/2012/7, para. 14).

3. At that session, GE.1 took note that, apart from apparent mistakes in the calculations and some lack of textual consistency, the CBA was final. It agreed on the methodology used by the consultants, but felt that some costs, e.g. training, and indirect benefits were missing from the calculations. It requested the secretariat to prepare this revised version of the document, containing corrections of the various mistakes and textual inconsistencies, for circulation among the network of eTIR focal points. Finally, it requested the secretariat to prepare a separate document for consideration at its next session, containing a summary of the consultants' CBA, in combination with an assessment by the secretariat of the limitations of the analysis, i.e. the missing costs and benefits, as well as recommendations (ECE/TRANS/WP.30/2013/5, paras. 12-13).

II. Disclaimer

4. All parts of the cost-benefit analysis, including but not limited to the various assumptions on which they are based, are the sole responsibility of the authors and do not necessarily reflect the views of the UNECE secretariat. The UNECE secretariat's contribution to the analysis has been limited to ensuring that the CBA methodology has been properly applied.

III. Further considerations

5. On the basis of all comments by GE.1 and eTIR Focal Points, the secretariat, with the assistance of the consultants, prepared the final version of the CBA, which is contained in Annex and will be circulated to eTIR Focal Points for information.

Cost Benefit analysis of the eTIR System

November 2012

Version: 1-12

United Nations

Economic Commission for Europe

Inland Transport Committee

SIVECO Romania SA

Contact address:

SIVECO Romania SA

Victoria Park

73-81. Bucuresti-Ploiesti Drive, Building C4,

District 1, 013685 Bucharest, Romania

Tel: +40 21 302 3300

fax: +40 21 318 1202

Cost Benefit analysis document

Deliverable: Phase 3:

Ref: UNECE-eTIR-CBA

Version 1-12

Revisions

Version	Rev.	Date	Description	Author	Action (*)	Chapter
09	72	28/02/2012	Creation	Iacob Crucianu	M	All
09	73	17/08/2012	Review	Siveco	U	All
09	74	24/08/2012	Proposed changes	AB/AS	U	All
1	11	17/09/2012	Review	Iacob Crucianu	U	All
1	12	19/09/2012	Corrections / Formatting	André Sceia	U	All
1	12	21/11/2012	Corrections	André Sceia	U	All
1	12	30/11/2012	Review	Dan Tuhar	U	All

(*) Actions: I = Insert, U = Update, D = Delete, M = Merge, C=Comments

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We will refer to SIVECO Romania SA in the present document by using **SIVECO**.

The current project: the Cost Benefit Analysis of eTIR will be referred to in this document as **eTIR-CBA.**

This document is going to be reviewed by UNECE and accepted.

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0. EXECUTIVE SUMMARY

0.1. ARCHITECTURE ALTERNATIVES

Based on the efforts already made in the Reference Model V3.0, we established the main architecture-related alternatives that will be taken into account in our analysis.

Three major alternatives, each one with several options has been further considered in the evaluation of the cost-benefit analysis:

- Implementation using cloud computing concepts
- Hosting all hardware infrastructure, hardware systems and software systems at the premises of the owner of the eTIR system and using a completely separate environment ;
- Implementation using cloud computing concepts by hosting the eTIR system at the premises of other IT systems. The infrastructure or the platform will be provided by a third party, e.g. UNOG (United Nations Office at Geneva) or UNICC (United Nations International Computing Centre);

From a technical point of view, the classification of solutions (the first is the best one) is the following:

1. Cloud computing implementation on a platform ;
2. UNOG, UNICC;
3. At one's own premises.

0.2. COST, BENEFIT ANALYSIS

The cost analysis was made considering 2 years for the system development and setup, and the following 10 years for operations, and contains the following:

- Costs evaluation for the development and implementation;
- Initial costs necessary for the system setup;
- Operational costs;
- Helpdesk costs;
- Costs necessary for the setup of the national customs IT system.

The cost evaluation for the development and implementation was based on the evaluation of the system's dimensions, performed by using Function Point Analysis and Analogy Estimation.

The development costs are considered to be the same for all architecture alternatives.

This risk ratio was selected as being 20%, based on the risk appetite used by SIVECO and also by other important software development companies, for successful software development projects.

All costs were evaluated for two scenarios:

- Gradual implementation of the eTIR system over a 10 year period (reaching 3 million TIR transports);
- Gradual implementation of the eTIR system over a 10 year period, while only 1.5 million of TIR transports will be computerized.

For each alternative, the architectures considered were: at premises, UNOG/ UNICC and three cloud computing implementation.

Subsequently, the Return On Investment (ROI) for individual Customs authorities was computed. This calculation emphasizes that the ROI increases as the number of registered eTIR Carnets increases and become positive as of 30, 000 eTIR Carnets registered per year.

The final and consolidated results indicate that the total costs, benefits, ROI are presented below:

0.2.1. Costs, Benefits, ROI and NPV of a gradual increased usage reaching 3 million TIR transports

		Premises	UNOG	UNICC	PAAS	IAAS	SAAS
Costs	Development	1,127,000	1,127,000	1,127,000	1,127,000	1,127,000	0
	Initial	1,450,000	792,500	743,000	183,000	743,000	15,000
	Oper. + Hosting	2,981,001	1,378,468	1,456,668	1,024,624	867,717	17,000,000
	Sub-total	5558001	3297967.667	3326667.667	2334624	2737716.72	17015000
	Help Desk	2,210,000	2,210,000	2,210,000	2,210,000	2,210,000	2,210,000
	National App	8,550,000	8,550,000	8,550,000	8,550,000	8,550,000	8,550,000
Total Costs		16318001	14057967.67	14086667.67	13094624	13497716.72	27775000
Total Costs (incl. 20% risk factor)		19581601.2	16869561.2	16904001.2	15713548.8	16197260.06	33330000
Discounted Costs (incl. risk factor)		14979068.75	12941676.07	12950076.76	12391640.15	12470893.72	23464072.7
Benefits for Customs (incl. 20% risk factor)		19,550,000	19,550,000	19,550,000	19,550,000	19,550,000	19,550,000
Total Benefits (incl. 20% risk factor)		121,210,000	121,210,000	121,210,000	121,210,000	121,210,000	121,210,000
Discounted Customs Benefits (incl.risk factor)		13,255,247	13,255,247	13,255,247	13,255,247	13,255,247	13,255,247
Discounted Overall Benefits (incl.risk factor)		82,182,532	82,182,532	82,182,532	82,182,532	82,182,532	82,182,532
ROI for Customs		-12%	2%	2%	7%	6%	-44%
Overall ROI		449%	535%	535%	563%	559%	250%
Net present value		67,203,464	69,240,856	69,232,456	69,790,892	69,711,639	58,718,460

Table 1. Costs, Benefits, ROI and NPV (USD) of a gradual increased usage reaching 3 million TIR transports.

0.2.2. Costs, Benefits, ROI and NPV of a gradual increased usage reaching 1.5 million TIR transports

			Premises	UNOG	UNICC	PAAS	IAAS	SAAS
Costs		Development	1,127,000	1,127,000	1,127,000	1,127,000	1,127,000	0
		Initial	1,450,000	792,500	743,000	183,000	743,000	15,000
		Oper. + Hosting	2,981,001	668,962	706,912	497,244	421,098	8,250,000
	Sub-total		5558001	2588462.25	2576912.25	1807244	2291097.82	8265000
	Help Desk		2,210,000	2,210,000	2,210,000	2,210,000	2,210,000	1,286,300
	National App		8,550,000	8,550,000	8,550,000	8,550,000	8,550,000	8,550,000
Total Costs			16318001	13348462.25	13336912.25	12567244	13051097.82	18101300
Total Costs (incl. 20% risk factor)			19581601.2	16018154.7	16004294.7	15080692.8	15661317.38	21721560
Discounted Costs (incl. risk factor)			14979068.75	12362150.6	12337675.01	11543029.87	12523939.72	15492842.56
Benefits for Customs (incl. 20% risk factor)			9,487,500	9,487,500	9,487,500	9,487,500	9,487,500	9,487,500
Total Benefits (incl. 20% risk factor)			58,822,500	58,822,500	58,822,500	58,822,500	58,822,500	58,822,500
Discounted Customs Benefits (incl.risk factor)			6,406,022	6,406,022	6,406,022	6,406,022	6,406,022	6,406,022
Discounted Overall Benefits (incl.risk factor)			39,717,335	39,717,335	39,717,335	39,717,335	39,717,335	39,717,335
ROI for Customs			-57%	-48%	-48%	-45%	-49%	-59%
Overall ROI			165%	221%	222%	244%	217%	156%
Net present value			24,738,266	27,355,184	27,379,660	28,174,305	27,193,395	24,224,492

Table 2. Costs, Benefits, ROI and NPV (USD) of a gradual increased usage reaching 1.5 million TIR transports.

1. INTRODUCTION

1.1. PROJECT OVERALL OBJECTIVE

The overall objective of the eTIR-CBA project is to analyze, from a technical and financial perspective, various technical options for the implementation of eTIR system for two scenarios:

- Gradual implementation of the eTIR system over a 10 year period (reaching 3 million TIR transports);
- Gradual implementation of the eTIR system over a 10 year period, while only 1.5 million of TIR transports will be computerized.

The first step in accomplishing this objective is defining the architecture alternatives, see Annex A.1.

The second step is an estimation of the software development costs for eTIR international system.

The third step is dedicated to the cost analysis (total cost of ownership - TCO) for the various architecture alternatives.

The fourth step is dedicated to the benefits analysis**,** ROI and Cash Flow.

Finally, conclusions and recommendations are formulated.

1.2. BACKGROUND

UNECE administers the TIR Convention, which was established in 1975 and has 68 Contracting Parties. The Convention provides for an internationally recognized procedure for facilitating cross-border transportation of goods in transit through the use of a standard, internationally recognized transit document (TIR Carnet).

For many years, the TIR Convention proved to be an effective facilitation tool. Nowadays, with the progress of technology, the use of the paper –based TIR Carnet seems to be obsolete, in particular when it comes to linking it to the procedures applied by the national Customs administrations.

At each border crossing, Customs officers are faced with the additional work of handling TIR Carnets in their national electronic system, often having to retype up to 50 data elements into the system, not to mention the risk due to human error.

Furthermore, this situation does not enable Customs authorities to effectively apply risk management procedures based on advanced cargo information, as it is demanded by an increasingly security-conscious environment.

In view of the above, the Working Party on Customs Questions affecting Transport has initiated the computerization of the TIR procedure (so-called “eTIR Project”), which aims, inter alia, at developing an information exchange platform for all actors involved in the TIR system, known as the eTIR international system.

Moreover, the introduction of the “TIR system” also implies parallel efforts from the Contracting Parties and the Guarantee Chain to develop or update national or private systems respectively.

The main project beneficiaries will be: Customs administrations of the Contracting Parties to the TIR Convention which use the TIR procedure, transport operators using the TIR procedure and the international Guarantee Chain on a daily basis, providing the required international warranties covering the TIR transports.

The computerization of the TIR procedure requires computerization of the information management by all the players involved in the procedure. Whereas most Customs administrations and the current Guarantee Chain have already partially or totally introduced IT into their part of the TIR procedure, the functions embedded in the paper-based TIR Carnet are not yet computerized (IT- based).

The eTIR international system will therefore be a platform allowing the management by the Customs authorities of data on guarantees and the secure exchange of data between national Customs

systems related to the international transit of goods, vehicles and/or containers according to the provisions of the TIR Convention.

The eTIR international system is involved in two parts of the procedure. On one hand, the Guarantee Chain will transmit information on the guarantees it has issued to the holders, so that those guarantees can be registered in the eTIR international system. On the other hand, the Customs authorities will use the eTIR international system to check the status of guarantees and to exchange information related to the TIR transport and to TIR operations.

Thus, the management by the Customs of the data on guarantees and the secured exchange of data between national Customs systems in relation to TIR transport information are the two basic features of the eTIR international system.

The eTIR project will also provide guidelines for promoting harmonization, especially in the context of the dialogue between the holder and the Customs authorities (standard declarations). Communication, security and fallback solutions constitute other key features of the system.

In view of the cost-benefit analysis of introducing the eTIR system, the financial benefits brought to all the actors (stakeholders) involved are expressed as major cost-reductions regarding operations.

2. DEVELOPMENT COSTS ESTIMATIONS

2.1. INTRODUCTION

This chapter presents a detailed estimation of the system dimensions and also estimates the costs and schedules for development. The final conclusion obtained after the whole estimation process, indicates the following costs for development:

The estimations of the eTIR international system have been performed while taking into account the functional and technical specifications contained in the eTIR Reference Model 3.0.

The estimations were made following several steps:

Step 1: Total Unadjusted Function Points (TUFP) were estimated based on the functional and technical specifications from the eTIR Reference Model using the methodology presented in Annex A.3.

Step 2: Adjusted Processing Complexity (APC) was estimated based on the general architecture presented in Annex A.1.

Step 3: Total Adjusted Function Points (TAFP) were calculated by applying APC to TUFP.

Step 4: Schedule and cost estimations were performed using the COCOMO II methodology, based on TAFP and environment variables.

2.2. ASSUMPTIONS

2.2.1. Assumptions regarding the quantity and type of data to be processed

The assumptions are based on the document **ECE/TRANS/WP.30/GE.1/2011/5 [R5]** and are reproduced below.

"On the basis of the functional requirements laid down in Chapter 2 and 3 of the eTIR Reference model1 and the available statistics on the distribution of TIR Carnets, the meeting formulated a set of preliminary assumptions with regard to the possible technical specifications of the future eTIR international system, as follows:"

• The eTIR international system should be able to manage approximately 3 million TIR transports per year;

• Each TIR transport consists, on average, of 3 TIR operations;

• 1% of guarantees, issued by the guarantee chain, are cancelled every year;

• 50% of all TIR transports give rise to direct queries of the eTIR international system, from both Customs and the guarantee chain;

• 10% of all initially lodged Customs declarations are later amended.

Estimated number of messages *Various types of eTIR messages*	*No. of messages*
Incoming	
E1 – Register guarantee	3,030,000
E3 – Cancel guarantee	30,000
E5 – Query guarantee	1,515,000
I1 – Accept guarantee	3,000,000
I5 – Query guarantee	1,500,000
I7 – Record Advance Cargo Information	3,300,000
I9 – Start TIR operation	9,000,000
I11 – Terminate TIR operation	9,000,000

I13 – Discharge TIR operation	9,000,000
Total Incoming	**39,375,000**
Outgoing	
I3 – Get holder info	27,375,000
E7 – Notify guarantee chain	33,300,000
I15 – Notify Customs	3,300,000
Total Outgoing	**63,975,000**

Table 3. Presents the assumed number of each message, as well as the totals.

2.2.2. Assumptions regarding the eTIR International functional components

Three main functional components of the eTIR International system are considered:

1. eTIR international kernel (called also eTIR kernel). This is the main component responsible for the business logic and data exchange, using web services.
2. eTIR international user interface system. This system is used as fallback procedure, to enter data into the system using a user interface. The business logic used is similar to the one used for the eTIR international kernel.
3. eTIR administration console, which is used in order to:
    a. Manage users, connections, reference data;
    b. Monitor the system;
    c. Audit actions.

The estimations were first performed for each functional component before presenting the aggregated results.

2.3. FPA ESTIMATION RESULTS

The final results after applying the FPA methodology are presented below.

The detailed estimation is presented in Annex A.3.

We present firstly a separated estimation for each functional module, then a consolidated estimation.

2.3.1. Assumptions, limitations

- All answer messages (I2, I4, I14, E2, E4, E10) were considered as just answers given by the system, without persistence in the system and consequently not counted as EO or ILF, but just as a RET for an EI or an EQ;
- Error messages were not counted as EO (just RET for EI);
- The workflow is considered established, and hardcoded. No changes in the messages' workflow are possible without changing the software;
- There is no separate history of actions. All messages are stored, but no separate history mechanism is considered;
- No follow-up of messages is possible, apart from the answer whether a message was received or not;
- There is no browsing mechanism for messages. If such a mechanism is necessary, new external enquiries should be defined;
- No risk analysis checks have been considered. If the checking of risky transactions is necessary, then new external enquiries should be defined;
- No printing mechanism exists for eTIR data;
- No export of data in other formats than the XML native format;
- No queue mechanism is considered.

2.3.2. Estimation results for the eTIR international kernel

Function Point Estimation Worksheet							
	Complexity						
Description	**Low**		**Medium**		**High**		**Total**
EI	1	x 3	2	x 4	7	x 6	53
EO	0	x 4	1	x 5	1	x 7	12
EQ	1	x 3		x 4	1	x 6	9
ILF	42	x 7	2	x 10	0	x 15	314
EIF	1	x 5	0	x 7	0	x 10	5
Total Unadjusted Function Points (TUFP):							**393**

2.3.3. Estimation results for the eTIR user interface

Function Point Estimation Worksheet							
	Complexity						
Description	**Low**		**Medium**		**High**		**Total**
EI	1	x 3	2	x 4	7	x 6	53
EO	0	x 4	1	x 5	1	x 7	12
EQ	1	x 3	10	x 4	1	x 6	49
ILF	42	x 7	2	x 10	0	x 15	314
EIF	1	x 5	0	x 7	0	x 10	5
Total Unadjusted Function Points (TUFP):							**433**

2.3.4. Estimation results for the eTIR administration console

Function Point Estimation – eTIR administration console							
	Complexity						
Description	**Low**		**Medium**		**High**		**Total**
EI	6	x 3	1	x 4	2	x 6	34
EO	8	x 4	1	x 5	0	x 7	37
EQ	1	x 3	6	x 4	0	x 6	27
ILF	8	x 7	0	x 10	0	x 15	56
EIF	6	x 5	1	x 7	0	x 10	37
Total Unadjusted Function Points (TUFP):							**191**

2.3.5. Estimation results for the full eTIR international system

No	Component	TUFP
1	eTIR international kernel	393
2	eTIR user interface	433
3	eTIR administration console	191
Total		**1,017**

2.3.6. General system characteristics influencing estimations

The general characteristics of the system have been used to compute the Total Adjusted Function Points, which subsequently are the input of the costs estimation.

GENERAL SYSTEM CHARACTERISTICS	Effect (0-5)
Centralized approach	5
Service Oriented Architecture	4
System Performance	5
Heavily Used Configuration, availability	5
Transaction frequencies, scalability	5
Online data entry	5
User-friendly interface, documentation quality	4
Online updates	4
Complexity of processing	4
Reusability of data (non-redundancy)	3
Easy to be installed and configured	4
Integration with third party applications, especially report tools	4
Configurable at runtime, facilitates change	5
Reliability and stability	5

Table 4. General system characteristics

0=no effect on processing complexity;
5=great effect on processing complexity;

Process complexity: 62
Adjusted Processing Complexity (PCA) =1.27

2.3.7. Total Adjusted Function Points (TAFP):

No	Component	TUFP	TAFP
1	eTIR international kernel	393	500
2	eTIR user interface	433	550
3	eTIR administration console	191	243
Total		**1,017**	**1,293**

Table 5. Total adjusted Function Points

2.3.8. Final remarks on FPA estimation

The estimation considers developing the system from scratch. For this very reason, some efforts could be smaller due to the existence of the eTIR Reference Model, which contains parts of the analysis and design phases.

By using analogy with other Customs systems, for which detailed data on project costs and schedule has been available, the current FPA estimation indicates that

- The overestimation risk is very low (<5%);
- The underestimation risk is acceptable (<20%).

2.4. FINAL RESULTS

Based on the schedule and cost estimations presented in Annex A.4, the development costs for the various implementation types are as follows:

	Development	
Impl. Type	***Current USD***	
	Min	***Max***
On premises	924,800	1,127,000
UNOG	924,800	1,127,000
UNICC	924,800	1,127,000
IaaS	924,800	1,127,000
PaaS	924,800	1,127,000
SaaS	0	0

Table 6. Summary of development costs

The costs are not dependent on the software architecture used.

A shorter development duration, employing a highly experienced team is calculated as follows:
Effort = 115.6 Person-months;
Unit Cost $8,000 man/month;
Schedule = 17.6 Months;

A longer development duration, employing a medium experienced team is calculated as follows:
Effort = 225.4 Person-months;
Unit Cost $5,000 man/month;
Schedule = 21.9 Months;

The above table is computed by summing up the costs estimated in current USD, based on FP.

Minimal values (first column) are computed by considering the minimal costs for development (cost estimations for the development of the full system, employing a highly experienced team)

Maximal values (second column) are computed by considering the maximal costs for development (cost estimates for the development of the full system, employing a medium experienced team).

2.5. CONCLUSIONS

For the eTIR international system, composed of three functional components (eTIR kernel, eTIR user interface and the eTIR administration console), the cost estimations are as follows:

- Development costs are between $924,800 and $1,127,000, depending on the qualifications of the development team and assuming the resources' costs at European level ;
- Development time varies from 17 to 22 months, depending on the qualifications of the development team;
- The development team can be reasonably small (maximum 9 persons for the highly experienced team and maximum 16 persons for the medium experienced team).

For the eTIR international kernel and administration console:

- Development costs are between $485,000 and $613,000, depending on the qualifications of the development team and assuming the resources' costs at European level;
- Development time varies from 15 to 18 months depending on the qualifications of the development team;
- The development team can be reasonably small (maximum 6 persons for the highly experienced team and maximum 9 persons for the medium experienced team).

For the eTIR international kernel:

- Development costs are between $330,000 and $357,000, depending on the qualifications of the development team and assuming the resources' costs at European level;
- Development time varies from 13 to 16 months depending on the qualification of the development team;
- The development team can be reasonably small (maximum 6 persons for the highly experienced team and maximum 8 persons for the medium experienced team).

3. COST ESTIMATIONS

3.1. INTRODUCTION

The purpose of the Cost Estimation is to present:

- The estimated development costs;
- The costs to support the system operations;
- The costs of a technical helpdesk;
- The costs necessary to adjust the national Customs IT systems to the interface with eTIR;
- The costs for transport operators;
- The costs estimate for a 10 years period, for the various architecture options and for the two envisaged scenarios:
    (a) the system is gradually implemented to reach 3 million TIR transports after 10 years;
    (b) the system is gradually implemented to reach 1.5 million TIR transports after 10 years.

The estimate error is considered to be less than 5% for over-evaluation and less than 20% for under-evaluation. For the estimations of the costs to support the system operations, we consider three types of costs:

- Software development and deployment costs;
- Initial infrastructure costs;
- Annual maintenance and operational costs for the next 10 years;
- Annual hosting and clouds costs for the next 10 years.

The software development costs are considered identical for each architecture alternative (except for the SaaS option, since the software development would be undertaken by the cloud computing provider).

The helpdesk is foreseen only for assisting the Customs administrations in connecting their national Customs IT systems to the eTIR international system (2 persons during working hours).

Cost estimations for changing the national Customs IT system in order to be interfaced with the eTIR system are computed based on the assumption that each country will implement the system from scratch, and independently, the interface.

The costs estimation for the Trader community reveals there are no important costs to be considered.

3.2. ASSUMPTIONS

The profile for the application being analyzed on the Windows Azure Platform is as follows:

- Application type: Business Management – Other Business Management Application;
- Development of this application / service: new development;
- Size of this application / service by the hardware and software components used: Large (>10 servers/VMs);
- Best method of the integration between this application and other applications, either on premises or in the cloud: highly integrated (>10 connections to ITDB and national Customs IT

Systems);

- Best method of user logins supported by the Business Management Application: Heavy user logins (A high number of login connections has to be considered, as each transaction requests a login);

- Profile of this application / service over time: Steady Growth – Consistent application usage growth over an extended period of time.

Based on the profile of the eTIR application and the type and quantity of data to be processed and exchanged, the system instances are specified as follows:

- Number of instances:
  - Windows Azure instances: 30 (distributed Azure with many instances);
  - Google: 16 (8 back end, 8 front end);
  - Amazon: 16;
  - At premises: 16 (8 back end, 8 front end);
  - UNOG: 16 (8 backend, 8 front end);
- Average use hours per day: 24.0;
- Average use days per year: 365;
- Storage per year for 3 million eTIR Carnets: 1,600GB;
- Transactions (millions) per year for 3 million eTIR Carnets: 150 Million;
- Bandwidth IN per year for 3 million eTIR Carnets: 450GB;
- Bandwidth OUT per year for 3 million eTIR Carnets 650GB.

Average values are used to define the system requirements for 3 million eTIR Carnets, in case the system will start with all TIR Carnets registered. The average values are those considered to date and do not take into account an increased number of registered TIR Carnets.

System workload, based on the assumptions presented in Chapter 2.2:

Characteristics/ Year	1	2	3	4	5	6	7	8	9	10
Number of eTIR Carnets (thousands)	100	700	800	1.200	1,300	2,000	2,500	2,600	2,800	3,000
Storage (GB)	600	700	800	900	1,000	1,200	1,300	1,400	1,500	1,600
Bandwidth IN (GB)	200	250	300	350	400	410	420	430	440	450
Bandwidth OUT (GB)	300	350	400	450	500	600	610	620	630	650
Transactions (Millions)	50	60	70	80	100	110	120	130	140	150

Table 7. Estimated eTIR system workload

Unit prices used are established considering the following:

- Price of labour is based on an average EU workforce price in 2011, published in EU statistics (between $3,000 and $8,000 per month, depending on personnel qualifications);
- Price for training: 1,000 per day/trainee;
- Price of electricity: $0.3 as an average price in the EU;
- Price of storage: $0.1 per GB, as results from a medium price of hard disks (list prices);
- Future scalability is linked to an increase of eTIR usage by circa 10% per year;
- Insurance: 0.1-0.4% for hardware and infrastructure, according to figures provided by representative insurance companies;
- The costs are based on the system's dimensions defined for the actual number of TIR transports.

3.3. DEVELOPMENT COSTS FOR THE ETIR SOLUTION

The costs for developing the eTIR solution are considered the same for each alternative. According to the previously made estimations (see Chapter 2), we have the following figures:

Impl.Type	*Min*	*Max*
At premises	$924,800	$1,127,000
UNOG	$924,800	$1,127,000
UNICC	$924,800	$1,127,000
IaaS	$924800	$1,127,000
PaaS	$924,800	$1,127,000
SaaS	-	-

Table 8. Total development costs

Minimal values (first column) are computed by considering the minimal costs for development (cost estimations for the development of the full system, employing a highly experienced team).

Maximal values (second column) are computed by considering the maximal costs for development (cost estimations for the development of the full system, employing a medium experienced team).

3.4. ETIR INTERNATIONAL SYSTEM COSTS

On the basis of the detailed cost analysis presented in Annex A.6, the development, initial, operational and cloud costs are as follows:

	Development		Initial costs		Operational Costs /Year		Cloud costs /year	
	Min	*Max*	*Min*	*Max*	*Min*	*Max*	*Min*	*Max*
At premises	$924,800	$1,127,000	$1,255,000	$1,450,000	$340,419	$526,059	$0	$0
UNOG	$924,800	$1,127,000	$681,500	$792,500	$84,739	$103,259	$110,000	$140,000
UNICC	$924,800	$1,127,000	$632,000	$743,000	$84,739	$103,259	$82,980	$153,800
IaaS	$924,800	$1,127,000	$632,000	$743,000	$84,739	$103,259	$28,663	$49,867
PaaS	$924,800	$1,127,000	$142,000	$183,000	$64,000	$78,000	$95,116	$102,816
SaaS	$0	$0	$10,000	$15,000	$1,500,000	$3,000,000	$0	$0

Table 9. Development, initial, operational and cloud costs,

(SaaS: minimum $0.5 per TIR Carnet, maximum $1 per TIR Carnet)

Operation and cloud costs are calculated considering that 3 million TIR transport would be handeled electronically each year.

On the basis of these annual variable cost we calculate a unit cost per TIR Carnet:

Variable costs per TIR transport		
Impl. Type	*Min*	*Max*
At premises	$0.11	$0.18
UNOG	$0.06	$0.08
UNICC	$0.06	$0.09
IaaS	$0.04	$0.05
PaaS	$0.05	$0.06
SaaS	$0.50	$1.00

Table 10. Variable costs per TIR Transport

3.5. HELPDESK COSTS

Considering that helpdesk is organized at one's premises (2 persons, working hours), the total costs for 10 years are:

	Min	*Max*
Initial	$24,500	$44,000
Operational	$181,800	$576,000
Personnel	$1,080,000	$1,590,000
Total	**$1,286,300**	**$2,210,000**

Table 11. Helpdesk costs

For SaaS, the helpdesk is considered to be included in the costs previously presented.

3.6. NATIONAL COSTS

The costs for adjusting the national Customs IT systems, for all 57 countries, in order to exchange data with eTIR, will be as follows:

	Min	*Max*	*Explanation*
Development	**$6,840,000**	**$8,550,000**	**~15 Man/month * $8,000 minimum costs or 30 Man/Month * $5,000 maximum costs** **57 countries**

Table 12. Adjustment costs of national IT systems

The estimation error is considered to be below 5% for over-evaluation and below 20% for under-evaluation.

The costs are based on the system's dimensions defined for the actual number of TIR transports.

3.7. COSTS FOR TRANSPORT OPERATORS

We consider that there are no costs involved for the Trader community.

3.8. DISTRIBUTION OF TOTAL COSTS

We consider a 2 years development and 10 years usage of the system.

- According to the results of Chapter 3, 2 years of development time are considered. This leads up a total of a 12 years period of analysis.

- The initial costs are distributed as follows:
  - 50% development costs in the first year;
  - 50% development costs in the second year;
  - 50% initial costs in the second year;
  - 50% initial costs in the third year, overlapping the first year of operation.

- The helpdesk costs will start in the 3rd year.

- We consider that ultimately all the 57 TIR Countries will upgrade their National system to connect to the eTIR International system. We assume that the process will take place over time as follows:

Year	1	2	3	4	5	6	7	8	9	10	11	12
# countries		3	3	3	5	10	10	5	5	5	4	4

- The operation and hosting costs are calculated for the following scenario:
  - The eTIR system will be gradually implemented (up to 3 million transports);
  - The eTIR system will be gradually implemented (up to 1.5 million transports).

Year	1	2	3	4	5	6	7	8	9	10	11	12
Scenario 1			100	700	800	1200	1300	2000	2500	2600	2800	3000
Scenario 1			50	300	400	500	600	1000	1200	1300	1400	1500

Table 13. Annual number of TIR transports handeled electronically (in thousands)

- Maximum costs are used.
- The discount rate used across the CBA it of 5%.
- A risk factor of 20% is applied to both costs and benefits.

3.8.1. Gradually distributed eTIR discounted costs (full usage)

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Total
Premises	676,200	1,986,857	1,581,644	818,241	1,092,762	1,811,848	1,741,272	1,123,422	1,141,137	1,100,361	963,295	942,030	14,979,069
UNOG	676,200	1,611,143	1,213,560	749,839	1,018,311	1,705,489	1,631,536	962,637	949,727	910,774	768,847	743,613	12,941,676
UNICC	676,200	1,582,857	1,187,122	753,177	1,021,944	1,710,679	1,636,891	970,483	959,067	920,025	778,335	753,295	12,950,077
PAAS	1,682,082	1,706,555	937,217	789,615	840,719	1,453,860	1,390,026	787,926	774,882	742,645	654,409	631,704	12,391,640
IAAS	676,200	1,582,857	1,183,352	728,038	994,582	1,671,591	1,596,562	911,393	888,722	850,350	706,873	680,375	12,470,894
SAAS	0	522,857	890,449	1,416,625	1,744,063	2,742,279	2,701,240	2,529,969	2,815,598	2,758,875	2,664,334	2,677,784	23,464,073

Table 14. Distribution of costs (USD), discounted, eTIR gradually distributed, full usage

(for SaaS, $0.5 per eTIR Carnet is calculated)

3.8.2. Gradually distributed eTIR discounted costs (half usage)

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Total
Premisses	676,200	1,986,857	1,581,644	818,241	1,092,762	1,811,848	1,741,272	1,123,422	1,141,137	1,100,361	963,295	942,030	14,979,069
UNOG	676,200	1,611,143	1,209,148	716,217	986,290	1,652,121	1,580,710	893,485	864,110	829,234	685,216	658,276	12,362,151
UNICC	676,200	1,582,857	1,182,459	717,648	988,106	1,654,284	1,583,181	897,408	868,594	833,860	689,961	663,117	12,337,675
PAAS	676,200	1,262,857	876,314	709,744	978,070	1,642,336	1,569,527	875,735	843,824	808,304	663,749	636,371	11,543,030
IAAS	1,682,082	2,026,555	1,238,197	761,753	813,273	1,409,853	1,347,287	728,653	702,247	672,755	582,727	558,559	12,523,940
SAAS	0	522,857	692,386	910,792	1,262,318	2,001,405	1,995,646	1,602,129	1,688,278	1,685,237	1,568,153	1,563,641	15,492,843

Table 15. Distribution of costs (USD), discounted, eTIR eTIR gradually distributed, half usage

(for SaaS, $0.5 per eTIR Carnet is calculated)

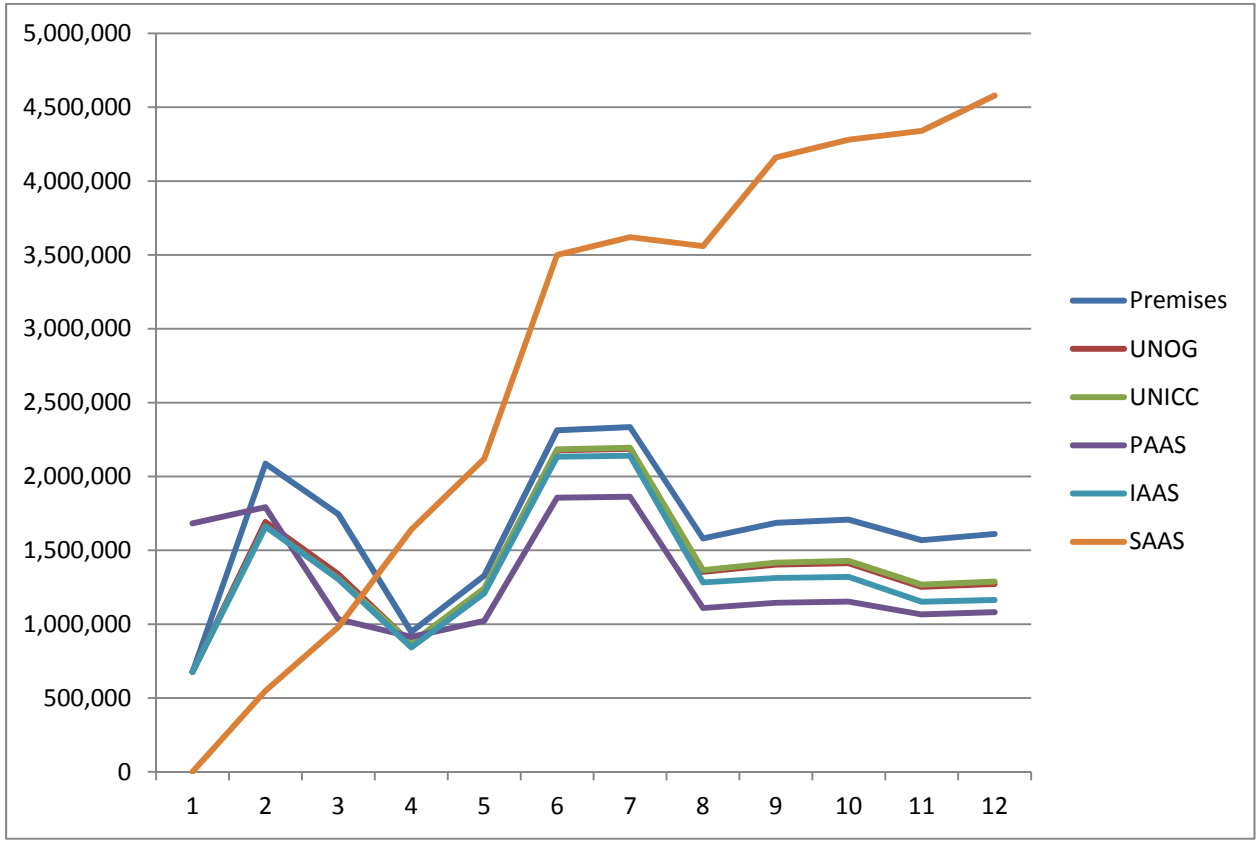

Fig 1. Total costs incl. 20% risk, not disctounted, gradually distributed (full usage)

4. ESTIMATION OF BENEFITS

4.1. INTRODUCTION

The purpose of the Benefit Estimation is to present the benefits of the eTIR international system for:

- National Customs administrations;
- TIR Carnet holders;
- Guarantee chain.

At this stage, only direct benefits are presented. The indirect benefits, resulting from facilitating legal and reducing illegal trade are not part of this analysis.

4.2. ASSUMPTIONS

4.2.1. Assumptions regarding the quantity and type of data to be processed

The assumptions are based on document **ECE/TRANS/WP.30/GE.1/2011/5 [R5]** and are reproduced below.

On the basis of the functional requirements laid down in Chapter 2 and 3 of the eTIR Reference model and the available statistics on the distribution of TIR Carnets, a set of preliminary assumptions with regard to the possible technical specifications of the future eTIR international system have been formulated, as follows:

- The eTIR international system should be able to manage approximately 3 million TIR transports per year;
- Each TIR transport consists, on average, of 3 TIR operations;
- 1% of guarantees, issued by the guarantee chain, are cancelled each year;
- 50% of all TIR transports give rise to direct queries of the eTIR international system, from both Customs and the Guarantee Chain;
- 10% of all initially lodged Customs declarations are later amended.

When computing the benefits, the current costs for using paper-based TIR Carnets are taken into account, as summarized below:

Estimated costs per TIR Carnet (USD)	***Min***	***Max***
Guarantee chain		
Printing of TIR Carnets	1	2
Distribution and issuance	1	2
Archiving costs (TIR Carnets to be stored for 5 years)	1	1
Holder		
Obtaining and filling in the TIR Carnet	1	3
Total	***$4***	***$8***
Estimated handling costs of a TIR Carnet per TIR operation (UDS)		
Filling in and stamping:	1	2
Typing of data in national system	3	5
Total	***$4***	***$7***

Table 16. Estimated costs for paper TIR Carnet

4.2.2. Assumptions on average time spent to fill in a customer request

First, the holder has to get a TIR Carnet from his/her issuing association. TIR Carnets are printed and distributed by an authorized international organization (currently, the International Road Transport Union (IRU)). The time required to obtain a TIR Carnet varies greatly from country to country. The holder fills in the TIR Carnet, which takes around 15-20 minutes. The TIR Carnet is then presented to Customs administrations of departure or entry, where, in most cases, Customs officers will fill-in the paper TIR Carnet and type the data into the national system: this can take up to 10- 15 minutes per operation. At Customs offices of exit and destination, the TIR Carnet will also be presented and filled in. Possibly, the Customs will also enter limited information into their national system. This will take from 5 to 10 minutes. At the end of the transport, the TIR Carnet is returned to the Guarantee Chain. The guarantee chain archives all TIR Carnets.

4.2.3. Assumptions on the average time to fill in the electronic form of eTIR

The assumption is based on the time required by Customs officers to fill in a NCTS TIR form, after being trained in the NCTS-TIR system.

The time was collected from a test done among 240 Customs officers, immediately after the training sessions. The training and the collection of time responses, was done for the Romanian Customs Administration, before launching NCTS in production.

The time spent is presented in the table below:

Time spent (minutes)	Number of users	%
15-20	7	2.92%
10-15	15	6.25%
7-10	35	14.58%
5-7	60	25.00%
4-5	86	35.83%
3-4	30	12.50%
2-3	5	2.08%
1-2	2	0.83%
Total	**240**	**100%**

Table 17. Time spent to fill in a form

It is assumed that TIR Carnet holders will require the same amount of time to fill in the electronic information currently contained in the paper TIR Carnet.

Considering that Customs officers receive the data filled in by the holder and will only be required to input minimal information (seals, control results, etc.), the assumption is that 30% of processing time will be saved during Customs clearance. (the figure of 30% is based on the percent of new data necessary to be filled in by Customs Officers. The other 70% is considered to be already filled in).

4.2.4. Weighted Labor costs

In the estimations of benefits, we are using weighted labour costs per month and per person.

The formula used is

$$Wlc = \sum_{cty=1}^{68} (clc * pTIR)_{cty}$$

Wlc = weighted labour cost per month, per person

clc = labour costs per month, per person for a country

pTIR = ratio of TIR Carnets used by a country (Number of TIR Carnets used by a country in one year/total number of TIR Carnets used over one year)

cty= country

For EU e considered the labour costs published by EUROSTAT (http://epp.eurostat.ec.europa.eu/cache/ITY_PUBLIC/3-24042012-AP/EN/3-24042012-AP-EN.PDF)

For non-EU countries, we have considered the labour costs published on:

http://www.bls.gov/home.htm

We considered the number of TIR Carnets presented on

http://www.unece.org/fileadmin/DAM/tir/figures/TIRCarnets11.pdf

After applying the formulas above, Wlc has been estimated at $1,600.

4.3. BENEFITS FOR NATIONAL CUSTOMS ADMINISTRATIONS PER YEAR OF FULL USAGE

4.3.1. Benefits from reducing the processing time

Firstly, the costs of using paper –based TIR Carnets versus eTIR are compared.

For a paper-based TIR Carnet, the keying in of data takes 10 to 15 minutes. Therefore, on the basis of 9,000,000 operations per year, Customs officers spend a minimum of 90,000,000 minutes on keying in data.

Considering the statistics on the time required to fill in TIR data electronically as presented in Chapter 4.2.3, the total time required for 9,000,000 eTIR operations is calculated below:

Time (Minutes)	% of users	Total minutes (9,000,000 TIR operations)
15-20	2.92%	3,675,000
10-15	6.25%	5,906,250
7-10	14.58%	9,187,500
5-7	25.00%	11,025,000
4-5	35.83%	11,287,500
3-4	12.50%	3,150,000
2-3	2.08%	393,750
1-2	0.83%	105,000
Total	***100.00%***	***44,730,000***

Table 18. Total time required to fill in eTIR Carnets

Compared to the paper-based TIR Carnet, the results show that the time spent for filling in data electronically represents half of the time required for filling in the paper-based TIR Carnet (45,270,000 minutes less).

Considering labour costs as presented in EUROSTAT, and applying the weight ratio given by the number of TIR Carnets used by each country, an approximate average labour cost of $1600 per month and per person can be computed.

Considering this average labour cost, benefits are estimated at **$7,185,714.29** per year.

It should further be considered that a shorter time required for processing a document does not necessarily lead to a benefit. For example: if there are only two TIR operations processed per day at a specific Customs office, it is not important if the time spent is reduced from 10 to 5 minutes.

Considering that only 60% of such time savings will ultimately lead to actual cost savings for government budget, an annual benefit worth **$4,311,428.57 can still be calculated.**

This is regarded as the direct benefit for Customs administrations, coming from the reduction of staff costs to process TIR operations in electronic form, rather than processing paper-based TIR Carnets.

In addition, it should be highlighted that there are also various indirect benefits of obtaining electronic information in advance, e.g. through improved use of equipment, control lanes, infrastructure, etc.

4.4. BENEFITS FOR THE GUARANTEE CHAIN

4.4.1. Benefits due to a paperless environment

Considering that the printing of TIR Carnets is no longer needed and that 3,000,000 TIR Carnets are used each year, benefits worth $3,000,000 per year ($1 printing cost per TIR Carnet) can easily be achieved.

4.4.2. Benefits from reducing the processing time

Considering also that the distribution and archiving is automatically done through the eTIR international system, benefits worth $3,000,000 per year can be achieved.

4.5. BENEFITS FOR THE TRADER COMMUNITY

4.5.1. Benefits resulted from reducing the processing time

Considering that every year, TIR Carnet holders fill in 3,000,000 TIR Carnets and that the average time required per TIR Carnets is 15 minutes, TIR Carnet holders spend a total 45,000,000 minutes per year with filling in paper TIR Carnets.

Taking into account the statistics in Chapter 4.2.3., the total time required to provide the information electronically is calculated as follows:

Time Interval	Percent Users	Time for 3 000 000 TIR Carnets
15-20	2.04%	1,750,000
10-15	4.38%	2,812,500
7-10	10.21%	4,375000
5-7	17.50%	5250000
4-5	25.08%	5375000
3-4	8.75%	1500000
2-3	1.46%	187500
1-2	0.58%	50000
Total		**21,300,000**

Table 19. Total time to fill in eTIR Carnets

This represents a reduction by 23,700,000 minutes, without even taking into account the fact that, in particular, large companies might adapt their IT systems to automatically process data received from their clients in order to generate the required messages.

Taking a weighted average labor costs of $1,600 per month, the benefits resulted by reducing the processing time are worth $3,761,904.76 per year.

4.5.2. Benefits from reducing time spent at the Customs.

As presented in Chapter 4.3.1, the time required to process a TIR operation by Customs decreases by 45,270,000 minutes per year.

Considering that in only 60% of the situations this reduction affects traffic, the total is calculated at 452,700 hours. (in 40% of situations the waiting time is used by traders for other necessary operations)[1]

Considering a weighted average cost of $35 per hour (personnel and means of transport costs), this gives a figure of **$12,675,600.00** per year (considering that all TIR Carnets are registered electronically).

4.6. BENEFITS WHEN eTIR IS GRADUALLY IMPLEMENTED

Considering the benefits calculated for each paper-based TIR Carnet replaced by an eTIR Carnet, we can estimate the yearly benefits when the eTIR system is implemented gradually.

We present the benefits for a period of 12 years. The first two years are dedicated to constructing the system, while no TIR Carnets are registered in the system during that period.

For the following 10 years, we assume that the number of registered TIR Carnets will be, in thousands:

100; 700; 800; 1,200; 1,300; 2,000; 2,500; 2,600; 2,800; 3,000

Benefits in this case will be:

4.6.1. Benefits (no risk ratio applied)

Year	eTIR (thousands)	Total Benefits	Benefits for Customs
1	0	0	$0.00
2	0	0	$0.00
3	100	$891,631.11	$143,714.29
4	700	$6,241,417.78	$1,006,000.00
5	800	$7,133,048.89	$1,149,714.29
6	1200	$10,699,573.33	$1,724,571.43
7	1300	$11,591,204.44	$1,868,285.71
8	2000	$17,832,622.22	$2,874,285.71
9	2500	$22,290,777.78	$3,592,857.14
10	2600	$23,182,408.89	$3,736,571.43
11	2800	$24,965,671.11	$4,024,000.00
12	3000	$26,748,933.33	$4,311,428.57

Table 20. Benefits, eTIR gradually implemented, no risk ratio

By applying a risk ratio of 80%, we obtain the following benefits per year:

Year	eTIR (thousands)	Total Benefits	Benefits for Customs
1	0	0	$0.00
2	0	0	$0.00
3	100	$713,304.89	$114,971.43
4	700	$4,993,134.22	$804,800.00
5	800	$5,706,439.11	$919,771.43

[1] 40% is based on interviews conducted with transit operators, regarding the time spent is customs

6	1200	$8,559,658.67	$1,379,657.14
7	1300	$9,272,963.55	$1,494,628.57
8	2000	$14,266,097.78	$2,299,428.57
9	2500	$17,832,622.22	$2,874,285.71
10	2600	$18,545,927.11	$2,989,257.14
11	2800	$19,972,536.89	$3,219,200.00
12	3000	$21,399,146.66	$3,449,142.86

Table 21. Benefits, eTIR gradually implemented, risk ratio

A more pessimistic scenario considers that a smaller number of TIR Carnets will be registered into the eTIR system. Such a scenario considers that after 10 year of usage only half of TIR Carnets will be registered in eTIR, the other half being still on paper.

For such a scenario, in the next 10 years we assume that the number of registered TIR Carnets will be, in thousands:

50; 300; 400; 500; 600; 1,000; 1,200; 1,300; 1,400; 1,500

Benefits in this case (after applying the risk factor of 80%) will be:

Year	eTIR (thousands)	Total Benefits	Benefits for Customs
1	0	0	$0.00
2	0	0	$0.00
3	50	$356,652.44	$57,485.71
4	300	$2,139,914.67	$344,914.29
5	400	$2,853,219.56	$459,885.71
6	500	$3,566,524.44	$574,857.14
7	600	$4,279,829.33	$689,828.57
8	1,000	$7,133,048.89	$1,149,714.29
9	1,200	$8,559,658.67	$1,379,657.14
10	1,300	$9,272,963.55	$1,494,628.57
11	1,400	$9,986,268.44	$1,609,600.00
12	1,500	$10,699,573.33	$1,724,571.43

Table 22. Total costs, eTIR gradually implemented

4.7. TOTAL DIRECT BENEFITS PER YEAR OF FULL USAGE

After identifying the possible benefits, and considering that all TIR Carnets are electronically processed, the direct benefits can be summarized as follows:

Type	Normal	Risk ratio (0.8)[2]
Customs (benefits resulted from reducing the processing time for each TIR operation)	$4,311,428	$3,449,143
Guarantee Chain (benefits resulted from paperless environment)	$6,000,000	$4,800,000

[2] 0.8 risk ratio is considered by consultant as the acceptable risk capacity ratio for successful software projects

Traders (Benefits resulted from reducing time to fill in documents)	$3,761,904	$3,009,524
Traders (benefit resulted from reducing time for document processing by the Customs)	$12,675,600	$10,140,480
Total	**$26,748,932**	**$21,399,147**

Table 23. Direct benefits of eTIR

The total benefits per TIR Carnet are: $8.92 (global benefit) or $7.13 benefit after risk ratio application.

The benefits for Customs administrations, per TIR Carnet, will be $1.44 (global benefit) or $1.15 after risk ratio applied.

The benefits per TIR Carnet does not depend on the number of TIR Carnets used, and these figures will be used for all scenarios (big-bang, gradually full usage, gradually partial usage or eTIR)

4.8. ROI AND NPV, eTIR LAUNCHED GRADUALLY

Considering the benefits in Chapter 4.6.1., and the eTIR costs presented in detail, the following tables indicate the ROI and Cash Flow.

The number of TIR Carnets used each year in eTIR is assumed to be as follows:

Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12
		100,000	700,000	800,000	1,200,000	1,300,000	2,000,000	2,500,000	2,600,000	2,800,000	3,000,000

It is assumed that all EU countries will enter the eTIR system in Year 8 (the increase of eTIR Carnet is from 1,300,000 to 2,000,000, then to 2,500,000).

The ROI and NPV are calculated as follows:

B_t : benefits in the year t
C_t :costs in the year t
r : discount rate
CF_t : cash flow in year t

$$CF_t = B_t - C_t$$

$$ROI = \frac{\sum_{t=1}^{12} \frac{B_t}{(1+r)^t} - \sum_{t=1}^{12} \frac{C_t}{(1+r)^t}}{\sum_{t=1}^{12} \frac{C_t}{(1+r)^t}}$$

$$NPV = \sum_{t=1}^{12} \frac{CF_t}{(1+r)^t}$$

		Premises	UNOG	UNICC	PAAS	IAAS	SAAS
Costs	Development	1,127,000	1,127,000	1,127,000	1,127,000	1,127,000	0
	Initial	1,450,000	792,500	743,000	183,000	743,000	15,000
	Oper. + Hosting	2,981,001	1,378,468	1,456,668	1,024,624	867,717	17,000,000
	Sub-total	5558001	3297967.667	3326667.667	2334624	2737716.72	17015000
	Help Desk	2,210,000	2,210,000	2,210,000	2,210,000	2,210,000	2,210,000
	National App	8,550,000	8,550,000	8,550,000	8,550,000	8,550,000	8,550,000
Total Costs		16318001	14057967.67	14086667.67	13094624	13497716.72	27775000
Total Costs (incl. 20% risk factor)		19581601.2	16869561.2	16904001.2	15713548.8	16197260.06	33330000
Discounted Costs (incl. risk factor)		14979068.75	12941676.07	12950076.76	12391640.15	12470893.72	23464072.7
Benefits for Customs (incl. 20% risk factor)		19,550,000	19,550,000	19,550,000	19,550,000	19,550,000	19,550,000
Total Benefits (incl. 20% risk factor)		121,210,000	121,210,000	121,210,000	121,210,000	121,210,000	121,210,000
Discounted Customs Benefits (incl.risk factor)		13,255,247	13,255,247	13,255,247	13,255,247	13,255,247	13,255,247
Discounted Overall Benefits (incl.risk factor)		82,182,532	82,182,532	82,182,532	82,182,532	82,182,532	82,182,532
ROI for Customs		-12%	2%	2%	7%	6%	-44%
Overall ROI		449%	535%	535%	563%	559%	250%
Net present value		67,203,464	69,240,856	69,232,456	69,790,892	69,711,639	58,718,460

Table 24. Summary of cost benefit analysis (USD), eTIR gradually used reaching 3 million TIR transports annually

4.9. ROI AND NPV, eTIR LAUNCHED GRADUALLY, HALF USAGE OF eTIR SYSTEM

Considering the benefits in Chapter 4.6.1, with only HALF of the total number of TIR Carnets registered in eTIR, the following tables indicates the ROI and Cash Flow.

The number of TIR Carnets used each year in eTIR is assumed to be as follows:

Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12
		50000	300000	400000	500000	600000	1000000	1200000	1300000	1400000	1500000

Using the same approach as presented in Chapter 4.8, we have obtained the following summary of costs benefits:

		Premises	UNOG	UNICC	PAAS	IAAS	SAAS
Costs	Development	1,127,000	1,127,000	1,127,000	1,127,000	1,127,000	0
	Initial	1,450,000	792,500	743,000	183,000	743,000	15,000
	Oper. + Hosting	2,981,001	668,962	706,912	497,244	421,098	8,250,000
	Sub-total	5558001	2588462.25	2576912.25	1807244	2291097.82	8265000
	Help Desk	2,210,000	2,210,000	2,210,000	2,210,000	2,210,000	1,286,300
	National App	8,550,000	8,550,000	8,550,000	8,550,000	8,550,000	8,550,000
Total Costs		16318001	13348462.25	13336912.25	12567244	13051097.82	18101300
Total Costs (incl. 20% risk factor)		19581601.2	16018154.7	16004294.7	15080692.8	15661317.38	21721560
Discounted Costs (incl. risk factor)		14979068.75	12362150.6	12337675.01	11543029.87	12523939.72	15492842.56
Benefits for Customs (incl. 20% risk factor)		9,487,500	9,487,500	9,487,500	9,487,500	9,487,500	9,487,500
Total Benefits (incl. 20% risk factor)		58,822,500	58,822,500	58,822,500	58,822,500	58,822,500	58,822,500
Discounted Customs Benefits (incl.risk factor)		6,406,022	6,406,022	6,406,022	6,406,022	6,406,022	6,406,022
Discounted Overall Benefits (incl.risk factor)		39,717,335	39,717,335	39,717,335	39,717,335	39,717,335	39,717,335
ROI for Customs		-57%	-48%	-48%	-45%	-49%	-59%
Overall ROI		165%	221%	222%	244%	217%	156%
Net present value		24,738,266	27,355,184	27,379,660	28,174,305	27,193,395	24,224,492

Table 25. Summary of cost benefit analysis, eTIR gradually used, finally half eTIR Carnets registered

4.10. ROI AND CASH FLOW FOR CUSTOMS, FOR ONE CUSTOMS ADMINISTRATION

Using the approach presented in Chapter 4.6, we are computing the ROI and cash flow for one country considering the following:

- All general costs are equally distributed for each country.
- We consider only the gradual implementation (full use) scenario.
- The initial cost to develop the National Interface to eTIR will be considered once, in the second year of development of eTIR system.
- The computations are made for various types of countries, according to the number of eTIR processed per year:
    - 30,000;
    - 100,000;
    - 500,000.

4.10.1. ROI, Cash flow and NPV for Customs for one country processing 30 000 TIR Carnets per year

	Premises	UNOG	UNICC	PAAS	IAAS	SAAS
Total Costs (for 1 country)	286,281	246,631	247,135	229,730	236,802	487,281
Total Costs (including 20% risk factor)	343,537	295,957	296,561	275,676	284,162	584,737
Discounted Costs (incl. risk factor)	299,896	264,152	264,300	247,172	255,893	448,756
Benefits for Customs (including 20% risk factor)	345,000	345,000	345,000	345,000	345,000	345,000
Discounted Overall Benefits (incl.risk factor)	253,714	253,714	253,714	253,714	253,714	253,714
ROI for Customs	-15%	-4%	-4%	3%	-1%	-43%
Net present value (for Customs)	-46,182	-10,438	-10,586	6,542	-2,179	-195,042

Table 26. Summary of cost- benefit analysis, 30 000 eTIR registered per year

4.10.2. ROI, Cash flow and NPV for Customs for one country processing 100,000 per year

Using the same approach and the same formulas as in the previous chapter, but using instead a different number of TIR Carnets registered, it results in the following summary of costs, benefits and ROI:

	Premises	UNOG	UNICC	PAAS	IAAS	SAAS
Total Costs (for 1 country)	286,281	246,631	247,135	229,730	236,802	487,281
Total Costs (including 20% risk factor)	343,537	295,957	296,561	275,676	284,162	584,737
Discounted Costs (incl. risk factor)	299,896	264,152	264,300	247,172	255,893	448,756
Benefits for Customs (including 20% risk factor)	1,150,000	1,150,000	1,150,000	1,150,000	1,150,000	1,150,000
Discounted Overall Benefits (incl.risk factor)	845,714	845,714	845,714	845,714	845,714	845,714
ROI for Customs	182%	220%	220%	242%	230%	88%
Net present value (for Customs)	545,818	581,562	581,414	598,542	589,821	396,958

Table 27. Summary of cost benefit analysis, 100 000 eTIR registered per year

4.10.3. ROI, Cash flow and NPV for customs for one country processing 500 000 per year

Using the same approach and the same formulas as in the previous chapter, with a different number of TIR Carnets registered, it results in the following summary of costs, benefits and ROI:

	Premises	UNOG	UNICC	PAAS	IAAS	SAAS
Total Costs (for 1 country)	286,281	246,631	247,135	229,730	236,802	487,281
Total Costs (including 20% risk factor)	343,537	295,957	296,561	275,676	284,162	584,737
Discounted Costs (incl. risk factor)	299,896	264,152	264,300	247,172	255,893	448,756
Benefits for Customs (including 20% risk factor)	5,750,000	5,750,000	5,750,000	5,750,000	5,750,000	5,750,000
Discounted Overall Benefits (incl.risk factor)	4,228,569	4,228,569	4,228,569	4,228,569	4,228,569	4,228,569
ROI for Customs	1310%	1501%	1500%	1611%	1552%	842%
Net present value (for Customs)	3,928,673	3,964,417	3,964,269	3,981,397	3,972,676	3,779,813

Table 28. Summary of cost benefit analysis, 500 000 eTIR registered per year

5. RECOMMENDATIONS AND CONCLUSIONS

Considering the technical characteristics, and the cost-benefit analysis, our recommendations/conclusions are as follows:

A. It is better to implement eTIR as soon as possible, in order to increase the benefits it can offer;
B. Given the technical assessment and the results of the CBA, we can rank the preferred architecture alternatives as follows:
    1. Implementation of eTIR using a PaaS (The best both from a technical point of view and ROI point of view);
    2. Implementation of eTIR using IaaS, UNOG or UNICC.
C. If the eTIR is used for half of the TIR Carnets, ROI for Customs is negative.

A minimal number of eTIR transports (approx. 30'000) is necessary to have a positive ROI for Customs, as described in chapter 4.10.

The benefits of implementing eTIR system are very important for all the stakeholders involved in the eTIR procedure: Customs, that benefits from reducing the processing time for each TIR operation, Guarantee Chain that benefits from using paperless environment, the Traders benefiting from reducing time to fill in TIR Carnets and from the time reduction for Customs' processing of the TIR Carnets.

For one country, the minimum number of eTIR Carnets to be registered in eTIR, so that ROI becomes positive (at least in one of the options), is around 30,000.

Moreover, the implementation of the eTIR system offers benefits also to all Customs administrations, providing numerous possibilities for risk management, based on the advance cargo information, thus reducing the fraud risk.

In conclusion, we consider that it is highly important for the project's success that all the stakeholders become involved in the implementation of the eTIR project from the very beginning.

A. ANNEXES

A.1. ARCHITECTURE ALTERNATIVES

A.1.1. *Introduction*

The present document presents different architectures that could be envisaged for the implementation of the eTIR international system. This document does not present use cases, processes and activity diagrams as they are described in detail in the eTIR Reference Model v3.0 [R1-R5]. It is assumed that the system will cover ALL the functionalities described in the eTIR Reference Model v3.0. This chapter is organized as follows:

First, we recall the eTIR objectives and boundaries, as contained in the eTIR Reference Model v3.0. Then, we present the technical requirements that have been taken into account for the eTIR-CBA.

This is followed by the conceptual architecture, which is based on four system tiers (Security, Management, Access, Kernel) and is independent of any hardware and software platform. In continuation, we introduce the logical architecture, in which all main logical components are presented.

Starting with the conceptual and logical architecture, we formulate proposals for two main categories of system solutions:

- Solutions based on clouds: Infrastructure as a Service (IaaS), Platform as a Servive (PaaS) and Software as Service (SaaS);

- Solution based on implementation at premises (Premises) (either a new environment or by means of using an existing environment).

For architectures based on clouds, a technical comparison is made between the three main cloud providers: Amazon, Google and Microsoft.

Finally, a technical comparison of the various architectural alternatives is made.

A.1.2. *eTIR Objectives and boundary*

A.1.2.1 eTIR Objectives

According to what has been established in the eTIR Reference Model [R1-R5], the objectives of eTIR are described below:

The final objectives of the eTIR Project are:

- Integrating the computerized TIR procedure in the overall process of technological development in international transport, trade and Customs procedures:
  - Simple and cost effective data capture and data transmission;
  - Facilitation of global intermodal application of the TIR Procedure;
  - Real time exchange of information among actors;
- Improving the efficiency and quality of the TIR procedure:
  - Reduction of processing times at border crossings and final destination;
  - Increased efficiency of internal administrative and control procedures;
  - Increased accuracy and reduction of errors;
  - Reduction of costs;

- Progressive replacement of paper TIR Carnet;
- Full use of international standard codes in order to eliminate language barriers;
- Availability of advance cargo information;

- Reducing the risk of fraud and improving security:
  - Automatic generation of data for risk assessment;
  - Facility to implement early-warning system;
  - Easy access to information for control and risk management purposes.

A.1.2.2 Boundary of the eTIR Project

The final objective of the eTIR project encompasses the computerization of the whole TIR Carnet life cycle (from issuance and distribution via the TIR transport to return and repository) and is ultimately aimed at replacing the current paper TIR Carnet. However, the eTIR Project will inevitably have repercussions on other parts of the TIR Procedure. Therefore, it is important to identify the boundaries of the project in order to realize the full impact the project may have and to ensure that the views of all stakeholders are taken into due account. The boundaries are defined along two axes: stakeholders and information.

A.1.2.3 Stakeholders

A stakeholder is defined as someone (or something) who is materially affected by the outcome of the system but may or may not be an actor of the system. Actors are stakeholders who are involved in the specific project as users and are thus part of the Reference Model. Stakeholders inside the boundary of the system are involved in the project as active participants in the work and/or members of decision-making bodies; those outside the boundary may participate in meeting to ensure any future compatibility where necessary.

Figure 2 shows the stakeholders inside and outside the boundaries of the project and emphasizes those who are also actors:

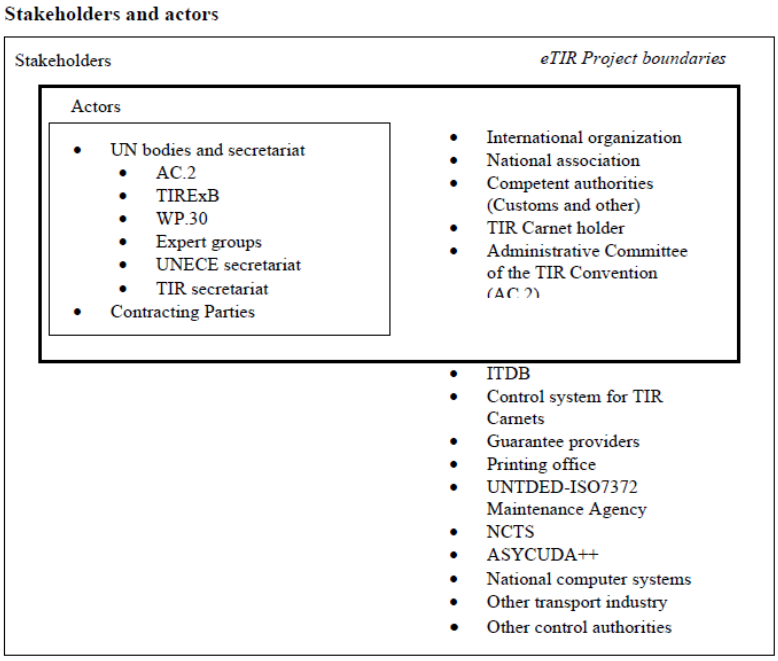

Fig 2. Stakeholders and actors[R1]

A.1.2.3.1 Information

The data elements inside the boundaries have been identified and are listed in Annex A.3 of the eTIR Reference Model. These data elements reflect the information contained in the current, paper-based, TIR Carnet and provide the basis for the elaboration of a minimal set of data to be computerized.

A.1.3. *Technical Characteristics*

A.1.3.1 Centralized approach

The eTIR international system will be fully centralized, both from a data and application point of view. Centralization of data will be accomplished by:

- Storage of all main information in only one central database;
- Access to external modules via a single communication interface, based on XML format.

Centralization of application will be accomplished by:

- Development of a dispatcher mechanism, used to orchestrate message exchange between actors involved (mainly Customs administrations). Exchange of messages will be done using web services. Both the synchronous and asynchronous mode will be used. In synchronous mode, notifications of data reception will be sent in response to a message. In asynchronous mode, more complicated notifications or messages will be sent as a result of status change of a document;
- Development of a web based system, with clients on web browsers used to view or update data. View of data will be accessible any time, under any circumstances. Process data in a web based centralized system will be possible as a fallback procedure, when the systems linked in the Service Oriented Architecture (SOA) environment do not work properly, or for situations when such systems do not provide a good data entry mechanism.

A.1.3.2 Web-based system, online data entry

The eTIR international system will be fully WEB based. It will follow J2ee or .NET organization. The servers will be J2ee servers, or Microsoft .NET.

Clients will be:

- Customs IT applications, connected to the central system using web services;
- Web browsers or smart clients accessing the main server, for data view or fallback procedures.

A.1.3.3 Service Oriented Architecture (SOA)

Service-Oriented Architecture (SOA) is defined as “the policies, practices, and frameworks that enable application functionalities to be provided and consumed as sets of services published at a granularity relevant to the service consumer. Services can be invoked, published and discovered and are abstracted away from the implementation by means of using a simple, standard-based forms of interface.”

The eTIR architecture will be compliant with the above definition of SOA. Web-services protocols will be “standard-based forms of interface” for eTIR. The eTIR functionality that is deemed to be of interest to other applications from Customs, from the External Domain or from other Government Agencies will be exposed at appropriate granularity levels via standards-based interfaces. New software applications (even in the next 10 or 20 years) will be able to consume these services and integrate with the eTIR international system because their interfaces are based on standards and are not proprietary.

A.1.3.4 Data exchange using XML and Web Services

Data exchange will be possible in the following ways:

- **Web Services: users (IT systems of national/regional Customs administrations) use web service to exchange data with the eTIR international system;**
- **Web application: users (Customs officers) access the eTIR international system by means of a secure web application that allows them to view and change data (according to roles). This option is mainly envisaged as a fallback solution.**

A.1.3.5 Integration with third party applications, in particular reporting tools

The system will have also a layer of **web services** offering data to external modules.

A.1.3.6 Reusability of data

Data will be registered by each Customs administration which will be the owner and the responsible entity for it.

All exchanged messages will also be stored in the central eTIR international system with their full history.

A.1.3.7 Scalability

The system will have a completely scalable architecture, both horizontally and vertically. The system will be able to handle larger volumes of data and users in a cost-effective manner by adding more processors and/or memory to the existing machines or by employing multiple servers without changes in the application code or general architecture.

The system will be modular and be prepared to be implemented in a scalable environment.

To cope with larger numbers of users, or increased calculation complexity, the system should also be able to scale with only configuration changes or/and additional hardware.

A.1.3.8 System Performance

The response time of the application will be closely monitored and optimized throughout all phases during the system life cycle.

The system will have the capability to handle an unlimited number of registered users.

This will be achieved using an extensible user management solution, either a Lightweight Directory Access Protocol (LDAP) or a customized security module, neither having any limitations in the number of users that can be stored.

To address the problem of concurrent sessions, the application will use software clustering on the existing hardware to improve availability and scalability. Similar application solutions have shown to support an almost linear dependency between the number of cluster nodes and the number of supported concurrent sessions.

The system should provide acceptable data exchange response times. For Customs-to-Customs (C2C) connections, in synchronous mode, the response time should be less than 1 second.

The system should provide acceptable screen response times in case the web user's interface is used (less than 3 seconds per page view during normal working hours, and less than 5 seconds per page view at peak time). Peak hours will be established depending on the maximum number of operations at a specific hour. Considering the actual statistics, peak time will be considered for time zones between GMT+1 (Central Europe) and GMT+3(Russia).

A.1.3.9 High availability

The application will be designed to allow all the tiers to run on clustered hardware and be deployed on a virtual cluster of one node. This will allow clustering without changing the application code.

The system is considered to be a mission critical application and, thus, should be 99.99% available. For calculation purposes, the maximum allowed downtime will be 1 hour per week.

A.1.3.10 Reliability and stability

The system should support advanced mechanisms to ensure reliable data delivery and processing, such as durable topics, local transactions, message expiration and acknowledgement.

- The system should support an initial capability of 80 concurrent system- to-system connections, exchanging data by means of using web services (57 possible Customs systems, plus possible other actors and a reasonable free number of connections);
- The system should support an initial capability of 1000 concurrent users accessing the web interface. The web user interface is developed as an alternative for a C2C system, for situations such as fallback procedures, or in case Customs systems do not yet provide sufficient services for the electronic treatment of TIR Carnets.

A.1.3.11 Expansibility, configurable at runtime

Modules can be easily added, with or without minimal changes in the current architecture. Also because of the common Application Programming Interfaces (API) used: Simple Object Access Protocol (SOAP), Remote Method Invocation (RMI), Java Naming and Directory Interface (JNDI), etc. Third party software will be able to integrate seamlessly.

A.1.3.12 General technical requirements

Below follows a list of general technical requirements that need to be met by the eTIR international system:

- Unicode compliance;
- For all documents: history of operations as well as owner of the document will be stored in the database.

A.1.4. *The eTIR international context*

The eTIR international system is a centralized system, which will be responsible for data exchange between the IT systems of different national Customs administrations.

Data exchange will be possible via two channels:

- Via web services. There will be system-to-system connections between national Customs administrations and the eTIR international system;
- On a web interface (usually on https) where users enter and view data in a web user interface. This is mainly designed for fallback procedures.

The relation between the eTIR international system and other IT systems is presented in the figure below:

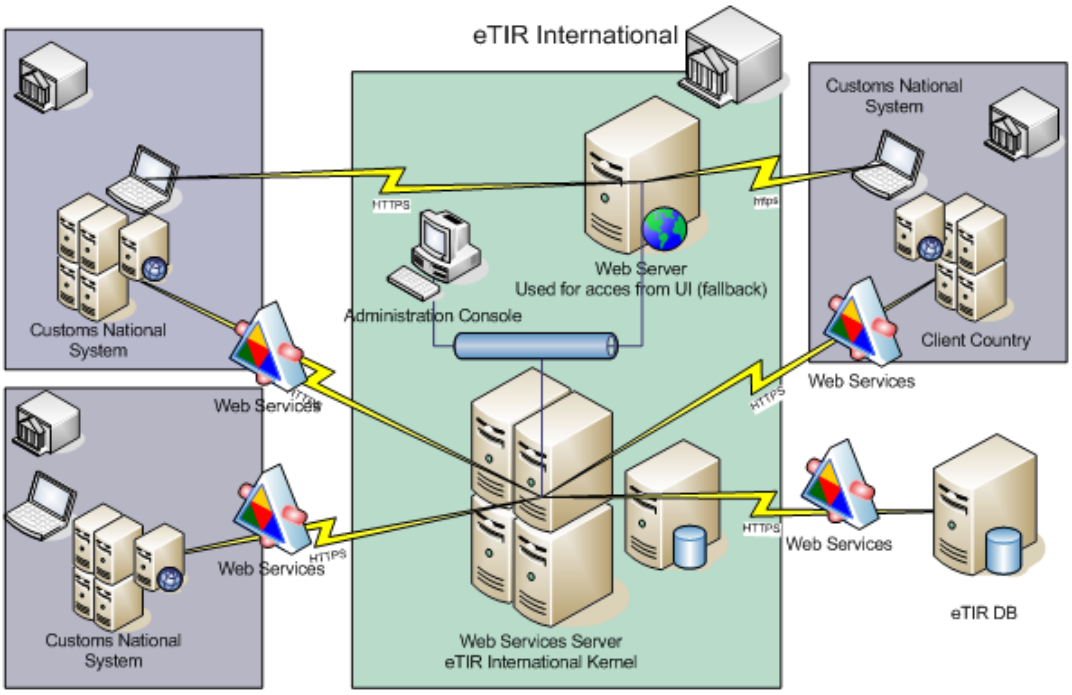

Fig 3. eTIR international context

A.1.5. *Conceptual architecture*

The eTIR system will integrate several multi-tier architecture systems in a global SOA concept. Each particular system will have a very well-defined functionality and will work both integrated, in the global SOA architecture, and separately, as a stand-alone application.

The conceptual architecture, presented in the figure below, is built up of several layers:

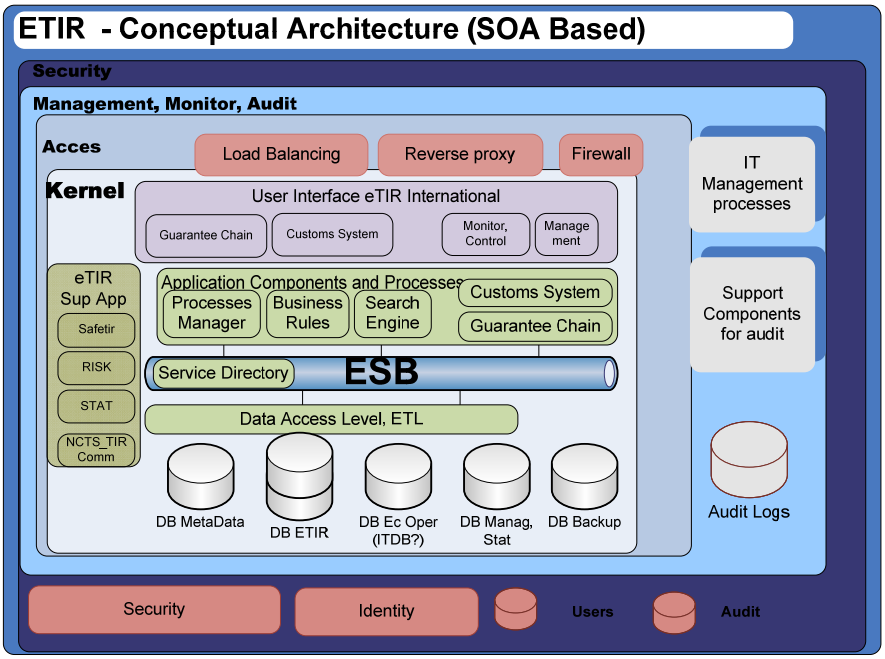

Fig 4. eTIR Conceptual Architecture

The following main layers are considered:

- Solution Security Layer;
- Software infrastructure, IT Management, Monitor, Audit Layer;
- Access Management and Load Balancing Layer;
- Kernel Layer.

A.1.5.1 Solution Security Layer

Due to the fact that, in any modern application, security is paramount, a complex security solution will be implemented, which will ensure data confidentiality in each application layer (Cross-layer security). All access information will be stored in a central repository, which will be implemented either as a Customs secure repository implementation or using LDAP.

The security system will implement both data security and functional security.

The application will be compliant with EU regulation EU 1663/95 and will follow the directives stated in ISO Standard No. 17799.

The application will use the principle of Single Sign-On and, once a user is authenticated, he will not be required to re-enter his credentials during the on-going session.

Data sent via Web Services will be signed and encrypted, using a private public pair key. Access to web services will be allowed only for well-known secured IPs. Firewalls and reverse proxy will protect system from not authorized access.

A.1.5.2 Software infrastructure, IT Management, Monitor, Audit Layer

IT Management, Monitoring and Auditing systems will be set up in order to avoid potential problems of the system in reporting incomprehensible or incoherent errors.

Two main aspects will be considered:

- The management and monitoring of Software systems;
- Error treatment.

A.1.5.2.1 Management and monitoring

A comprehensive, integrated management solution that helps businesses achieve high levels of performance and availability and reduce the costs of managing applications is required. This should, proactively, monitor the health of all application components, the hosts that they run on and the key business processes that they support.

Besides monitoring and diagnostics, management of the configuration of application environments through its integrated configuration management tool is also required. Management will include:

- Ensuring performance and availability;
- Resolving problems quickly if they occur in order to minimize their impact;
- Containing the on-going costs associated with managing the applications;
- Aligning IT and line-of-business priorities so that the resources are deployed towards those activities which generate the greatest benefits for business.

A.1.5.2.2 Error detection and recording

Errors, displayed to the system users, will have defined error types identified by appropriate numbers. Additionally, each error type reported by the application will be recorded with a unique number, enabling its identification by the system administrator.

The application will provide detailed error handling regarding two types of errors that may occur: business and application errors.

A.1.5.3 Access Layer

The Access Layer will be based on Application Server components and clusters. Also at the access layer, the following is necessary:

- Web server load balancing - to load-balance transactions to the least-highly-loaded HTTP server (HS);
- Cluster instance load balancing;
- Automated Storage Load balancing. Shared disk storage resources can alternatively be assigned to individual databases and easily be moved from one database to another as processing requirements change;
- Data Guard Load Balancing - load balancing between standby databases.

A.1.5.4 Kernel Layer

The **Kernel Layer is responsible for the business process in the eTIR international system.** It is also composed of several tiers:

UI (Presentation) Tier;

Application Tier;

Persistence Tier.

The **UI** (**Presentation) Tier** contains the user interface and is responsible for the interaction between the end user and the application. The client will use a standard Web Browser (Microsoft Internet Explorer, Mozilla Firefox, Apple Safari, Opera, etc.) to interact with the application. Every modern operating system has a Web Browser, so no additional software will be needed in order to use the application. On the server side, this tier will be composed of a Web Server, which will serve the static content and will act as a reverse proxy for the Application Server. It should be noted that the presentation tier will follow the Single Access Window concept. This allows users to use the same entry point for data in all system modules.

This User interface is for fallback procedure, as the main functionality of the system is based on data exchange via web services.

The **Application (Middle) Tier** will encapsulate the application logic and behavior and will be based on a standard JEE application server or .NET application Server.

The proposed application server is able to run in a clustered environment and to load balance requests to all the nodes, share state information between nodes and recover from server failure.

The **Persistence Tier** is responsible for data storage and retrieval and will be an Relational Database Management System (RDBMS) instance.

A.1.5.4.1 Presentation Tier

The presentation tier contains the user interface and exposes the services of the system to the user. The client will access the application using a standard Web Browser, which will require JavaScript.

The HTML pages displayed by this tier will be generated in the application tier. Simple validation will be carried out on the client side (through a browser using JavaScript), but the final data validation will be done in the application tier.

For security reasons, some, or all, communications will be done through HTTPS, a protocol which adds a layer of Secure Socket Layer (SSL) encryption over standard HTTP. The use of this protocol will ensure confidential communication between the server and the client.

The web application will use a single point of authentication. The user will be authenticated only once per session. The user interface is generated dynamically and the user will see and have access only to the functionalities for which he is authorized.

A.1.5.4.2 Application (Middle) Tier

The Application Tier is divided into two distinct but interconnected parts: the domain logic and the application logic. The domain logic models the processes of the business, while the application logic models the aspects of this software implementation.

The domain logic will be implemented using simple domain objects and business objects. The domain objects will be simple objects, which do not contain any business logic; they merely hold the state of the application. These domain objects will be shared between the three layers of the application. The business objects will encapsulate the business rules and are responsible for the business logic. The core business logic will be encapsulated in packages and Java distinct classes, which will allow a consistent implementation across the different modules and promote code re-usability.

The application logic boundary will be defined using a Service Layer, a layer of services that establishes a set of available operations and coordinates the application response to each operation. The service layer will coordinate the persistence but will not persist the objects.

In this way, the modules could work in a SOA environment, as orchestrated services or as a choreography established by the process manager. They could also work separately, with very well-defined functionalities, to couple to the SOA architecture, when necessary.

The Application Tier will contain the business logic for the following modules:

- eTIR Main business:
  - eTIR transport (registration and exchange of declaration information);
  - eTIR operations;
  - Enquiry and recovery;
  - Reference data and authorizations.
- Guarantee management.
- Management and monitoring modules:
  - Management and administrations;
  - Monitoring system;
  - Knowledge base.
- eTIR Sub modules:
  - SafeTir communications;
  - NCTS_TIR data exchange module;
  - Reports, Statistics;
  - Connectivity to the ITDB. This might be a submodule tp be developed.

A.1.5.4.3 Persistence (Data Source) Tier

This tier will be responsible for storing and retrieving the data processed by the Business Tier. The data will be stored in an Relation Database Management System (DBMS). The database should be compatible with the platform chosen, such as, for instance, Oracle Database. But in a cloud of type PaaS, other options are available, like Microsoft Azure. The business layer will access the data source tier through the persistence layer located in the Business Tier.

The database should offer centralized administration and built-in validation, data protection and disaster recovery facilities, through the use of standard management tools.

Employing data constraints like foreign keys, unique keys and field constraints will ensure information integrity. The database should support internationalization, and will use the UTF-8 Character set, which provides support for almost any alphabet and language.

The database should refer to the following logical components:

- DB Metadata – will contain the metadata used to define all configurations of the eTIR international system. Also Reference tables will be stored there;
- DB eTIR – will contain the main data used by the eTIR international system operational. Messages received via web services, or sent via web services, with all history and accompanying information will be stored there;
- DB Ec Operator – will contain information about TIR Carnet holders. It is recommended to use the International TIR Database (ITDB), but if this tool is not available online, it is recommended to use a local database for this purpose;
- DB Management and Statistics – this will be a staging database used to store data for Data Warehouse purpose, reports, statistics;
- DB Backup – this will be a staging database used for backups.

In order to integrate different data sources, a Data ETL (Extract, Transform, Load) module will be available.

A.1.6. *Logical architecture*

The components described in the conceptual model could logically be grouped, based on their main functionality, in:

- **eTIR international kernel. (called also eTIR kernel)**

  This part is responsible for:

  - business logic implementation;
  - communication management using web services or web access;
  - data persistence;
  - public interfaces to other modules or systems.

- **eTIR user interface**

  This part will be responsible for data viewing and processing, via a web user interface.

  It will call processes defined in eTIR Kernel and will be used mainly as a fallback procedure, when system-to-system communications between the eTIR kernel and other participants in the eTIR life cycle will not work properly.

- **eTIR administration console**

  This part has functions for system administration and monitoring. It will be used by the system administrator to manage users, roles, reference data, to monitor system functionality and to audit the processes.

  The distribution of logical components and the relation with external interfaces is presented in the figure below.

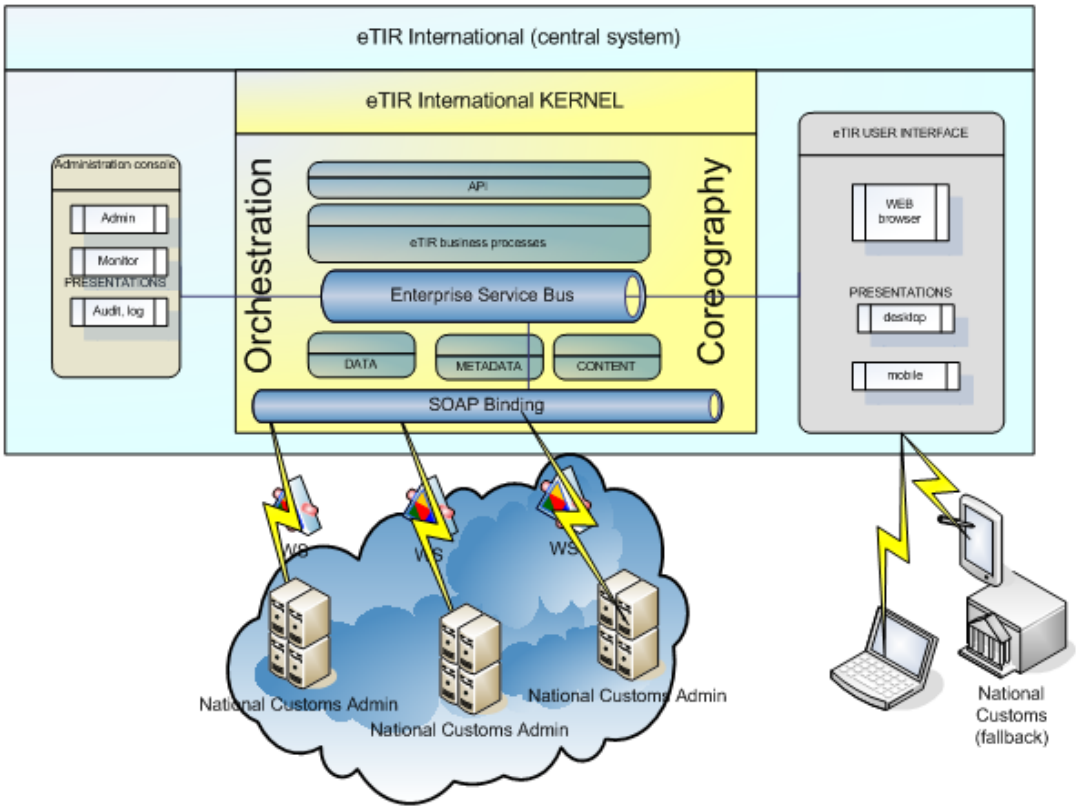

Fig 5. eTIR logical architecture

A.1.7. *Solutions Overview*

This section presents the envisaged solutions. Based on the efforts already made in the eTIR Reference Model V3.0, it has been established that the analysis will include the following architectural alternatives.

Three major alternatives, each one with several options will be considered in the evaluation of the cost-benefit analysis:

- Implementation using cloud computing concepts (described below):
    a. Infrastructure as a Service (IaaS);
    b. Platform as a Service (PaaS);
    c. Software as a Service (SaaS);
- Hosting all hardware infrastructure, hardware systems, software systems at the premises of the owner of the eTIR system and using a completely separate environment ('Premises', described below);
- Implementation using cloud computing concepts by hosting the eTIR system at the premises of other IT systems ('UNICC/UNOG', described below). This alternative is similar to IaaS or PaaS, but the infrastructure or the platform will be provided by a third party, e.g.UNOG (United Nations Office at Geneva) or UNICC (United Nations International Computing Center).

The next chapters will present a detailed description of all alternatives to be considered.

A.1.8. *Clouds for eTIR*

A.1.8.1 Clouds definitions[1]

As defined by American National Institute for Standards and Technology (NIST),

"Cloud computing is a pay-per-use model for enabling available, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, services) that can be rapidly provisioned and released with minimal management effort or service provider interaction. "

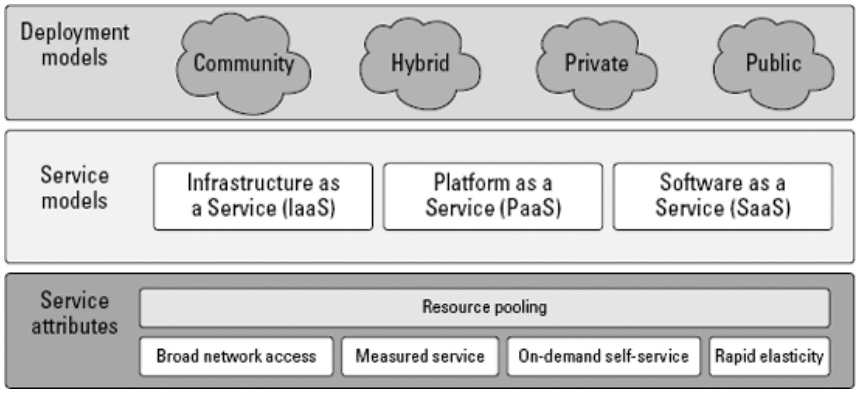

Fig 6. Clouds defined by NIST[1]

A.1.8.2 Clouds implementations

There are several implementations of the concept of cloud computing. Mainly they could be categorized in:

- *Private cloud.* The cloud infrastructure is owned or leased by a single organization and is operated solely for that organization;
- *Community cloud.* The cloud infrastructure is shared by several organizations and supports a specific community that has shared concerns (e.g., mission, security requirements, policy, and compliance considerations);
- *Public cloud.* The cloud infrastructure is owned by an organization selling cloud services to the general public or to a large industry group;
- *Hybrid cloud.* The cloud infrastructure is a composition of two or more clouds (internal, community, or public) that remain unique entities but are bound together by standardized or proprietary technology that enables data and application portability (e.g., cloud bursting).

Each deployment model instance has one of two types: internal or external.

Internal clouds reside within an organization's network security perimeter and external clouds reside outside the same perimeter.

This will be the first architectural option described and analyzed.

A.1.8.3 Clouds alternatives[1][3][6][7]

When discussing alternatives for clouds, the following sub-alternatives will be presented:

- Infrastructure as a Service (IaaS);
- Platform as a Service (PaaS);
- Application as a Service (AaaS) or Software as a Service (SaaS).

The proposed implementation of the eTIR international system by means of clouds alternatives will have the following characteristics:

A.1.8.3.1 Infrastructure as a Service (IaaS)

For this alternative:

- The hardware and infrastructure are owned and maintained by a **cloud provider**. (for example: Amazon). For the purpose of this analysis, a private cloud is necessary (dedicated hardware owned by a cloud provider and used only by UNECE). The costs are per usage of data storage, processor operations and network traffic;
- Platforms are owned, installed, configured and maintained by **UNECE;**
- The eTIR international system is developed, owned, installed, configured and maintained by **UNECE;**

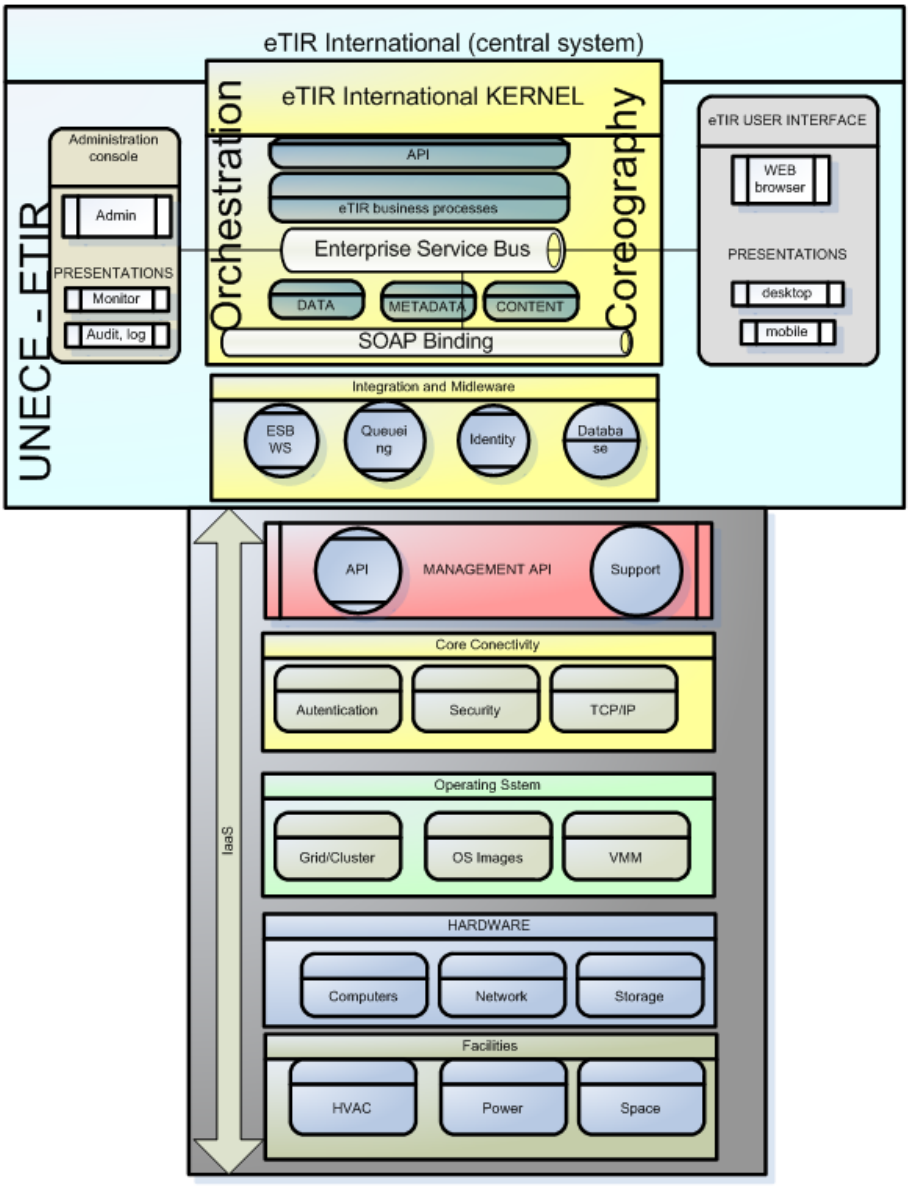

Fig 7. eTIR in IaaS

A.1.8.3.2 Platform as a Service (PaaS)

For this alternative:

- The hardware and infrastructure are owned and maintained by a **cloud provider** (for example: Google or Microsoft). The cloud should be a private cloud (dedicated hardware for UNECE usage only);
- Platforms are owned, installed, configured and maintained by a **cloud provider. Platforms are defined by UNECE.** The costs are per usage of data storage, processor operations and network traffic;
- The eTIR international system is developed, owned, installed, configured and maintained by **UNECE**;

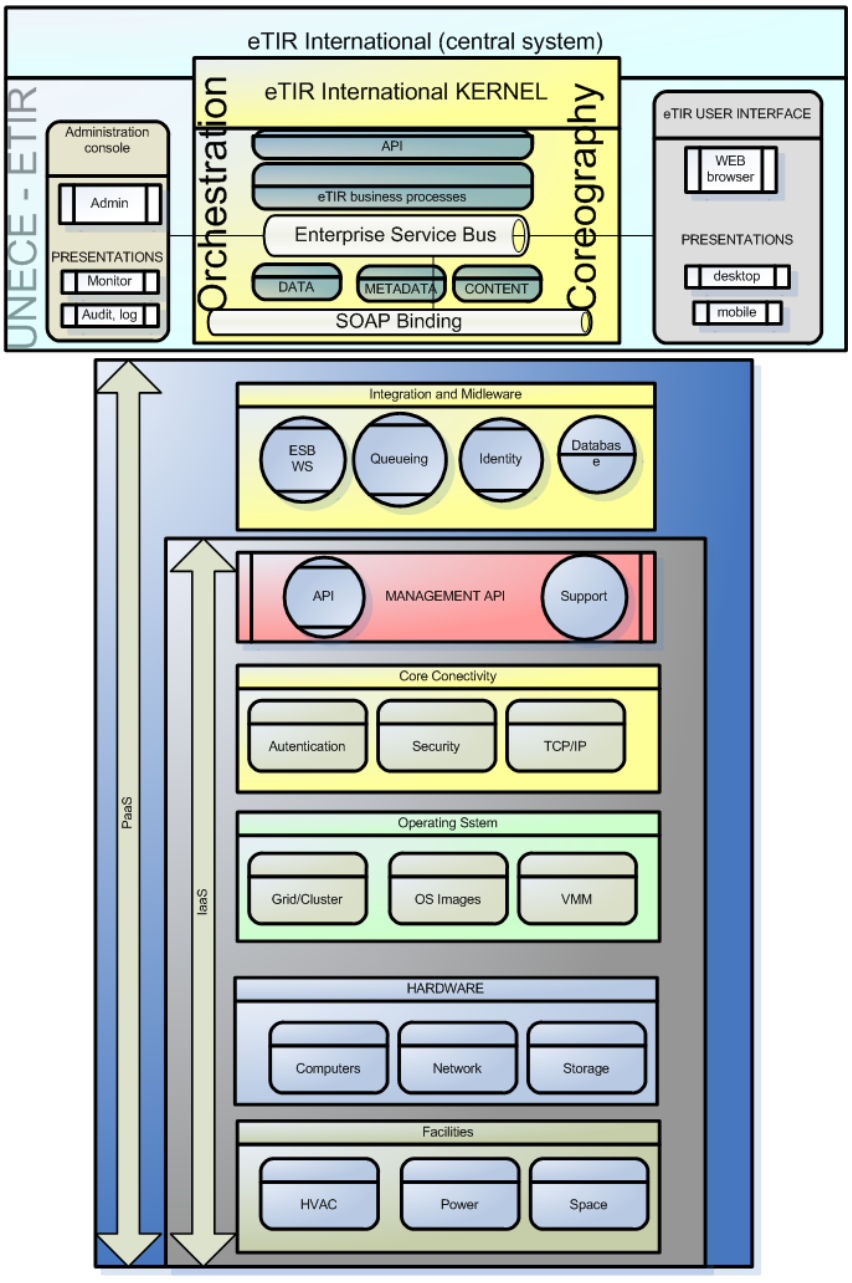

Fig 8. eTIR in PaaS

A.1.8.3.3 Software as a Service (SaaS)

For this alternative:

- The hardware and infrastructure are owned and maintained by a **cloud provider** (for example: a private company able to develop Customs software services). The cloud should be a private cloud (dedicated hardware for UNECE usage only). It might also be obtained from another provider, like for PaaS or Iaas;
- Platforms are owned, installed, configured and maintained by a **cloud provider;**
- The eTIR international system is developed, owned, installed, configured and maintained by a **cloud provider contracted by UNECE according to strict criteria and conditions.** The costs are per guarantee;

From an architectural point of view, the implementation is similar to the at premises alternative. The big difference resides in the fact that at premises everything (hardware, software) is owned, maintained and operated by UNECE, whereas in SaaS everything (hardware, software) is owned, maintained and operated by the SaaS provider.

A.1.9. *New hardware and software environment*

This option considers building the whole system from scratch: from building space, facilities, up to the eTIR software system.

The architecture considers a fully web-based centralized system, accessible from any place. High availability, scalability and high performance are the most important requirements for such a system.

For this alternative:

- The hardware and infrastructure are owned and maintained by **UNECE;**
- Platforms are owned, installed, configured and maintained by **UNECE;**
- The eTIR system is developed, owned, installed, configured and maintained by **UNECE;**

For this alternative, the following items will be taken into account:

  - Infrastructure (buildings, heating, power supply, facilities, backups, etc);
  - Hardware environment (computers, networks);
  - Software environment (operating systems, databases, frameworks, monitoring systems).

All expenses for buying, installing and maintaining the components will be considered.

The architecture is presented in the figure below:

eTIR physical architecture

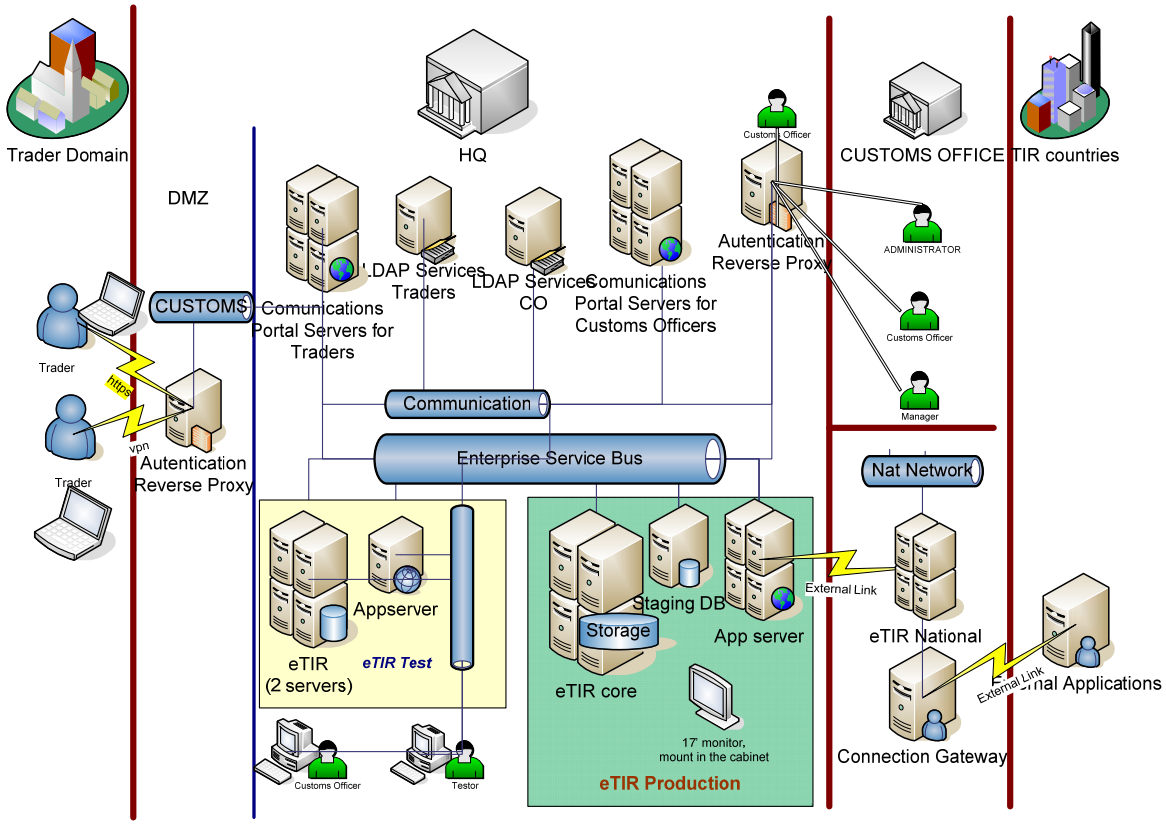

Fig 9. Hosting eTIR on own premises

A.1.10. *Hosting the eTIR system at the premises of other IT systems*

This option might be similar to a private cloud. The eTIR (IaaS) will be hosted in the environment of an existing IT system, like UNOG or UNICC. The difference between cloud-PaaS and this approach refers to the owner of the infrastructure and the relation between the eTIR owner and the infrastructure owner.

This option assumes that the eTIR international system will be installed using the hardware and software infrastructure of an organization involved in the eTIR international system or a specialized company.

From a technical point of view, this solution is similar with cloud-PaaS. For this reason, all elements of PaaS will be considered as part of its assessment. It offers a platform where the system could be developed.

Differences might also occur when we refer to the quality of service. But such differences exist between all PAAS providers.

Especially is important to notice that the mentioned providers (UNOG, UNICC) are strongly linked to the eTIR community

For this alternative:

- The hardware and infrastructure are owned and maintained by **UNICC/UNOG;**
- Platforms are owned, installed, configured and maintained by **UNICC/UNOG;**
- The eTIR system is developed, owned, installed, configured and maintained by **UNECE;**

The deployment schema is similar to the one for PaaS (fig 6), with the difference that the hosting is done at UNUG premises.

A.1.11. *Solution Comparison.*

This paragraph contains a review of the solution comparisons, with explanations of the criteria used.

Qualitative points are given from 1 to 5, where 1 means that the solution is not considered appropriate for the eTIR system and 5 means that the solution is considered as very appropriate for the eTIR system.

The more points in a specific category means the higher the implementation of the alternative is recommended.

No	Category	IaaS	PaaS	SaaS	UNOG/ UNICC	Premises
1	24/7 Reliability (Uptime is Imperative)	4	5	5	4	3
2	Performance	4	5	3	3	2
3	Security	1	3	3	4	5
4	Scalability	4	5	2	3	3
5	Availability/Access From Anywhere	4	5	5	4	3
6	Flexibility & Customization	4	3	2	3	5
7	Mental Blocks / Culture	3	3	2	4	5
8	Administration	3	4	5	4	1
9	Maturity of technology	3	2	1	4	5
	Total	***30***	***35***	***27***	***33***	***32***

In conclusion, from a technical point of view, the best solutions are PaaS and UNOG/UNICC

It should, however, be noted that clouds are evolving very rapidly and that, in the near future, good solutions for current weak points could very well be found.

A.1.11.1 Explanations regarding categories

A.1.11.1.1 24/7 Reliability

Reliability : the ability of the system or components to perform the required functions under stated conditions for a specified period of time.

SaaS/Cloud computing is going to be housed in a data centre usually staffed around the clock, with redundant power, air-conditioning, etc.

Premises servers can be accessed from anywhere with a stable, high-bandwidth Internet connection, but most privately owned data centres do not have the redundancy that a cloud provider data centre has, nor do they have 24/7 support staff. The latter can be mitigated by engaging a managed IT service provider.

The scale of cloud computing networks and their ability to provide load balancing and failover makes them highly reliable, often much more reliable than can be achieved in a single organization.

From a reliability point of view, considering the above PaaS and SaaS are classified most reliable (5 points).

IaaS is given 4 points next, as it offers only the hardware solution. The software platform should be maintained by the user The same is true for UNOG/UNICC.

Premises qualifies as the weakest in this category, because it is difficult to achieve the redundancy of a data centre, nor does it have 24/7 support staff (3 points).

A.1.11.1.2 Performance:

System performance is measured in number of transactions per second, medium time to view a page and medium time to call a web service.

For cloud systems, performance could be obtained as defined in Service Level Agreements (SLA). For on premises performance, this is dependent on the hardware and platform installed.

It is easier to define a SLA for a better performance than to install a very good platform on premises.

In PaaS, a SLA can be defined according to requirements. Hardware and software will be updated by the provider in line with the SLA. This is regarded as the best solution (5 points).

For IaaS, the SLA can be defined only at the hardware level. For this reason, it is considered less appropriate than PaaS (4 points).

As UNOG/UNICC is not specialized in cloud, it is not certain that a SLA with high requirements could be established. For this reason, it gets 3 points.

Regarding SaaS, considering that the whole system is outsourced to a cloud provider, the contract is usually based on the services, not on the performance. For this reason, it also gets 3 points.

Premises is the weakest in this category, because it has to be computed from scratch and is not adjustable to the real system needs. Thus, it gets 2 points.

A.1.11.1.3 Security.

This aspect refers to computer security, network security, and, more broadly, information security.

There are a number of security issues/concerns associated with cloud computing, but these issues fall into two broad categories: Security issues, faced by cloud providers (organizations providing SaaS, PaaS or IaaS via a cloud) and security issues faced by their customers.

Compared with Premises, cloud implementations are considered less secure. The characteristics of private clouds offer good solutions to address security issues.

Premises is considered the most secure solution, because it provides full control (5 points), followed by the use of UNOG/UNICC (4 points) and Paas (3 points) where both hardware and software are maintained by the cloud provider, which in turn could define a dedicated cloud. SaaS is considered just as secure as PaaS as it resides entirely with the cloud provider and a dedicated cloud could be attributed to it (3 points). IaaS is considered least secure; even if dedicated clouds are used, this is not a usual approach (1 point).

A.1.11.1.4 Scalability.

This is the ability of a system, network, or process, to handle growing amounts of work in a capable manner or its ability to be enlarged to accommodate that growth. Cloud implementations are much more scalable, as more computing power could be added as needed.

Scalability is important in the eventuality of an increasing number of ETIR carnets added for processing in the next years (more than planned initially).

The risk of not being scalable is materialized in the necessity to redesign the system.

PaaS is considered as most scalable; resources (hardware and software)are allocated as they are needed (5 points), followed by IaaS, because only hardware resources can be added as needed. Software resources might be not scalable (4 points). SaaS is awarded 2 points, because the cloud provider is developing a solution which might or might not be scalable. The risk of SAAS not being scalable is materialized in the availability of the system or more costs per processing unit. Premises could be scalable if so designed, but the risk of not being well-scalable is greater than for the other solutions. On premises there is a limited amount of resources and, usually, systems are designed to fit the existing resources. Thus, compared to SaaS, it also gets 3 points. UNOG/UNICC is considered as scalable, as at premises (3points).

A.1.11.1.5 Availability/Access From Anywhere

Availability is the degree to which a system, subsystem, or equipment is in a specified operable and committable state at the start of a mission, when the mission is called for at an unknown, i.e., a random, time. Simply put: availability is the proportion of time that a system is in a functioning condition.

Availability depends on the redundancy of the system, on the time balancing or restoration is done, on the way the system is monitored, on the way the system is configured to perform critical operations, etc.

Access From Anywhere refers to the availability of the system from any place, which needs the system functions.

Bearing the above in mind PaaS and SaaS are considered as most accessible (5 points). IaaS and UNOG/UNICC come next, as it offers only the hardware solution, whereas the software platform needs to be maintained by the user (4 points). Premises is the weakest in this category (high costs are involved to increase this characteristic under this solution) (3 points).

A.1.11.1.6 Flexibility & Customization

While SaaS vendors generally come out with updates far more frequently than server-based applications, they cannot be customized easily, or not at all, in some cases. The business will generally align its processes around how the product functions versus making the SaaS behave as desired. This also means that there will be significantly less third-party add-ons, especially if the vendor has not made his APIs Application Programming Interfaces (API) available.In other words: a SAAS is made for initial specifications. Subsequent changes in business processes are difficult to implement.

Premises is considered as the most flexible as this process of customization could be performed immediately (5 points). IaaS comes next, as only hardware infrastructure is from the cloud provider. All the other parts are under control of the eTIR owner and could be immediately customized (4 points). PaaS and UNOG/UNICC are less customizable, because the whole platform is owned by a cloud provider and customizations are limited (3 points). SaaS is considered least flexible, because everything is owned and maintained by a cloud provider and customizations depend entirely on the cloud SaaS provider (2 points).

A.1.11.1.7 Mental Blocks & Culture

Hosting any kind of data or business process off-premises is a big leap of faith for business owners, especially ones who are not yet comfortable with information technology.

For these reasons, Premises is awarded 5 points, whereas UNOG/UNICC gets 4 because it is a well-known organization. 3 points are given equally to IaaS and PaaS, because there is limited access to resources and 1 point to SaaS because there is no access to resources.

A.1.11.1.8 Administration.

This aspect counts the effort necessary to administer the system. No administration is necessary for SaaS. (5 points). PaaS and UNOG/UNICC only require application administration (4 points). Application and platform administration are necessary in IaaS (3 points). Because premises requires full administration, it only gets 12 point.

A.1.11.1.9 Maturity of technology

For a system where time is critical and subject to aligned to technological constraints, like the eTIR system, it is important to use a mature technology, with proven results in other systems.

Mature technology is used to buit the system. For example an operating system which was in use for at least 5 years, a developing environment version older that a number of years.

When developing at premises one has the full possibility to choose. In other situations, the technology should be chosen from a limited list of possibilities, and usually is the latest, and not necessarily proven as stable. From this point of view, Premises is regarded as the most mature solution, obtaining 5 points. The others are in decrease order of points: UNOG/UNICC (4 points) IaaS (3 points), PaaS (2 points), SaaS (1 point).

A.2. CLOUD PROVIDERS

At the moment of creating the present document, many cloud providers offer their services.

Below a comparison of the solutions of three main providers (Amazon, Google, Microsoft):

	Amazon AWS	Google App Engine	Windows Azure
Cloud Services	*Paas* *Iaas*	*Paas*	*Paas* *Iaas*
Platforms supported	Operating systems Red Hat Enterprise Linux Windows Server 2003/2008 Oracle Enterprise Linux OpenSolaris OpenSUSE Linux Ubuntu Linux Fedora Gentoo Linux Debian Software IBM DB2 IBM Informix Dynamic Server Microsoft SQL Server Standard 2005 MySQL Enterprise Oracle Database 11g Hadoop	Runtime Java Runtime Environment Python Runtime Environment Features Integration with Google Accounts URL Fetch Mail Memcache Image Manipulation Scheduled Tasks and Task Queues XMPP Blobstore (which supports objects upto 50MB in size) Software External software like AppServers Databases cannot be installed	Operating systems Windows 7 Windows Server 2008 Windows Vista
Cloud services and tools	Amazon CloudWatch API Tools Auto Scaling API Tools Elastic Load Balancing API Tools AWS Toolkit for Eclipse AWS Management Console Amazon EC2 API Tools Amazon EC2 AMI Tools Elasticfox Firefox Extension for Amazon EC2 Javascript Scratchpad for Amazon EC2 Amazon S3 Authentication Tool for Curl CloudBerry Explorer for Amazon S3 and CloudFront Manager for Amazon CloudFront Firefox Organizer for Amazon S3 and Amazon CloudFront (S3Fox) AWSzone.com Javascript Scratchpad for Amazon SQS Amazon Mechanical Turk Developer Sandbox Amazon Mechanical Turk Command Line Tools	Google Secure Data Connector Private gadgets Google Visualization API Google Apps APIs Google web toolkit IDE support	Windows Azure Platform Training Kit Windows Azure Software Development Kit Microsoft Visual Studio 2008 Service Pack 1 Windows Azure platform AppFabric SDK V1.0 Windows 7 Training Kit For Developers
Integrated DB supported	MySql	GAE doesn't support external databases; it provides a data store of its own which can be accessed through standard JDO and JPA APIs.	Sql azure
Maximum limits	Amazon S3 - Store object up to 5 GB Amazon EC2 [Elastic Block storage] - Volume sizes ranging from 1GB to 1TB (20 TB/account limit while in beta)	Automatic scaling is built in with App Engine No matter how many users you have or how much data your application stores, App Engine can scale to meet your needs	Azure has a 64MB limit on individual blobs and also allows you to split a blob into blocks of 4MB each

	Amazon AWS	Google App Engine	Windows Azure
Service Level Agreements availability	Amazon S3 - available with a Monthly Uptime Percentage of at least 99.9% during any monthly billing cycle Amazon EC2 - available with an Annual Uptime Percentage of at least 99.95% during the Service Year	100% Uptime	99.9% uptime
Support Pricing Policy	Premium Support - Silver and Gold support available and are charged accordingly	Free Support is available 24x7x365 from on-site cloud hosting experts	Developer support is charged on a per incident basis. However, you are able to utilize support incidents that you already have from existing programs such as the Microsoft Developer Network (MSDN) and the Microsoft Partner Network (MPN).
Support response time	Severity level vs response time Urgent - 1 hour (available for Gold subscribers only) High - 4 business hours Normal - 1 business day Low - 2 business days	Not available	Not available
Service credit for an outage	Monthly uptime percentage vs Service credit percentage Amazon S3 Equal to or greater than 99% but less than 99.9% - 10% less than 99% - 25% Amazon EC2 If the Annual Uptime Percentage for a customer drops below 99.95% for the Service Year, that customer is eligible to receive a Service Credit equal to 10% of their bill (excluding one-time payments made for Reserved Instances) for the Eligible Credit Period	Not available	Microsoft will provide a 10 percent credit if compute connectivity falls below 99.95 percent uptime; a 10 percent credit if role-instance uptime or storage falls below 99.9 percent uptime. If it falls below 99 percent availability across anything, 25 percent credit will be provided
Incidence notification approach	Amazon Web Services publishes the most up-to-the-minute information on service availability in Service Health Dashboard Amazon Web Services keeps a running log of all service interruptions	The user should subscribe to this announcement-only list to receive updates on system outages, maintenance periods, and other service disruptions. Go to the group: google-appengine-downtime-notify Subscribe via email: google-appengine-downtime-notify-subscribe@googlegroups.com Apart from the above,when there is a scheduled down time, GAE puts the data store in read-only mode. During that time any attempt to write data to the data store will throw an exception which can be caught in the application to show a user friendly message to the user	Microsoft may send periodic e-mails informing you of technical service issues related to a product or service you requested
Access/usage reports	Amazon Cloud watch	The Administrative console provides the following details, view access data and error logs, and analyze traffic browse the application's datastore and manage indexes view the status of the application's scheduled tasks	"Dallas" Features allows users to get detailed access report containing the services/datasets that were accessed, grouped by date and by account key
Community News/Blogs	http://aws.typepad.com	http://code.google.com/appengine/community.html http://googleappengine.blogspot.com	http://blogs.technet.com/microsoft_blog/archive/tags/Azure/default.aspx

	Amazon AWS	Google App Engine	Windows Azure
Data backup	Amazon RDS automatically patches the database software and backs up the database, storing the backups for a user-defined retention period Amazon AWS may delete, without liability of any kind, any of the Amazon SQS Content that sits in a queue or any queue that remains inactive for more than the number of days specified in the user documentation. Amazon SimpleDB, in during the previous six (6) months you if there are no incurred fees for SimpleDB and have registered no usage of the Amazon SimpleDB Content, Amazon AWS may delete, without liability of any kind, the Amazon SimpleDB Content upon thirty (30) days prior notice to you. Amazon S3 versioning provides an additional layer of protection for your S3 objects. You can	The user is solely responsible for securing and backing up the Application and any Content. Google has no responsibility or liability for the deletion or failure to store any Content and other communications maintained or transmitted through use of the Service.	The user is solely responsible for securing and backing up the data.
Data after termination	Amazon will not take any action to intentionally erase any of the data stored on the Services for a period of thirty (30) days after the effective date of termination Post termination retrieval of data stored on the Services will be conditioned on the payment of Service data storage charges for the period following termination, payment in full of any other amounts due Amazon,and the compliance with terms and conditions Amazon may establish with respect to such data retrieval	If Google suspends or terminates the use of the Service with cause (or if the user voluntarily discontinues the use of the Service), the user will have access to, and the ability to export, the Content for a period of ninety (90) days following such suspension or termination. Fees will continue to be assessed for usage of the Service in excess of any portion of the Fee Threshold during the 90 day period	Upon expiration or termination of your online service subscription, you must contact Microsoft and tell whether to: (1)disable your account and then delete your subscriber data; or (2) Retain your subscriber data in a limited function account for at least 90 days after expiration or termination of your subscription (the ―retention period‖) so that you may extract the data. If you indicate (1), you will not be able to extract your subscriber data from your account. If you indicate (2), you will reimburse Microsoft for any applicable costs. If you do not indicate (1) or (2), Microsoft will retain your subscriber data in accordance with (2). Following the expiration of the retention period, Microsoft will disable your account and then delete your subscriber data.
Data security	Amazon Elastic Compute Cloud (EC2) provides Host Operating System,Guest operating system and a complete firewall solution. It also provides a way to encrypt the API calls in transit with SSL to maintain confidentiality.AWS network provides significant protection and also enables customer to implement futher protection Amazon Simple Storage Service (Amazon S3):Amazon S3 is accessible via SSL encrypted endpoints. Data stored within Amazon S3 is not encrypted at rest by AWS. However, users can encrypt their data before it is uploaded to Amazon S3 so that the data cannot be accessed or tampered with by unauthorized parties. SimpleDB APIs provide domain-	App Engine runs Java applications using the Java 6 virtual machine (JVM). The JVM runs in a secured "sandbox" environment to isolate your application for service and security. The JVM can execute any Java bytecode that operates within the sandbox restrictions The Python interpreter also runs in a secured "sandbox" environment to isolate your application for service and security	Filtering Routers Firewalls Cryptographic Protection of Messages Software Security Patch Management centralized monitoring, correlation, and analysis systems Network Segmentation Service Administration Access Physical Security limited number of Microsoft personnel may access customer information to respond to support requests and as part of incident response Windows Azure compute provides optional sandboxing technology and mandatory sandboxing features that attempts to limit the harm to the

	Amazon AWS	Google App Engine	Windows Azure
	level controls that only permit authenticated access by domain creator, therefore the customer maintains full control over who has access to their data.SimpleDB access can be granted based on an AWS Account ID.SimpleDB is accessible via SSL-encrypted endpoints.		infrastructure and all other customers from such bugs. Windows Azure provides virtual machines to customers, giving them access to most of the same security options available in Windows Server. Updates to the software and configuration are
Virtualization platform	EC2 uses modified Xen virtualization	Not available	Modified Hyper-V hypervisor
Control Panel	Web based Interface	Web based Interface	Web based Interface
Age of Service	Since early 2006	Since July 2008	Since October 2008

A.3. FPA METHODOLOGY

In order to apply FPA, the following references have been used:

- Use cases described in the **eTIR Reference Model [R2**], Chapter 2.3 pg. 89-116;
- Activity analysis described in the **eTIR Reference Model [R2]**, Chapter 3.1 pg 117-128;
- Data model described in the **eTIR Reference Model [R2]**, Chapter 3.1 pg 117-128;
- Management by Customs of data on guarantees class diagram in the **eTIR Reference Model [R2]**, Chapter 3.2.1 pg. 136;
- Declaration class diagram in the **eTIR Reference Model [R2]**, Chapter 3.2.2 pg. 137;
- TIR operations class diagram in the **eTIR Reference Model [R2]**, Chapter 3.2.3 pg. 138;
- eTIR declaration mechanism described in the **eTIR Reference Model [R2],** Annex VI, pg. 501-515;
- Data element definitions (the Ix messages and Ex messages) as defined in the **eTIR Reference Model [R2**], Chapter 3.2.5 pg. 141-279.);
- The general system characteristics, as defined in Annex A.1 Chapter A.1.5.

Use cases and sequence diagrams have been used to identify the required functionalities of the eTIR international system. Based on the identified functionalities and data processing involved, we have computed the **Total Unadjusted Function Points (TUFP).**

Based on the required technical characteristics, we have computed the **Total Adjusted Function Points (TAFP).**

When computing TUFP, we have used the following elements:

- External Inputs (EI);
- External Outputs (EO);
- External Inquiry (EQ);
- Internal Logical Files (ILF);
- External Interface Files (EIF).

The relationship between these elements is based on the following matrix:

Entity	RETs	FTRs	DETs
EI	Not counted	To be counted	To be counted
EO	Not counted	To be counted	To be counted
EQ	Not Counted	To be counted	To be counted
EIF	To be counted	Not Counted	To be counted
ILF	To be counted	Not Counted	To be counted

When computing TUFP and TAFP, the following definitions have been applied:

- **External Inputs (EI)** – is an elementary process in which data crosses the boundary from outside to inside. This data is external to the application. The data may come from a data input screen or another application. The data may be used to maintain one or more internal logical files. The data can be either control information or business information. If the data is control information it does not have to maintain an internal logical file.

FTRs and DETs are used to determine EI.

- **External Outputs (EO)** – it is an elementary process in which derived data passes across the boundary from inside to outside. Additionally, an EO may update an ILF. The data creates reports or output files sent to other applications. These reports and files are created from information contained in one or more internal logical files and external interface files.

FTRs and DETs are used to determine EO.

- **External Inquiry (EQ)** – is an elementary process with both input and output components that result in data retrieval from one or more internal logical files and external interface files. The input process does not update or maintain any FTR's (Internal Logical Files or External Interface Files) and the output side does not contain derived data.

FTRs (File Type Referenced) and DETs (Data Element Type) are used to determine EQ.

- **Internal Logical Files (ILF)** – a user identifiable group of logically related data that resides entirely within the application boundary and is maintained through External Inputs. An internal logical file has the inherent meaning that it is internally maintained, has some logical structure and is stored in a file.
- **External Interface Files (EIF)** – a user identifiable group of logically related data that is used for reference purposes only. The data resides entirely outside the application boundary and is maintained by another application' external inputs. The external interface file is an internal logical file for another application. An application may count a file as either an EIF or ILF, but not both. An external interface file has the inherent meaning that it is externally maintained (probably by some other application), that an interface has to be developed to get the data and that it is stored in a file.

Record Element Type (RET): A RET is a user recognizable subgroup of data elements within an ILF or an EIF. It is best to look at logical groupings of data to help identify them.

Message				
Guarantee	1	..	1	R
Error	0	..	unbounded	D
Pointer	1	..	unbounded	R

c. Classes and attributes (English Only)

Message				
Type, coded				
Message reference number				
Message function, coded				
Functional reference				
GUARANTEE	**Occurrence**	**1**	**..**	**1**
Reference				
ERROR	**Occurrence**	**0**	**..**	**unbounded**
Error, coded				
POINTER	**Occurrence**	**1**	**..**	**unbounded**
Sequence number				
Document/message section, coded				
Tag identifier				

Fig 10. Definition of eTIR message

File Type Referenced (FTR): A FTR is a file type referenced by a transaction. An FTR must also be an internal logical file or an external interface file.

Data Element Type (DET): A DET is a user field recognized as being unique, non-recursive (non-repetitive). A DET is information that is dynamic and not static. A dynamic field is read from a file or created from DETs contained in a FTR. Additionally, a DET can invoke transactions or can be additional information regarding transactions.

A.4. SCHEDULE AND COSTS ESTIMATION

A.4.1. *Introduction*

Based on the estimated Function Points (described in Chapter 2.3. and Annexes A.3. and A.5.), the COCOMO II methodology [2][8] has been applied to estimate the schedule and the cost for the development of the eTIR international system.

It should be noted that the estimations only apply to the development and implementation phases.

The following costs are NOT included: Training, maintenance, technical support, consultancy on legal aspects, helpdesk, changes (if any) in national Customs IT systems, changes (if any) in trader IT systems, changes (if any) for ITDB, changes (if any) requested by guarantee chain systems.

There are two alternatives (options):

- The first variant is based on a medium qualified and experienced team;
- The second variant is based on the assumption that the eTIR international system is developed and implemented by a highly qualified and experienced team.

A.4.2. *Assumptions*

The assumptions used when computing the schedule and cost estimates are those presented in the table below:

For a medium qualified team we assume that:

Development style	
Precedence	Medium
Development Flexibility	Medium
Software Cost Drivers	
Required Software Reliability	Medium
Data Base Size	Medium
Product Complexity	Medium
Developed for Reusability	Medium
Documentation Match to Lifecycle Needs	Medium
Architecture / Risk Resolution	Medium
Personnel	
Team Cohesion	Medium
Analyst Capability	Medium
Programmer Capability	Medium
Personnel Continuity	Medium
Application Experience	Medium
Platform Experience	Medium
Language and Toolset Experience	Medium
Process Maturity	Medium
Platform	
Time Constraint	Medium

Storage Constraint	Medium
Platform Volatility	Medium
Project	
Use of Software Tools	Medium
Multi-site Development	Medium
Required Development Schedule	Medium

Cost per Person-Month (Dollars): $5,000

For a highly experienced team we assume that:

Development style	
Precedence	Medium
Development Flexibility	Medium
Software Cost Drivers	
Required Software Reliability	High
Data Base Size	Medium
Product Complexity	High
Developed for Reusability	Medium
Documentation Match to Lifecycle Needs	High
Architecture / Risk Resolution	High
Personnel	
Team Cohesion	High
Analyst Capability	High
Programmer Capability	High
Personnel Continuity	Very High
Application Experience	Very High
Platform Experience	High
Language and Toolset Experience	High
Process Maturity	High
Platform	
Time Constraint	Medium
Storage Constraint	Medium
Platform Volatility	Medium
Project	
Use of Software Tools	High
Multi-site Development	Medium
Required Development Schedule	Medium

Cost per Person-Month (Dollars): $8,000

A.4.3. Costs and schedule for the full system when employing a medium experienced *development team*

Software Engineering

Effort = 225.4 Person-months
Schedule = 21.9 Months
Cost = $1,127,000
Total Equivalent Source Lines of Code =51,720

Phase Distribution

Phase	Effort (Person-months)	Schedule (Months)	Average Staff	Cost (Dollars)
Inception	9.4	2.7	4.9	$47,000
Elaboration	47	8.2	6.6	$235,000
Construction	147	13.7	12.5	$735,000
Transition	22	2.7	9.9	$110,000
Total	225.4			$1,127,000

Software Effort Distribution for RUP/MBASE (Person-Months)

Phase/Activity	Inception	Elaboration	Construction	Transition	Total
Management	1	5.5	15	3	24.5
Environment/CM	0.8	4.3	8	1	14.1
Requirements	3	7.7	11	1	22.7
Design	2.2	16.5	22	1	41.7
Implementation	1	6	45	4	56
Assessment	1	5.4	41	5	52.4
Deployment	0.4	1.6	5	7	14
Total	9.4	47	147	22	

A.4.4. *Costs and schedule for the full system when employing a highly experienced development team*

Software Engineering

Effort = 115.6 Person-months
Schedule = 17.6 Months
Cost = $924,800
Total Equivalent Source Lines of Code = 51,720

Phase Distribution

Phase	Effort (Person-months)	Schedule (Months)	Average Staff	Cost (Dollars)
Inception	5.6	2.2	3.2	$44,800
Elaboration	24	6.6	4.2	$192,000
Construction	75	11	8	$600,000
Transition	11	2.2	6.3	$88,000
Total	115.6			$924,800

Software Effort Distribution for RUP/MBASE (Person-Months)

Phase/Activity	Inception	Elaboration	Construction	Transition	Total
Management	1	3	5	1	10

Environment/CM	0.5	2	3	0.5	6
Requirements	2	4	7	0.5	13.5
Design	1	8	14	0.5	23.5
Implementation	0.5	3.5	24	2.5	30.5
Assessment	0.4	2.5	20	3	25.9
Deployment	0.2	1	2	3	6.2
Total	5.6	24	75	11	

A.4.5. *Costs and schedule for the eTIR international kernel when employing a medium experienced team*

Software Engineering

Effort = 71.3 Person-months
Schedule = 15.0 Months
Cost = $356,500
Total Equivalent Source Lines of Code =20,000

Phase Distribution

Phase	Effort (Person-months)	Schedule (Months)	Average Staff	Cost (Dollars)
Inception	3	1.9	2.3	$15,000
Elaboration	14	5.6	3	$70,000
Construction	48	9.4	5.8	$240,000
Transition	6.3	1.9	4.6	$31,500
Total	71.3			$356,500

Software Effort Distribution for RUP/MBASE (Person-Months)

Phase/Activity	Inception	Elaboration	Construction	Transition	Total
Management	0.5	1.5	4	1	7
Environment/CM	0.2	1	2.5	0.2	3.9
Requirements	1.2	3	4	0.2	8.4
Design	0.5	5	8	0.3	13.8
Implementation	0.3	1.5	16	1.1	18.9
Assessment	0.2	1.5	12	2	15.7
Deployment	0.1	0.5	1.5	1.5	3.6
Total	3	14	48	6.3	

A.4.6. *Costs and schedule for the eTIR international kernel when employing a highly experienced team*

Software Engineering

Effort = 41.2 Person-months
Schedule = 12.5 Months

Cost = $329,600
Total Equivalent Source Lines of Code = 20,000

Phase Distribution

Phase	Effort (Person-months)	Schedule (Months)	Average Staff	Cost (Dollars)
Inception	2	1.6	1.6	$16,000
Elaboration	8.2	4.7	2.1	$65,600
Construction	27	7.8	4	$216,000
Transition	4	1.6	3.2	$32,000
Total	41.2			$329,600

Software Effort Distribution for RUP/MBASE (Person-Months)

Phase/Activity	Inception	Elaboration	Construction	Transition	Total
Management	0.1	1	2	0.2	3.3
Environment/CM	0.2	0.5	1.5	0.2	2.4
Requirements	0.7	1.5	2	0.2	4.4
Design	0.5	3	4	0.2	7.7
Implementation	0.2	1	10	0.7	11.9
Assessment	0.2	1	7	1	9.2
Deployment	0.1	0.2	0.5	1.5	2.3
Total	2	8.2	27	4	

A.4.7. *Costs and schedule for the eTIR kernel and administration when employing a medium experienced development team*

Software Engineering

Effort = 122.5 Person-months
Schedule = 17.9 Months
Cost = $612,500
Total Equivalent Source Lines of Code =29,720

Phase Distribution

Phase	Effort (Person-months)	Schedule (Months)	Average Staff	Cost (Dollars)
Inception	7.5	2.2	3.3	$37,500
Elaboration	23	6.7	4.4	$115,000
Construction	80	11.2	8.3	$400,000
Transition	12	2.2	6.6	$60,000
Total	122.5			$612,500

Software Effort Distribution for RUP/MBASE (Person-Months)

Phase/Activity	Inception	Elaboration	Construction	Transition	Total
Management	1	2	7	1.5	11.5

Environment/CM	0.7	2	4	0.5	7.2
Requirements	3	4	8	0.5	15.5
Design	1.4	9	12	0.5	22.9
Implementation	0.6	3	25	3	31.6
Assessment	0.6	2	21	2	25.6
Deployment	0.2	1	3	4	8.2
Total	7.5	23	80	12	

A.4.8. *Costs and schedule for the eTIR kernel and administration when employing a highly experienced development team*

Software Engineering

Effort = 60.7 Person-months
Schedule = 14.2 Months
Cost = $485,600
Total Equivalent Source Lines of Code= 29,720

Phase Distribution

Phase	Effort (Person-months)	Schedule (Months)	Average Staff	Cost (Dollars)
Inception	3	1.8	2	$24,000
Elaboration	11	5.3	2.7	$88,000
Construction	40	8.9	5.2	$320,000
Transition	6.7	1.8	4.1	$53,600
Total	60.7			$485,600

Software Effort Distribution for RUP/MBASE (Person-Months)

Phase/Activity	Inception	Elaboration	Construction	Transition	Total
Management	0.2	1	3	0.5	4.7
Environment/CM	0.4	1	1	0.4	2.8
Requirements	1.2	2	3	0.3	6.5
Design	0.6	4	7	0.3	11.9
Implementation	0.3	1.6	14	1.4	17.3
Assessment	0.2	1	11	1.6	13.8
Deployment	0.1	0.4	1	2.2	3.7
Total	3	11	40	6.7	

A.5. DETAILED FUNCTION POINT ANALYSIS

A.5.1. *What we count and how we count it*

We consider hereby the three main functional components of eTIR international system:

1. eTIR international kernel (also called eTIR Kernel). This is the main component responsible for the business logic and data exchange using web services.
2. eTIR international USER INTERFACE system. This is to be used as fallback procedure, to enter data into the system using a user interface. The business logic used is that from the eTIR international kernel.
3. eTIR administration console. Used to:
    a. Manage users, connections, reference data,
    b. Monitor the system
    c. Audit actions

Estimation was done for each functional component, and finally the results were aggregated.

A.5.1.1 Estimations for eTIR kernel

eTIR international kernel is responsible for:

- Data storage and transport;
- Business process management;
- Data exchange between eTIR actors.

The whole estimation process is based on the eTIR messages defined in the reference Model.

A.5.1.2 Estimations for eTIR Administration console

We consider that the administration console is used to administer the main elements in the system.

The following actions are considered as a minimum:

1. Administer Users and roles
2. Administer Guarantee chain data
3. Administer Holder data
4. Administer Customs Office Data
5. Administer Reference data
6. Configuration of communication channels
7. Monitor the system
8. Administer general parameters
9.Loging and auditing

For each action we have considered one entity defined by:

EI: A page used to manage the corresponding data. In the case of monitoring we consider one page per each chart graph displayed in real time;

EO. Error message;

EQ. We consider that for each entity administered, there should be a query with at least 3 parameters in filter and at least 3 elements in answer;

ILF. We consider that for each EI an ILF is used (same number of DET);

EIF. We consider the printing of entities (in row format just for administration purposes).

A.5.2. *FPA-eTIR International kernel*

A.5.2.1 FPA Summary results

Function Point Estimation Worksheet

Description	Complexity						Total
	Low		Medium		High		
EI	1	x 3	2	x 4	7	x 6	53
EO	0	x 4	1	x 5	1	x 7	12
EQ	1	x 3		x 4	1	x 6	9
ILF	42	x 7	2	x 10	0	x 15	314
EIF	1	x 5	0	x 7	0	x 10	5

Total Unadjusted Function Points (TUFP): 393

A.5.2.2 FPA Detailed results

3.1.1.1.2 Register guarantee, Request	**EI**	**E1**		2	7	**0**	**1**	**0**
	EO					**0**	**0**	**0**
	EQ					**0**	**0**	**0**
3.1.1.1.3 Cancel guarantee, request	**EI**	**E3**		**2**	**7**	**0**	**1**	**0**
	EO					**0**	**0**	**0**
	EQ					**0**	**0**	**0**
3.1.1.1.4 Accept guarantee, Request	**EI**	**I1**		**3**	**9**	**0**	**0**	**1**
	EO					**0**	**0**	**0**
	EQ					**0**	**0**	**0**
3.1.1.1.5 Get holder information	**EI**	**I3**		**1**	**2**	**1**	**0**	**0**
	EO					**0**	**0**	**0**
	EQ					**0**	**0**	**0**
3.1.1.2.1 Record consignment information, Invoke	**EI**	**I7**		**38**	**100**	**0**	**0**	**1**
	EO			0	0	**0**	**0**	**0**
	EQ			0	0	**0**	**0**	**0**
3.1.1.2.2 Update consignment information, Invoke	**EI**	**I7**		**38**	**100**	**0**	**0**	**1**
	EO					**0**	**0**	**0**
	EQ					**0**	**0**	**0**
3.1.1.2.3 Start of TIR operation, Invoke	**EI**	**I9**		**13**	**35**	**0**	**0**	**1**
	EO					**0**	**0**	**0**
	EQ					**0**	**0**	**0**
3.1.1.2.4 Terminate TIR operation,, Invoke	**EI**	**I11**		**12**	**33**	**0**	**0**	**1**

	EO					**0**	**0**	**0**
	EQ					**0**	**0**	**0**
3.1.1.2.5 Discharge TIR operation, Invoke	**EI**	**I13**		**6**	**17**	**0**	**0**	**1**
	EO					**0**	**0**	**0**
	EQ					**0**	**0**	**0**
3.1.1.2.6 Notify guarantee chain, Invoke	**EI**					**0**	**0**	**0**
	EO	**E7**		2	7	**0**	**1**	**0**
	EQ					**0**	**0**	**0**
3.1.1.2.7 Notify subsequent countries, Invoke	**EI**					**0**	**0**	**0**
	EO	**I15**		61	100	**0**	**0**	**1**
	EQ					**0**	**0**	**0**
3.1.1.2.7 Notify subsequent countries, Response	**EI**	**I16**		**8**	**23**	**0**	**0**	**1**
	EO					**0**	**0**	**0**
	EQ					**0**	**0**	**0**
3.1.1.1.6 Query guarantee	**EI**					**0**	**0**	**0**
	EO					**0**	**0**	**0**
	EQ	**E5**		38	100	**0**	**0**	**1**
Authentication	**EI**					**0**	**0**	**0**
	EO					**0**	**0**	**0**
	EQ			1	1	**1**	**0**	**0**

ILF		40 ILF low complexity	Low					
		I user data	Medium					
		1 Reference data	Medium					
		1 Log data	Medium					
		System Parameters	Low					
EIF		ITDB	Medium					

A.5.3. *FPA-eTIR International USER INTERFACE*

A.5.3.1 FPA-Summary results

Function Point Estimation Worksheet

	Complexity						
Description	Low		Medium		High		Total
EI	1	x 3	2	x 4	7	x 6	53
EO	0	x 4	1	x 5	1	x 7	12
EQ	1	x 3	10	x 4	1	x 6	49
ILF	42	x 7	2	x 10	0	x 15	314

EIF	1 x 5	0 x 7	0 x 10	5

Total Unadjusted Function Points (TUFP): 433

A.5.3.2 FPA-Detailed results

	EO					**0**	**0**	**0**
	EQ					**0**	**0**	**0**
3.1.1.1.3 Cancel guarantee, request	**EI**	**E3**		**2**	**7**	**0**	**1**	**0**
	EO					**0**	**0**	**0**
	EQ					**0**	**0**	**0**
3.1.1.1.4 Accept guarantee, Request	**EI**	**I1**		**3**	**9**	**0**	**0**	**1**
	EO					**0**	**0**	**0**
	EQ					**0**	**0**	**0**
3.1.1.1.5 Get holder information	**EI**	**I3**		**1**	**2**	**1**	**0**	**0**
	EO					**0**	**0**	**0**
	EQ					**0**	**0**	**0**
3.1.1.2.1 Record consignment information, Invoke	**EI**	**I7**		**38**	**100**	**0**	**0**	**1**
	EO			0	0	**0**	**0**	**0**
	EQ			0	0	**0**	**0**	**0**
3.1.1.2.2 Update consignment information, Invoke	**EI**	**I7**		**38**	**100**	**0**	**0**	**1**
	EO					**0**	**0**	**0**
	EQ					**0**	**0**	**0**
3.1.1.2.3 Start of TIR operation, Invoke	**EI**	**I9**		**13**	**35**	**0**	**0**	**1**
	EO					**0**	**0**	**0**
	EQ					**0**	**0**	**0**
3.1.1.2.4 Terminate TIR operation, Invoke	**EI**	**I11**		**12**	**33**	**0**	**0**	**1**
	EO					**0**	**0**	**0**
	EQ					**0**	**0**	**0**
3.1.1.2.5 Discharge TIR operation, Invoke	**EI**	**I13**		**6**	**17**	**0**	**0**	**1**
	EO					**0**	**0**	**0**
	EQ					**0**	**0**	**0**
3.1.1.2.6 Notify guarantee chain, Invoke	**EI**					**0**	**0**	**0**
	EO	**E7**		2	7	**0**	**1**	**0**
	EQ					**0**	**0**	**0**
3.1.1.2.7 Notify subsequent countries, Invoke	**EI**					**0**	**0**	**0**
	EO	**I15**		61	100	**0**	**0**	**1**
	EQ					**0**	**0**	**0**
3.1.1.2.7 Notify	**EI**	**I16**		**8**	**23**	**0**	**0**	**1**

subsequent countries, Response								
	EO					**0**	**0**	**0**
	EQ					**0**	**0**	**0**
3.1.1.1.6 Query guarantee	**EI**					**0**	**0**	**0**
	EO					**0**	**0**	**0**
	EQ	**E5**		38	100	**0**	**0**	**1**
Authentication	**EI**					**0**	**0**	**0**
	EO					**0**	**0**	**0**
	EQ			1	1	**1**	**0**	**0**

ILF		40 ILF low complexity	Low				
		I user data	Medium				
		1 Reference data	Medium				
		1 Log data	Medium				
		System Parameters	Low				
EIF		ITDB	Medium				
EQ		10 Queries to fill in Popup	Medium				

A.5.4. *FPA-eTIR International Administration Console*

A.5.4.1 FPA-Summary results

Function Point Estimation Worksheet							
	Complexity						
Description	**Low**		**Medium**		**High**		**Total**
EI	6	x 3	1	x 4	2	x 6	34
EO	8	x 4	1	x 5	0	x 7	37
EQ	1	x 3	6	x 4	0	x 6	27
ILF	8	x 7	0	x 10	0	x 15	56
EIF	6	x 5	1	x 7	0	x 10	37
		Total Unadjusted Function Points (TUFP):					191

A.5.4.2 FPA-Detailed results

(ILF/EIF/EI/EO/EQ)		RET	FTR	DET	Complexity			FTR Detailed	DET Detailed
					Low	Medium	High		
1. Administer Users and roles	**EI**		2	10	**0**	**1**	**0**	User data, Roles	User fields (6), Roles fields(4)
	EO		1	1	**1**	**0**	**0**	Error message	Error message content
	EQ		2	6	**0**	**1**	**0**	Query on Users and roles filter, User and roles report	Holder data, Cargo Info, Risk Data
	ILF	2		10	**1**	**0**	**0**	User record, Roles record	User and role elements
	EIF	1		1	**1**	**0**	**0**	Printing users and roles	
2. Administer Guarantee chain data	**EI**		**1**	**10**	**1**	**0**	**0**	Guarantee chain page	Guarantee chain info on page
	EO		1	1	**1**	**0**	**0**	Error message	Error message content
	EQ		2	6	**0**	**1**	**0**	Query filter, Report	minimum 3 elements in filter, minimum 3 element in report
	ILF	1		10	**1**	**0**	**0**	Guarantee chain record	Guarantee chain elements
	EIF	1		1	**1**	**0**	**0**	Print guarantee chain data	
3. Administer Holder data	**EI**		**1**	**10**	**1**	**0**	**0**	Holder page	Holder info on page
	EO		1	1	**1**	**0**	**0**	Error message	Error message content
	EQ		2	6	**0**	**1**	**0**	Query filter, Report	minimum 3 elements in filter, minimum 3 element in report
	ILF	1		10	**1**	**0**	**0**	Holder record	Holder elements
	EIF	1		1	**1**	**0**	**0**	Print holder data	

4. Administer Customs Office Data	**EI**		**1**	**20**	**0**	**0**	**1**	Customs Office page	Customs Office info on page
	EO		1	1	**1**	**0**	**0**	Error message	Error message content
	EQ		2	6	**0**	**1**	**0**	Query filter, Report	minimum 3 elements in filter, minimum 3 element in report
	ILF	1		20	**1**	**0**	**0**	CUO record	CUO elements
	EIF	1		1	**1**	**0**	**0**	Print CUO data	
5. Administer Reference data	**EI**		**1**	**5**	**1**	**0**	**0**	25 Code lists, 5 elements in each code list (treated as one type)	At least code, value, type, start valid, end valid
	EO		1	1	**1**	**0**	**0**	Error message	Error message
	EQ				**0**	**0**	**0**	Query filter, Report	minimum 3 elements in filter, minimum 3 element in report
	ILF	1		5	**1**	**0**	**0**		
	EIF				**0**	**0**	**0**		
6. Configuration of communication channels	**EI**		**1**	**10**	**1**	**0**	**0**	Configuration setup page	At least 10 elements define the configuration (address, port, protocol, etc)
	EO		1	1	**1**	**0**	**0**	Error message	Error message content
	EQ		2	5	**1**	**0**	**0**	Query filter, Report	minimum 3 elements in filter, minimum 3 element in report
	ILF	1		10	**1**	**0**	**0**	Configuration parameters	
	EIF				**0**	**0**	**0**		

7. Monitor the system	**EI**		**6**	**5**	**0**	**0**	**1**	6 Monitoring charts	Monitoring data
	EO		4	5	**0**	**1**	**0**	Error message	Error Message
	EQ		2	6	**0**	**1**	**0**	Query filter, Report	minimum 3 elements in filter, minimum 3 element in report
	ILF				**0**	**0**	**0**		
	EIF	6		2	**0**	**1**	**0**	Chart graphs	at least two elements each
8. Administer general parameters	**EI**		**1**	**5**	**1**	**0**	**0**	One page with a list of parameters	Each parameter is defined by at least 5 elements (Name, Value, Period, type)
	EO		1	1	**1**	**0**	**0**	error message	error message
	EQ				**0**	**0**	**0**		
	ILF	1		5	**1**	**0**	**0**	Parameters record	
	EIF	1		1	**1**	**0**	**0**	Print Parameters	
9.Log recording and audit	**EI**		**1**	**5**	**1**	**0**	**0**	One page with a list logs	Each log entry is defined by at least 5 elements (type, severity, short description, timestamp, place)
	EO		1	1	**1**	**0**	**0**	error message	error message
	EQ		2	6	**0**	**1**	**0**	Filter record and report record	Filter record contains at least 3 elements, record report contains at least 3 elements
	ILF	1		5	**1**	**0**	**0**	Log record	
	EIF	1		1	**1**	**0**	**0**	Print Log report	

A.6. DETAILED COST ANALYSIS

A.6.1. *Initial costs*

We present hereby the costs expressed in current USD. Initial costs on premises implementation are as follows:

Cost Type	At premises		
	Min	***Max***	***Comments***
Purchasing research	10,000	15,000	2 month, 1-1.5 persons
Setup, Organization (eTIR system)	30,000	40,000	3-4 month, 2 persons
Facilities (HVAC, Power Supply, Space)	190,000	200,000	As presented in **R[5]-ECE/ /TRANS/WP.30/GE.1/2010/05**
Hardware(Computers, Networks, Storage)	430,000	500,000	As presented in R[5]-
Software (OS, Database Servers, Core Connectivity)	370,000	400,000	As presented in R[5]-
Integration Middleware	120,000	160,000	As presented in R[5]-
Technology training (200-250 days/person)	100,000	125,000	200-250 days/person X 500$
Personnel recruitment	5,000	10,000	5-10 Persons X 1,000$
Total	**$1,255,000**	**$1,450,000**	

Table 29. Initial costs, at premises implementation

A.6.1.1 Initial costs when implementing eTIR at UNOG premises

Cost Type	At premises		
	Min	**Max**	**Comments**
Purchasing research	10,000	15,000	2 month, 1-1.5 persons
Setup, Organization (eTIR system)	30,000	40,000	3-4 month, 2 persons
Facilities (HVAC, Power, Space)			No initial costs
Hardware(Computers, Networks, Storage)	49,500	49,500	Initial supplementary storage and setup costs
Software (OS, Database Servers, Core Connectivity)	370,000	400,000	As presented in R[5]-
Integration Middleware	120,000	160,000	As presented in R[5]-

Technology training (100-125 days/person)	100,000	125,000	100-120 days/person X 500$ - administrators of eTIR
Personnel recruitment	2,000	3,000	2-3 Persons X 1,000$
Total	**$681,500**	**$792,500**	

Table 30. Initial costs, UNOG implementation

A.6.1.2 Initial costs when implementing eTIR at UNICC premises

	Initial Costs, UNICC		
	Min	**Max**	**Comments**
Purchasing research	10,000	15,000	2 month, 1-1.5 persons
Setup, Organization (eTIR system)	30,000	40,000	3-4 month, 2 persons
Facilities (HVAC, Power Supply, Space)			No initial costs
Hardware(Computers, Networks, Storage)			No initial costs
Software (OS, Database Servers, Core Connectivity)	370,000	400,000	As presented in R[5]-
Integration Middleware	120,000	160,000	As presented in R[5]-
Technology training (100-125 days/person)	100,000	125,000	100-120 days/person X 500$ - administrators of eTIR
Personnel recruitment	2,000	3,000	2-3 Persons X 1,000$
Total	**$632,000**	**$743,000**	

Table 31. Initial costs UNICC implementation

A.6.1.3 Initial costs when implementing in IaaS

Cost Type	IaaS		
	Min	**Max**	**Comments**
Purchasing research	10,000	15,000	2 month, 1-1.5 persons
Setup, Organization (eTIR system)	30,000	40,000	3-4 month, 2 persons
Facilities (HVAC, Power, Space)			No initial costs
Hardware(Computers, Networks, Storage)			No initial costs
Software (OS, Database Servers, Core Connectivity)	370,000	400,000	As presented in R[5]-
Integration Middleware	120,000	160,000	As presented in R[5]-
Technology training (100-125 days/person)	100,000	125,000	100-120 days/person X 500$ - administrators of eTIR
Personnel recruitment	2,000	3,000	2-3 Persons X 1,000$
Total	**$632,000**	**$743,000**	

Table 32. Initial costs IaaS

A.6.1.4 Initial costs when implementing in PaaS

Cost Type	PaaS		
	Min	**Max**	**Comments**
Purchasing research	10,000	15,000	2 month, 1-1.5 persons
Setup, Organization (eTIR system)	30,000	40,000	3-4 month, 2 persons
Facilities (HVAC, Power, Space)			No initial costs
Hardware(Computers, Networks, Storage)			No initial costs
Software (OS, Database Servers, Core Connectivity)			No initial costs
Integration Middleware			No initial costs
Technology training (100-125 days/person)	100,000	125,000	100-120 days/person X 500$ - administrators of eTIR
Personnel recruitment	2,000	3,000	2-3 Persons X 1,000$
Total	**$142,000**	**$183,000**	

Table 33. Initial costs, PaaS implementation

A.6.1.5 Initial costs when implementing SaaS

Cost Type	SaaS		
	Min	***Max***	***Comments***
Purchasing research	10,000	15,000	2 month, 1-1.5 persons
Setup, Organization (eTIR system)			No initial costs
Facilities (HVAC, Power, Space)			No initial costs
Hardware(Computers, Networks, Storage)			No initial costs
Software (OS, Database Servers, Core Connectivity)			No initial costs
Integration Middleware			No initial costs
eTIR International development and implementation			No initial costs
Technology training (100-125 days/person)			No initial costs
Personnel recruitment			No initial costs
Total	**$10,000**	**$15,000**	

Table 34. Initial Costs SaaS implementation

A.6.1.6 Initial costs, Summary (current USD)

Initial Total	Min	Max
At premises	**$1,255,000**	**$1,450,000**
UNOG	**$681,500**	**$792,500**
UNICC	**$632,000**	**$743,000**
IaaS	**$632,000**	**$743,000**
PaaS	**$142,000**	**$183,000**
SaaS	**$10,000**	**$15,000**

Table 35. Initial Costs, Summary

A.6.2. *Costs of operations per year*

We consider hereby the usage of the system, for a year year, in the situation where three million TIR Carnets are registered in the system. The evolution of costs per year depending on the number of TIR Carnets registered in the system will be presented later.

We hereby present the costs expressed in current USD. Operations costs per year, at premises are:

On premises			
	Minimum	***Maximum***	***Explanations***
Operation expenses			
Infrastructure (floor space maintenance) (man/days)	$7,200	$9,600	240 days, 30-40 $ per hour, one hour per day
Electricity (for related equipment, cooling, backup power supply)120 kW/Day*$0.3	$11,680	$14,600	96-120 kW/Day*$0.3 or 4-5 kW per hour
Internet access	$20,000	$30,000	64 M

Testing costs for new releases.	$10,000	$20,000	Two new releases per year, each one tested 5-10 days by two persons
Backup and recovery process(space and processing time)	$12,739	$13,259	Medium space 1,000 GB for all data, Medium processing time 2 hours, price per space=0.1$; price per processing hour=0.3$. Backup incremental weekly (10-20GB x 52 weeks), monthly full (1,000G x 12 month).
Disaster recovery costs (external storage space)	$300	$600	1,000-2,000G per year, 0.3$ per GB storage
Technology training for SE and DBA	$8,000	$20,000	Training for SE and DBA (4-6 persons trained, 5 days training each)
System operations Audit (internal and external)-	$10,000	$15,000	Internal audit 2*5 days * 500$.- External audit 1*5 days X 1,000$ - 2*5 days X 1,000$
Security audit	$4,000	$6,000	Internal audit 2*2 days * 500$.- External audit 1*2 days X 1,000$ - 2*2 days X 1,000$
Insurance 0.1% from hardware (100,000)	$5,000	$20,000	0.1%-0.4% from hardware (500,000$)
Information technology personnel (Only for general operations not related to business process)	$180,000	$300,000	minimum 3 SE (24 hours), Maximum 3 SE, 2DBA X 5,000$ a month
Corporate management time (50 days)	$50,000	$52,000	50-52 Days * 1,000 $
Long term expenses			
Replacement (5% from hardware per year)	$21,500	$25,000	
Total	***$340,419***	***$526,059***	

Table 36. Costs of operations, implementation On premises

Operations costs per year, UNOG implementation

UNOG			
	Min	***Max***	***Explanations***
Operation expenses			
Infrastructure (floor space maintenance) (man/days)			No costs
Electricity (for related equipment, cooling, backup power supply)120 kW /Day*$0.3			No costs
Testing costs for new releases.	$10,000	$20,000	Two new releases per year, each one tested 5-10 days by two

			persons
Backup and recovery process(space and processing time)	$12,739	$13,259	Medium space 1,000 GB for all data, Medium processing time 2 hours, price per space=0.1$; price per processing hour=0.3$. Backup incremental weekly (10-20GB x 52 weeks), monthly full (1,000G x 12 month).
Disaster recovery costs (external storage space)			No costs
Technology training for SE and DBA	$8,000	$12,000	Training for SE and DBA (4-6 persons trained, 5 days training each)
System operations Audit (internal and external)-			No costs
Security audit	$4,000	$6,000	Internal audit 2*2 days * 500$.- External audit 1*2 days X 1,000$ - 2*2 days X 1,000$
Insurance 0.1% from hardware (100,000)			No costs
Information technology personnel (Only for general operations not related to business process)			No costs
Corporate management time (50 days)	$50,000	$52,000	50-52 Days * 1,000 $
Long term expenses			
Replacement (5% from hardware per year)			
Total	***$84,739***	***$103,259***	

Table 37. Costs of operations, UNOG implementation

Operations costs per year, UNICC implementation

UNICC			
	Min	***Max***	***Explanations***
Operation expenses			
Infrastructure (floor space maintenance) (man/days)			No costs
Electricity (for related equipment, cooling, backup power supply)120 kW/Day*$0.3			No costs
Testing costs for new releases.	$10,000	$20,000	Two new releases per year, each one tested 5-10 days by two persons

Backup and recovery process(space and processing time)	$12,739	$13,259	Medium space 1,000 GB for all data, Medium processing time 2 hours, price per space=0.1$; price per processing hour=0.3$. Backup incremental weekly (10-20GB x 52 weeks), monthly full (1,000GB x 12 month).
Disaster recovery costs (external storage space)			No costs
Technology training for SE and DBA	$8,000	$12,000	Training for SE and DBA (4-6 persons trained, 5 days training each)
System operations Audit (internal and external)-			No costs
Security audit	$4,000	$6,000	Internal audit 2*2 days * 500$.- External audit 1*2 days X 1,000$ - 2*2 days X 1,000$
Insurance 0.1% from hardware (100,000)			No costs
Information technology personnel (Only for general operations not related to business process)			No costs
Corporate management time (50 days)	$50,000	$52,000	50-52 Days * 1,000 $
Long term expenses			
Replacement (5% from hardware per year)			
Total	***$84,739***	***$103,259***	

Table 38. Costs of operations, UNICC implementation

Operations costs per year, IaaS implementation

IaaS			
	Min	***Max***	***Explanations***
Operation expenses			
Infrastructure (floor space maintenance) (man/days)			No costs
Electricity (for related equipment, cooling, backup power supply)120 kW /Day*$0.3			No costs
Testing costs for new releases.	10,000	20,000	Two new releases per year, each one tested 5-10 days by two persons

Backup and recovery process(space and processing time)	12,739	13,259	Medium space 1,000 GB for all data, Medium processing time 2 hours, price per space=0.1$ price per processing hour=0.3$. Backup incremental weekly (10-20GB x 52 weeks), monthly full (1,000GB x 12 month).
Disaster recovery costs (external storage space)			No costs
Technology training for SE and DBA	8,000	12,000	Training for SE and DBA (4-6 persons trained, 5 days training each)
System operations Audit (internal and external)-			No costs
Security audit	4,000	6,000	Internal audit 2*2 days * 500$.- External audit 1*2 days X 1,000$ - 2*2 days X 1,000$
Insurance 0.1% from hardware (100,000)			No costs
Information technology personnel (Only for general operations not related to business process)			No costs
Corporate management time (50 days)	50,000	52,000	50-52 Days * 1,000 $
Long term expenses			
Replacement (5% from hardware per year)			
Total	***$84,739***	***$103,259***	

Table 39. Costs of operations, IaaS implementation

Operations costs per year, PaaS implementation

PaaS			
	Min	***Max***	***Explanations***
Operation expenses			
Infrastructure (floor space maintenance) (man/days)			No costs
Electricity (for related equipment, cooling, backup power supply)120 kW /Day*$0.3			No costs
Testing costs for new releases.	10,000	20,000	Two new releases per year, each one tested 5-10 days by two persons
Backup and recovery process(space and processing time)			Medium space 1,000 GB for all data, Medium processing time 2 hours, price per space=0.1$ price per processing hour=0.3$. Backup incremental weekly (10-20GB x 52 weeks), monthly full (1,000GB x 12 month).

Disaster recovery costs (external storage space)			No costs
Technology training for SE and DBA			Training for SE and DBA (4-6 persons trained, 5 days training each)
System operations Audit (internal and external)-			No costs
Security audit	4,000	6,000	Internal audit 2*2 days * 500$.- External audit 1*2 days X 1,000$ - 2*2 days X 1,000$
Insurance 0.1% from hardware (100,000)			No costs
Information technology personnel (Only for general operations not related to business process)			No costs
Corporate management time (50 days)	50,000	52,000	50-52 Days * 1,000 $
Migration			
Long term expenses			
Replacement (5% from hardware per year)			
Total	***$64,000***	***$78,000***	

Table 40. Costs of operations, PaaS implementation

Each line in the table below represents the last one (Total line) in the tables above. The values represent current USD.

Implementation	*Min*	*Max*
At premises	$340,419	$526,059
UNOG	$84,739	$103,259
UNICC	$84,739	$103,259
IaaS	$84,739	$103,259
PaaS	$64,000	$78,000
SaaS	$0	$0

Table 41. Total annual operational costs

A.6.3. *Clouds and hosting costs*

Variable costs, for a full system workload, are computed for the following providers and types:

1. Microsoft PaaS on Azure platform;
2. Google PaaS on Google App Engine platform;
3. Amazon IaaS;
4. UNOG (IaaS type);
5. UNICC (IaaS type);
6. SaaS.

The price model is very different for each of the mentioned providers. However, at this stage, the total costs of such service per year are important.

For all providers, the costs of services have been computed considering a system workload as presented in Chapter 3.2.

It is considered that this is the first year of operation, having 3 million TIR transport processed by the system.

Solution	*Current USD*
PaaS	$95,116 - $102,816 / year
UNOG	$110,000 - $140,000 / year
UNICC	$82,980 - $153,800/ year
IaaS	$28,663 - $49,867 / year
SaaS	$0.5 - $1 / TIR Transport

Table 42. Cloud and Hosting Costs

A.6.4. *Helpdesk costs*

A helpdesk is provided for both business and technical related assistance for connections with the national Customs IT systems.

The helpdesk is functioning during normal working hours (8 hours a day, 2 system engineers).

With regard to the helpdesk, we consider three categories of costs:

- Initial costs;
- Operation costs per year (personnel costs not included);
- Personnel costs.

A.6.4.1 Initial costs

Cost Type	**Help Desk**		
	Min	***Max***	***Comments***
Setup, Organization (eTIR system)	$5,000	$6,000	1 month, 1 person
Hardware(Computers, Networks, Storage)	$5,000	$10,000	2 servers, 3 desktop computers, phone lines and equipment,
Software (OS, Database Servers, Core Connectivity)	$5,000	$10,000	OS, Database, Helpdesk Software
Technology training (200-250 days/person)	$7,500	$15,000	15-30 days/person X 500$ (3 persons trained)
Personnel recruitment	$2,000	$3,000	2-3 Persons X 1,000$
Total	**$24,500**	**$44,000**	

Table 43. Helpdesk detailed costs

A.6.4.2 Operating costs per year

Help desk			
	Min	**Max**	***Explanations***
Operational expenses			
Infrastructure (floor space maintenance) (man/days)	$15,000	$30,000	50 square meters office
Electricity (for related equipment, cooling, backup power supply)120 kW /Day*$0.3	$11,680	$14,600	96-120 kW/Day*$0.3 (4-5 kW per hour)
Phone and internet lines	$6,000	$12,000	Corporate subscription 1,000-2,000 per month
Other expenses (spared parts)	$500	$1000	paper, CDs, replacement of equipment (10% of hardware)
Total	**$18,180**	**$57,600**	

Table 44. Help Desk costs per year

A.6.4.3 Personnel costs per year

Personnel costs			
	Min	**Max**	***Explanations***
Helpdesk level 1			
Helpdesk level 1 personnel	$96,000	$144,000	2-3 operators * 4,000 per month * 12 month
Managers	$12,000	$15,000	1 manager 1 day per week, 5,000-6,000 per month
Total	***$108,000***	***$159,000***	

Table 45. Personnel costs per year

A.6.4.4 Total helpdesk costs, 10 years

The table below contains the total data from the previous tables, multiplied by 10 (10 years).

	Min	Max
Initial	$24,500	$44,000
Operational	$181,800	$576,000
Personnel	$1,080,000	$1,590,000
Total	$1,286,300	$2,210,000

Table 46. Total helpdesk costs for 10 years

A.6.5. *Costs to adjust the national system interfaces*

A.6.5.1 Assumptions

Currently, TIR Carnet data is entered in and processed by all national IT systems (If this is not the case, the eTIR User Interface module is an option, which could be considered).

The EU countries and candidate countries, signatories of the CTC (Common Transit Convention) are using the Common Transit System /NCTS system to key in the TIR Carnet data; while Turkey (a candidate country, not yet member of CTC), is using its national IT system (BILGE).

In Russia and Ukraine similar systems are used. The systems are well-known and cover all processes. We consider that there will be no changes in the current way of working with the system, but personnel training will be involved. Only the development costs are considered important and, thus, presented hereby.

Developing interfaces between the actual national Customs IT systems and the eTIR international system requires the following:

- Changes in the actual national systems, so that all information required by the eTIR international system can be entered;
- Changes in the actual national systems, so that the business processes which interfere with TIR Carnets are able to exchange data with the eTIR international system;
- Development of software interfaces (web services) for the eTIR international system.

The interfaces are the same for all eTIR implementations (at premises, UNOG, IaaS, PaaS).

For the evaluation of the costs of the eTIR national interfaces, we are using the analogy with the development of similar systems used in this case:

The development of the NCTS-TIR and its integration into the full NCTS system.

In order to develop this system in 3 countries, we consider that the whole development process, using RUP methodology involves 3 persons for a period of 3- 6 month, (10-20 man /month) depending on the team qualifications and its knowledge of the national Customs IT systems.

We present the costs in current USD.

A.6.5.2 Cost evaluation

For the estimation, we consider the following development schedule:

Name	Duration	Scheduled Work
eTIR National Interfaces	82 days	309 days
Inception	6 days	12 days
Startup	1 day	2 days

Prepare Inception report	5 days	5 days
Project Quality Plan	5 days	5 days
Elaboration	20 days	90 days
Specifications	20 days	60 days
Application Specifications Document	10 days	10 days
Technical Specifications Document	10 days	10 days
Security Specifications Document	10 days	10 days
Interoperability Specifications	10 days	10 days
Business Process Modeling	10 days	10 days
Acceptance Test Scenarios Document	10 days	10 days
eTIR Interfaces System Design	5 days	20 days
Service Model	5 days	5 days
Data Model	5 days	5 days
Technical design document	5 days	5 days
Business Processes treatment	5 days	5 days
eTIR Interfaces Proof Of Concept	5 days	10 days
Construction	45 days	165 days
Specifications	10 days	40 days
Detailed Application Specifications Document	5 days	10 days
Detailed Technical Specifications Document	5 days	10 days
Detailed Security Specifications Document	5 days	10 days
Detailed Interoperability Specifications	5 days	10 days
eTIR Interfaces Detailed Design	5 days	15 days
Data Model	5 days	5 days
Communication Model	5 days	5 days
Interface specifications	5 days	5 days
eTIR Interfaces Development	20 days	80 days
Changes in Data Capture and presentation	10 days	20 days
XML parsing and processing	10 days	20 days
Business process treatment	10 days	20 days
Web Services	10 days	20 days
Unit and Integration Testing	10 days	30 days
Test Data entry system	5 days	10 days
Test Business Process system	5 days	10 days
Tests web (WS) Interfaces	5 days	10 days
Transition	10 days	40 days
Update specifications and design documents	5 days	10 days
Changes in the system, as required by the tests' results	5 days	10 days
Acceptance tests	10 days	20 days
Close –up	1 day	2 days

Table 47. Effort estimation for National IT system

Based on the schedule previously presented (which is considered as minimum and requiring the employment of a highly qualified team), we have the following costs for each national system:

	Min	*Max*	*Explanation*
Development	$120,000	$150,000	~15 Man/month * $8,000 minimum costs or 30 Man/Month * $5,000 maximum costs

Table 48. Cost per country, to adapt National IT system

Considering the 57 countries of the TIR convention where the TIR system is active, the total costs might be as follows:

	Min	*Max*	*Explanation*
Development	$6,840,000	$8,550,000	~15 Man/month * $8,000 minimum costs or 30 Man/Month * $5,000 maximum costs 57 countries

Table 49. Total costs to adapt all National IT systems

A.6.6. *Costs for transport operators*

A.6.6.1 Assumptions

Transport agents (carriers) are supposed to be in one of the situations:

A. They already have their own system where they register data. Using a system-to-system connection, they are exchanging data with the national Customs IT systems;
B. They are using a third party system (like IRU's TIR-EPD) to exchange data with the national Customs IT systems;
C. They are using declaration mechanisms of national Customs IT systems to exchange data directly with Customs;
D. They do not register TIR data in any system.

A.6.6.2 Costs for eTIR adoption

For categories A, B and C, we consider there are no necessary costs, as they will continue to work as they currently do. It will be the national Customs IT applications which will be interfaced with the eTIR international system. Changes, if any, are small and not relevant for the present cost estimations.

Transport operators belonging to D category will have the possibility to use solutions B and C for free.

In conclusion, we consider that there are no real costs involved for the Trader community.

A.6.7. *Total costs of the eTIR international system*

The total costs for 10 years of usage, are presented below.

The assumption presented in Chapter 3.8 for both scenarios are used to calculate the sum of operational and cloud costs for a period of 10 years. The cost of adaptation of national IT system is not included in the tables below.

	Development		Initial costs		Oper/Cloud x10		Helpdesk x10		Total	
Impl. Type	*Min*	*Max*	*Min*	*Max*	*Min*	*Max*	*Min*	*Max*	*Min*	*Max*
At premises	924,800	1,127,000	1,255,000	1,450,000	1,929,041	2,981,001	1,286,300	2,210,000	5,395,141	7,768,001
UNOG	924,800	1,127,000	681,500	792,500	1,103,521	1,378,468	1,286,300	2,210,000	3,996,121	5,507,968
UNICC	924,800	1,127,000	632,000	743,000	950,408	1,456,668	1,286,300	2,210,000	3,793,508	5,536,668
IaaS	924,800	1,127,000	632,000	743,000	642,609	867,717	1,286,300	2,210,000	3,485,709	4,947,717
PaaS	924,800	1,127,000	142,000	183,000	901,657	1,024,624	1,286,300	2,210,000	3,254,757	4,544,624
SaaS			10,000	15,000	8,500,000	17,000,000	1,286,300	2,210,000	9,796,300	19,225,000

Table 50. Total costs (USD) for gradual usage reaching 3 million TIR transports

	Development		Initial costs		Oper/Cloud x10		Helpdesk x10		Total	
Impl. Type	*Min*	*Max*	*Min*	*Max*	*Min*	*Max*	*Min*	*Max*	*Min*	*Max*
At premises	924,800	1,127,000	1,255,000	1,450,000	964,521	1,490,501	1,286,300	2,210,000	4,430,621	6,277,501
UNOG	924,800	1,127,000	681,500	792,500	551,761	689,234	1,286,300	2,210,000	3,444,361	4,818,734
UNICC	924,800	1,127,000	632,000	743,000	475,204	728,334	1,286,300	2,210,000	3,318,304	4,808,334
IaaS	924,800	1,127,000	632,000	743,000	321,305	433,858	1,286,300	2,210,000	3,164,405	4,513,858
PaaS	924,800	1,127,000	142,000	183,000	450,829	512,312	1,286,300	2,210,000	2,803,929	4,032,312
SaaS			10,000	15,000	4,250,000	8,500,000	1,286,300	2,210,000	5,546,300	10,725,000

Table 51. Total costs (USD) for gradual usage reaching 1.5 million TIR transports

The costs above are expressed in terms of current USD. No discounts and/or risk rates are applied. The maximum costs are used in the next chapter (using a risk factor and discounted) to calculate the return on investement (ROI) and the net present value (NPV) of each option and for both scenarios.

A.7. DETAILED COST-BENEFIT TABLES

A.7.1. *Gradual full usage of eTIR system*

A.7.1.1 At premises implementation, eTIR Carnets distributed gradually

		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Total
Costs	Development	563,500	563,500											1,127,000
	Initial		725,000	725,000										1,450,000
	Oper. + Hosting			17,535	122,747	140,282	210,424	227,959	350,706	438,383	455,918	490,988	526,059	2,981,001
	Sub-total	563,500	1,288,500	742,535	122,747	140,282	210,424	227,959	350,706	438,383	455,918	490,988	526,059	5,558,001
	Help Desk			260,600	216,600	216,600	216,600	216,600	216,600	216,600	216,600	216,600	216,600	2,210,000
	National App	0	450,000	450,000	450,000	750,000	1,500,000	1,500,000	750,000	750,000	750,000	600,000	600,000	8,550,000
Total Costs		563,500	1,738,500	1,453,135	789,347	1,106,882	1,927,024	1,944,559	1,317,306	1,404,983	1,422,518	1,307,588	1,342,659	16,318,001
Total Costs (incl. 20% risk factor)		676,200	2,086,200	1,743,762	947,217	1,328,259	2,312,428	2,333,471	1,580,767	1,685,979	1,707,021	1,569,106	1,611,191	19,581,601
Discounted Costs (incl. risk factor)		676,200	1,986,857	1,581,644	818,241	1,092,762	1,811,848	1,741,272	1,123,422	1,141,137	1,100,361	963,295	942,030	14,979,069
Benefits for Customs (incl. 20% risk factor)				115,000	805,000	920,000	1,380,000	1,495,000	2,300,000	2,875,000	2,990,000	3,220,000	3,450,000	19,550,000
Total Benefits (incl. 20% risk factor)				713,000	4,991,000	5,704,000	8,556,000	9,269,000	14,260,000	17,825,000	18,538,000	19,964,000	21,390,000	121,210,000
Discounted Customs Benefits (incl.risk factor)				104,308	695,389	756,886	1,081,266	1,115,592	1,634,567	1,945,913	1,927,381	1,976,801	2,017,144	13,255,247
Discounted Overall Benefits (incl.risk factor)				646,712	4,311,413	4,692,695	6,703,850	6,916,671	10,134,316	12,064,662	11,949,760	12,256,164	12,506,290	82,182,532
ROI for Customs														-12%
Overall ROI														449%
Cash Flow for customs		-676,200	-2,086,200	-1,628,762	-142,217	-408,259	-932,428	-838,471	719,233	1,189,021	1,282,979	1,650,894	1,838,809	-31,601
Overall Cash Flow		-676,200	-2,086,200	-1,030,762	4,043,783	4,375,741	6,243,572	6,935,529	12,679,233	16,139,021	16,830,979	18,394,894	19,778,809	101,628,399
Discounted CF		-676,200	-1,986,857	-934,932	3,493,172	3,599,933	4,892,002	5,175,399	9,010,894	10,923,525	10,849,399	11,292,869	11,564,260	67,203,464
Net present value														67,203,464

Table 52. Costs, benefits, all eTIR Carnets registered gradually, for at premises implementation

A.7.1.2 UNOG implementation, eTIR Carnets distributed gradually

		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Total
Costs	Development	563,500	563,500											1,127,000
	Initial		396,250	396,250										792,500
	Oper. + Hosting			8,109	56,760	64,869	97,304	105,412	162,173	202,716	210,824	227,042	243,259	1,378,468
	Sub-total	563,500	959,750	404,359	56,760	64,869	97,304	105,412	162,173	202,716	210,824	227,042	243,259	3,297,968
	Help Desk			260,600	216,600	216,600	216,600	216,600	216,600	216,600	216,600	216,600	216,600	2,210,000
	National App	0	450,000	450,000	450,000	750,000	1,500,000	1,500,000	750,000	750,000	750,000	600,000	600,000	8,550,000
Total Costs		563,500	1,409,750	1,114,959	723,360	1,031,469	1,813,904	1,822,012	1,128,773	1,169,316	1,177,424	1,043,642	1,059,859	14,057,968
Total Costs (incl. 20% risk factor)		676,200	1,691,700	1,337,950	868,033	1,237,763	2,176,684	2,186,415	1,354,527	1,403,179	1,412,909	1,252,370	1,271,831	16,869,561
Discounted Costs (incl. risk factor)		676,200	1,611,143	1,213,560	749,839	1,018,311	1,705,489	1,631,536	962,637	949,727	910,774	768,847	743,613	12,941,676
Benefits for Customs (incl. 20% risk factor)				115,000	805,000	920,000	1,380,000	1,495,000	2,300,000	2,875,000	2,990,000	3,220,000	3,450,000	19,550,000
Total Benefits (incl. 20% risk factor)				713,000	4,991,000	5,704,000	8,556,000	9,269,000	14,260,000	17,825,000	18,538,000	19,964,000	21,390,000	121,210,000
Discounted Customs Benefits (incl.risk factor)				104,308	695,389	756,886	1,081,266	1,115,592	1,634,567	1,945,913	1,927,381	1,976,801	2,017,144	13,255,247
Discounted Overall Benefits (incl.risk factor)				646,712	4,311,413	4,692,695	6,703,850	6,916,671	10,134,316	12,064,662	11,949,760	12,256,164	12,506,290	82,182,532
ROI for Customs														2%
Overall ROI														535%
Cash Flow for customs		-676,200	-1,691,700	-1,222,950	-63,033	-317,763	-796,684	-691,415	945,473	1,471,821	1,577,091	1,967,630	2,178,169	2,680,439
Overall Cash Flow		-676,200	-1,691,700	-624,950	4,122,967	4,466,237	6,379,316	7,082,585	12,905,473	16,421,821	17,125,091	18,711,630	20,118,169	104,340,439
Discounted CF		-676,200	-1,611,143	-566,848	3,561,574	3,674,384	4,998,361	5,285,134	9,171,679	11,114,935	11,038,986	11,487,318	11,762,677	69,240,856
Net present value														69,240,856

Table 53. Costs, benefits all eTIR Carnets registered gradually, UNOG implementation

A.7.1.3 UNICC implementation, eTIR Carnets distributed gradually

		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Total
Costs	Development	563,500	563,500											1,127,000
	Initial		371,500	371,500										743,000
	Oper. + Hosting			8,569	59,980	68,549	102,824	111,392	171,373	214,216	222,784	239,922	257,059	1,456,668
	Sub-total	563,500	935,000	380,069	59,980	68,549	102,824	111,392	171,373	214,216	222,784	239,922	257,059	3,326,668
	Help Desk			260,600	216,600	216,600	216,600	216,600	216,600	216,600	216,600	216,600	216,600	2,210,000
	National App	0	450,000	450,000	450,000	750,000	1,500,000	1,500,000	750,000	750,000	750,000	600,000	600,000	8,550,000
Total Costs		563,500	1,385,000	1,090,669	726,580	1,035,149	1,819,424	1,827,992	1,137,973	1,180,816	1,189,384	1,056,522	1,073,659	14,086,668
Total Costs (incl. 20% risk factor)		676,200	1,662,000	1,308,802	871,897	1,242,179	2,183,308	2,193,591	1,365,567	1,416,979	1,427,261	1,267,826	1,288,391	16,904,001
Discounted Costs (incl. risk factor)		676,200	1,582,857	1,187,122	753,177	1,021,944	1,710,679	1,636,891	970,483	959,067	920,025	778,335	753,295	12,950,077
Benefits for Customs (incl. 20% risk factor)				115,000	805,000	920,000	1,380,000	1,495,000	2,300,000	2,875,000	2,990,000	3,220,000	3,450,000	19,550,000
Total Benefits (incl. 20% risk factor)				713,000	4,991,000	5,704,000	8,556,000	9,269,000	14,260,000	17,825,000	18,538,000	19,964,000	21,390,000	121,210,000
Discounted Customs Benefits (incl.risk factor)				104,308	695,389	756,886	1,081,266	1,115,592	1,634,567	1,945,913	1,927,381	1,976,801	2,017,144	13,255,247
Discounted Overall Benefits (incl.risk factor)				646,712	4,311,413	4,692,695	6,703,850	6,916,671	10,134,316	12,064,662	11,949,760	12,256,164	12,506,290	82,182,532
ROI for Customs														2%
Overall ROI														535%
Cash Flow for customs		-676,200	-1,662,000	-1,193,802	-66,897	-322,179	-803,308	-698,591	934,433	1,458,021	1,562,739	1,952,174	2,161,609	2,645,999
Overall Cash Flow		-676,200	-1,662,000	-595,802	4,119,103	4,461,821	6,372,692	7,075,409	12,894,433	16,408,021	17,110,739	18,696,174	20,101,609	104,305,999
Discounted CF		-676,200	-1,582,857	-540,410	3,558,236	3,670,751	4,993,171	5,279,779	9,163,833	11,105,594	11,029,735	11,477,829	11,752,995	69,232,456
Net present value														69,232,456

Table 54. Costs, benefits, all eTIR Carnets registered gradually, UNICC implementation

A.7.1.4 PaaS implementation, eTIR Carnets distributed gradually

		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Total
Costs	Development	563,500	563,500											1,127,000
	Initial		91,500	91,500										183,000
	Oper. + Hosting			6,027	42,190	48,218	72,326	78,354	120,544	150,680	156,707	168,762	180,816	1,024,624
	Sub-total	563,500	655,000	97,527	42,190	48,218	72,326	78,354	120,544	150,680	156,707	168,762	180,816	2,334,624
	Help Desk			260,600	216,600	216,600	216,600	216,600	216,600	216,600	216,600	216,600	216,600	2,210,000
	National App	838,235	838,235	502,941	502,941	586,765	1,257,353	1,257,353	586,765	586,765	586,765	502,941	502,941	8,550,000
Total Costs		1,401,735	1,493,235	861,068	761,732	851,582	1,546,279	1,552,307	923,909	954,045	960,072	888,303	900,357	13,094,624
Total Costs (incl. 20% risk factor)		1,682,082	1,791,882	1,033,282	914,078	1,021,899	1,855,535	1,862,768	1,108,690	1,144,854	1,152,086	1,065,963	1,080,429	15,713,549
Discounted Costs (incl. risk factor)		1,682,082	1,706,555	937,217	789,615	840,719	1,453,860	1,390,026	787,926	774,882	742,645	654,409	631,704	12,391,640
Benefits for Customs (incl. 20% risk factor)				115,000	805,000	920,000	1,380,000	1,495,000	2,300,000	2,875,000	2,990,000	3,220,000	3,450,000	19,550,000
Total Benefits (incl. 20% risk factor)				713,000	4,991,000	5,704,000	8,556,000	9,269,000	14,260,000	17,825,000	18,538,000	19,964,000	21,390,000	121,210,000
Discounted Customs Benefits (incl.risk factor)				104,308	695,389	756,886	1,081,266	1,115,592	1,634,567	1,945,913	1,927,381	1,976,801	2,017,144	13,255,247
Discounted Overall Benefits (incl.risk factor)				646,712	4,311,413	4,692,695	6,703,850	6,916,671	10,134,316	12,064,662	11,949,760	12,256,164	12,506,290	82,182,532
ROI for Customs														7%
Overall ROI														563%
Cash Flow for customs		-1,682,082	-1,791,882	-918,282	-109,078	-101,899	-475,535	-367,768	1,191,310	1,730,146	1,837,914	2,154,037	2,369,571	3,836,451
Overall Cash Flow		-1,682,082	-1,791,882	-320,282	4,076,922	4,682,101	6,700,465	7,406,232	13,151,310	16,680,146	17,385,914	18,898,037	20,309,571	105,496,451
Discounted CF		-1,682,082	-1,706,555	-290,505	3,521,799	3,851,976	5,249,989	5,526,644	9,346,390	11,289,780	11,207,115	11,601,755	11,874,586	69,790,892
Net present value														69,790,892

Table 55. Costs, benefits, all eTIR Carnets registered gradually, PaaS implementation

A.7.1.5 IaaS implementation, eTIR Carnets distributed gradually

		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Total
Costs	Development	563,500	563,500											1,127,000
	Initial		371,500	371,500										743,000
	Oper. + Hosting			5,104	35,730	40,834	61,251	66,355	102,084	127,605	132,710	142,918	153,126	867,717
	Sub-total	563,500	935,000	376,604	35,730	40,834	61,251	66,355	102,084	127,605	132,710	142,918	153,126	2,737,717
	Help Desk			260,600	216,600	216,600	216,600	216,600	216,600	216,600	216,600	216,600	216,600	2,210,000
	National App	0	450,000	450,000	450,000	750,000	1,500,000	1,500,000	750,000	750,000	750,000	600,000	600,000	8,550,000
Total Costs		563,500	1,385,000	1,087,204	702,330	1,007,434	1,777,851	1,782,955	1,068,684	1,094,205	1,099,310	959,518	969,726	13,497,717
Total Costs (incl. 20% risk factor)		676,200	1,662,000	1,304,645	842,795	1,208,920	2,133,421	2,139,546	1,282,421	1,313,046	1,319,172	1,151,422	1,163,672	16,197,260
Discounted Costs (incl. risk factor)		676,200	1,582,857	1,183,352	728,038	994,582	1,671,591	1,596,562	911,393	888,722	850,350	706,873	680,375	12,470,894
Benefits for Customs (incl. 20% risk factor)				115,000	805,000	920,000	1,380,000	1,495,000	2,300,000	2,875,000	2,990,000	3,220,000	3,450,000	19,550,000
Total Benefits (incl. 20% risk factor)				713,000	4,991,000	5,704,000	8,556,000	9,269,000	14,260,000	17,825,000	18,538,000	19,964,000	21,390,000	121,210,000
Discounted Customs Benefits (incl.risk factor)				104,308	695,389	756,886	1,081,266	1,115,592	1,634,567	1,945,913	1,927,381	1,976,801	2,017,144	13,255,247
Discounted Overall Benefits (incl.risk factor)				646,712	4,311,413	4,692,695	6,703,850	6,916,671	10,134,316	12,064,662	11,949,760	12,256,164	12,506,290	82,182,532
ROI for Customs														6%
Overall ROI														559%
Cash Flow for customs		-676,200	-1,662,000	-1,189,645	-37,795	-288,920	-753,421	-644,546	1,017,579	1,561,954	1,670,828	2,068,578	2,286,328	3,352,740
Overall Cash Flow		-676,200	-1,662,000	-591,645	4,148,205	4,495,080	6,422,579	7,129,454	12,977,579	16,511,954	17,218,828	18,812,578	20,226,328	105,012,740
Discounted CF		-676,200	-1,582,857	-536,640	3,583,375	3,698,113	5,032,259	5,320,109	9,222,923	11,175,940	11,099,410	11,549,291	11,825,915	69,711,639
Net present value														69,711,639

Table 56. Costs, benefits, all eTIR Carnets registered gradually, IaaS implementation

A.7.1.6 SaaS implementation, eTIR Carnets distributed gradually

		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Total
Costs	Development													0
	Initial		7,500	7,500										15,000
	Oper. + Hosting			100,000	700,000	800,000	1,200,000	1,300,000	2,000,000	2,500,000	2,600,000	2,800,000	3,000,000	17,000,000
	Sub-total	0	7,500	107,500	700,000	800,000	1,200,000	1,300,000	2,000,000	2,500,000	2,600,000	2,800,000	3,000,000	17,015,000
	Help Desk			260,600	216,600	216,600	216,600	216,600	216,600	216,600	216,600	216,600	216,600	2,210,000
	National App	0	450,000	450,000	450,000	750,000	1,500,000	1,500,000	750,000	750,000	750,000	600,000	600,000	8,550,000
Total Costs		0	457,500	818,100	1,366,600	1,766,600	2,916,600	3,016,600	2,966,600	3,466,600	3,566,600	3,616,600	3,816,600	27,775,000
Total Costs (incl. 20% risk factor)		0	549,000	981,720	1,639,920	2,119,920	3,499,920	3,619,920	3,559,920	4,159,920	4,279,920	4,339,920	4,579,920	33,330,000
Discounted Costs (incl. risk factor)		0	522,857	890,449	1,416,625	1,744,063	2,742,279	2,701,240	2,529,969	2,815,598	2,758,875	2,664,334	2,677,784	23,464,073
Benefits for Customs (incl. 20% risk factor)				115000	805000	920000	1380000	1495000	2300000	2875000	2990000	3220000	3450000	19550000
Total Benefits (incl. 20% risk factor)				713000	4991000	5704000	8556000	9269000	14260000	17825000	18538000	19964000	21390000	121210000
Discounted Customs Benefits (incl.risk factor)				104308.39	695389.27	756886.28	1081266.1	1115592	1634567.1	1945913.2	1927380.7	1976800.7	2017143.5	13255247.17
Discounted Overall Benefits (incl.risk factor)				646712.02	4311413.5	4692694.9	6703849.9	6916670.5	10134316	12064662	11949760	12256164	12506290	82182532.45
ROI for Customs														-44%
Overall ROI														250%
Cash Flow for customs		0	-522,857	-866,720	-834,920	-1,199,920	-2,119,920	-2,124,920	-1,259,920	-1,284,920	-1,289,920	-1,119,920	-1,129,920	-13,780,000
Overall Cash Flow		0	-549,000	-268,720	3,351,080	3,584,080	5,056,080	5,649,080	10,700,080	13,665,080	14,258,080	15,624,080	16,810,080	87,880,000
Discounted CF		0	-522,857	-243,737	2,894,789	2,948,631	3,961,571	4,215,430	7,604,347	9,249,064	9,190,885	9,591,830	9,828,506	58,718,460
Net present value														58,718,460

Table 57. Costs, benefits, all eTIR Carnets registered gradually, SaaS implementation

A.7.2. *Gradual half usage of eTIR system*

A.7.2.1 At Premises implementation, eTIR Carnets distributed gradually, half usage

		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Total
Costs	Development	563,500	563,500											1,127,000
	Initial		725,000	725,000										1,450,000
	Oper. + Hosting			17,535	122,747	140,282	210,424	227,959	350,706	438,383	455,918	490,988	526,059	2,981,001
	Sub-total	563,500	1,288,500	742,535	122,747	140,282	210,424	227,959	350,706	438,383	455,918	490,988	526,059	5,558,001
	Help Desk			260,600	216,600	216,600	216,600	216,600	216,600	216,600	216,600	216,600	216,600	2,210,000
	National App	0	450,000	450,000	450,000	750,000	1,500,000	1,500,000	750,000	750,000	750,000	600,000	600,000	8,550,000
Total Costs		563,500	1,738,500	1,453,135	789,347	1,106,882	1,927,024	1,944,559	1,317,306	1,404,983	1,422,518	1,307,588	1,342,659	16,318,001
Total Costs (incl. 20% risk factor)		676,200	2,086,200	1,743,762	947,217	1,328,259	2,312,428	2,333,471	1,580,767	1,685,979	1,707,021	1,569,106	1,611,191	19,581,601
Discounted Costs (incl. risk factor)		676,200	1,986,857	1,581,644	818,241	1,092,762	1,811,848	1,741,272	1,123,422	1,141,137	1,100,361	963,295	942,030	14,979,069
Benefits for Customs (incl. 20% risk factor)				57,500	345,000	460,000	575,000	690,000	1,150,000	1,380,000	1,495,000	1,610,000	1,725,000	9,487,500
Total Benefits (incl. 20% risk factor)				356,500	2,139,000	2,852,000	3,565,000	4,278,000	7,130,000	8,556,000	9,269,000	9,982,000	10,695,000	58,822,500
Discounted Customs Benefits (incl.risk factor)				52,154	298,024	378,443	450,528	514,889	817,284	934,038	963,690	988,400	1,008,572	6,406,022
Discounted Overall Benefits (incl.risk factor)				323,356	1,847,749	2,346,347	2,793,271	3,192,309	5,067,158	5,791,038	5,974,880	6,128,082	6,253,145	39,717,335
ROI for Customs														-57%
Overall ROI														165%
Cash Flow for customs		-676,200	-2,086,200	-1,686,262	-602,217	-868,259	-1,737,428	-1,643,471	-430,767	-305,979	-212,021	40,894	113,809	-10,094,101
Overall Cash Flow		-676,200	-2,086,200	-1,387,262	1,191,783	1,523,741	1,252,572	1,944,529	5,549,233	6,870,021	7,561,979	8,412,894	9,083,809	39,240,899
Discounted CF		-676,200	-1,986,857	-1,258,288	1,029,507	1,253,586	981,423	1,451,038	3,943,736	4,649,901	4,874,519	5,164,787	5,311,115	24,738,266
Net present value														24,738,266

Table 58. Costs, benefits, eTIR Carnets registered gradually half usage and at premises implementation

A.7.2.2 UNOG implementation, eTIR Carnets distributed gradually, half usage

		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Total
Costs	Development	563,500	563,500											1,127,000
	Initial		396,250	396,250										792,500
	Oper. + Hosting			4,054	24,326	32,435	40,543	48,652	81,086	97,304	105,412	113,521	121,630	668,962
	Sub-total	563,500	959,750	400,304	24,326	32,435	40,543	48,652	81,086	97,304	105,412	113,521	121,630	2,588,462
	Help Desk			260,600	216,600	216,600	216,600	216,600	216,600	216,600	216,600	216,600	216,600	2,210,000
	National App	0	450,000	450,000	450,000	750,000	1,500,000	1,500,000	750,000	750,000	750,000	600,000	600,000	8,550,000
Total Costs		563,500	1,409,750	1,110,904	690,926	999,035	1,757,143	1,765,252	1,047,686	1,063,904	1,072,012	930,121	938,230	13,348,462
Total Costs (incl. 20% risk factor)		676,200	1,691,700	1,333,085	829,111	1,198,841	2,108,572	2,118,302	1,257,224	1,276,684	1,286,415	1,116,145	1,125,875	16,018,155
Discounted Costs (incl. risk factor)		676,200	1,611,143	1,209,148	716,217	986,290	1,652,121	1,580,710	893,485	864,110	829,234	685,216	658,276	12,362,151
Benefits for Customs (incl. 20% risk factor)				57,500	345,000	460,000	575,000	690,000	1,150,000	1,380,000	1,495,000	1,610,000	1,725,000	9,487,500
Total Benefits (incl. 20% risk factor)				356,500	2,139,000	2,852,000	3,565,000	4,278,000	7,130,000	8,556,000	9,269,000	9,982,000	10,695,000	58,822,500
Discounted Customs Benefits (incl.risk factor)				52,154	298,024	378,443	450,528	514,889	817,284	934,038	963,690	988,400	1,008,572	6,406,022
Discounted Overall Benefits (incl.risk factor)				323,356	1,847,749	2,346,347	2,793,271	3,192,309	5,067,158	5,791,038	5,974,880	6,128,082	6,253,145	39,717,335
ROI for Customs														-48%
Overall ROI														221%
Cash Flow for customs		-676,200	-1,691,700	-1,275,585	-484,111	-738,841	-1,533,572	-1,428,302	-107,224	103,316	208,585	493,855	599,125	-6,530,655
Overall Cash Flow		-676,200	-1,691,700	-976,585	1,309,889	1,653,159	1,456,428	2,159,698	5,872,776	7,279,316	7,982,585	8,865,855	9,569,125	42,804,345
Discounted CF		-676,200	-1,611,143	-885,792	1,131,531	1,360,058	1,141,150	1,611,600	4,173,673	4,926,927	5,145,646	5,442,866	5,594,869	27,355,184
Net present value														27,355,184

Table 59. Costs, benefits, eTIR Carnets registered gradually, UNOG implementation, half usage

A.7.2.3 UNICC implementation, eTIR Carnets distributed gradually, half usage

		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Total
Costs	Development	563,500	563,500											1,127,000
	Initial		371,500	371,500										743,000
	Oper. + Hosting			4,284	25,706	34,275	42,843	51,412	85,686	102,824	111,392	119,961	128,530	706,912
	Sub-total	563,500	935,000	375,784	25,706	34,275	42,843	51,412	85,686	102,824	111,392	119,961	128,530	2,576,912
	Help Desk			260,600	216,600	216,600	216,600	216,600	216,600	216,600	216,600	216,600	216,600	2,210,000
	National App	0	450,000	450,000	450,000	750,000	1,500,000	1,500,000	750,000	750,000	750,000	600,000	600,000	8,550,000
Total Costs		563,500	1,385,000	1,086,384	692,306	1,000,875	1,759,443	1,768,012	1,052,286	1,069,424	1,077,992	936,561	945,130	13,336,912
Total Costs (incl. 20% risk factor)		676,200	1,662,000	1,303,661	830,767	1,201,049	2,111,332	2,121,614	1,262,744	1,283,308	1,293,591	1,123,873	1,134,155	16,004,295
Discounted Costs (incl. risk factor)		676,200	1,582,857	1,182,459	717,648	988,106	1,654,284	1,583,181	897,408	868,594	833,860	689,961	663,117	12,337,675
Benefits for Customs (incl. 20% risk factor)				57,500	345,000	460,000	575,000	690,000	1,150,000	1,380,000	1,495,000	1,610,000	1,725,000	9,487,500
Total Benefits (incl. 20% risk factor)				356,500	2,139,000	2,852,000	3,565,000	4,278,000	7,130,000	8,556,000	9,269,000	9,982,000	10,695,000	58,822,500
Discounted Customs Benefits (incl.risk factor)				52,154	298,024	378,443	450,528	514,889	817,284	934,038	963,690	988,400	1,008,572	6,406,022
Discounted Overall Benefits (incl.risk factor)				323,356	1,847,749	2,346,347	2,793,271	3,192,309	5,067,158	5,791,038	5,974,880	6,128,082	6,253,145	39,717,335
ROI for Customs														-48%
Overall ROI														222%
Cash Flow for customs		-676,200	-1,662,000	-1,246,161	-485,767	-741,049	-1,536,332	-1,431,614	-112,744	96,692	201,409	486,127	590,845	-6,516,795
Overall Cash Flow		-676,200	-1,662,000	-947,161	1,308,233	1,650,951	1,453,668	2,156,386	5,867,256	7,272,692	7,975,409	8,858,127	9,560,845	42,818,205
Discounted CF		-676,200	-1,582,857	-859,103	1,130,101	1,358,241	1,138,987	1,609,128	4,169,750	4,922,444	5,141,020	5,438,122	5,590,028	27,379,660
Net present value														27,379,660

Table 60. Costs, benefits, eTIR Carnets registered gradually, UNICC implementation, half usage

A.7.2.4 PaaS implementation, eTIR Carnets distributed gradually, half usage

		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Total
Costs	Development	563,500	563,500											1,127,000
	Initial		91,500	91,500										183,000
	Oper. + Hosting			3,014	18,082	24,109	30,136	36,163	60,272	72,326	78,354	84,381	90,408	497,244
	Sub-total	563,500	655,000	94,514	18,082	24,109	30,136	36,163	60,272	72,326	78,354	84,381	90,408	1,807,244
	Help Desk			260,600	216,600	216,600	216,600	216,600	216,600	216,600	216,600	216,600	216,600	2,210,000
	National App	0	450,000	450,000	450,000	750,000	1,500,000	1,500,000	750,000	750,000	750,000	600,000	600,000	8,550,000
Total Costs		563,500	1,105,000	805,114	684,682	990,709	1,746,736	1,752,763	1,026,872	1,038,926	1,044,954	900,981	907,008	12,567,244
Total Costs (incl. 20% risk factor)		676,200	1,326,000	966,136	821,618	1,188,851	2,096,083	2,103,316	1,232,246	1,246,712	1,253,944	1,081,177	1,088,410	15,080,693
Discounted Costs (incl. risk factor)		676,200	1,262,857	876,314	709,744	978,070	1,642,336	1,569,527	875,735	843,824	808,304	663,749	636,371	11,543,030
Benefits for Customs (incl. 20% risk factor)				57,500	345,000	460,000	575,000	690,000	1,150,000	1,380,000	1,495,000	1,610,000	1,725,000	9,487,500
Total Benefits (incl. 20% risk factor)				356,500	2,139,000	2,852,000	3,565,000	4,278,000	7,130,000	8,556,000	9,269,000	9,982,000	10,695,000	58,822,500
Discounted Customs Benefits (incl.risk factor)				52,154	298,024	378,443	450,528	514,889	817,284	934,038	963,690	988,400	1,008,572	6,406,022
Discounted Overall Benefits (incl.risk factor)				323,356	1,847,749	2,346,347	2,793,271	3,192,309	5,067,158	5,791,038	5,974,880	6,128,082	6,253,145	39,717,335
ROI for Customs														-45%
Overall ROI														244%
Cash Flow for customs		-676,200	-1,326,000	-908,636	-476,618	-728,851	-1,521,083	-1,413,316	-82,246	133,288	241,056	528,823	636,590	-5,593,193
Overall Cash Flow		-676,200	-1,326,000	-609,636	1,317,382	1,663,149	1,468,917	2,174,684	5,897,754	7,309,288	8,015,056	8,900,823	9,606,590	43,741,807
Discounted CF		-676,200	-1,262,857	-552,958	1,138,004	1,368,277	1,150,935	1,622,783	4,191,423	4,947,214	5,166,576	5,464,333	5,616,774	28,174,305
Net present value														28,174,305

Table 61. Costs, benefits, eTIR Carnets registered gradually, PaaS implementation, half usage

A.7.2.5 IaaS implementation, eTIR Carnets distributed gradually, half usage

		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Total
Costs	Development	563,500	563,500											1,127,000
	Initial		371,500	371,500										743,000
	Oper. + Hosting			2,552	15,313	20,417	25,521	30,625	51,042	61,251	66,355	71,459	76,563	421,098
	Sub-total	563,500	935,000	374,052	15,313	20,417	25,521	30,625	51,042	61,251	66,355	71,459	76,563	2,291,098
	Help Desk			260,600	216,600	216,600	216,600	216,600	216,600	216,600	216,600	216,600	216,600	2,210,000
	National App	838,235	838,235	502,941	502,941	586,765	1,257,353	1,257,353	586,765	586,765	586,765	502,941	502,941	8,550,000
Total Costs		1,401,735	1,773,235	1,137,593	734,854	823,782	1,499,474	1,504,578	854,407	864,615	869,720	791,000	796,104	13,051,098
Total Costs (incl. 20% risk factor)		1,682,082	2,127,882	1,365,112	881,825	988,538	1,799,369	1,805,494	1,025,288	1,037,538	1,043,663	949,200	955,325	15,661,317
Discounted Costs (incl. risk factor)		1,682,082	2,026,555	1,238,197	761,753	813,273	1,409,853	1,347,287	728,653	702,247	672,755	582,727	558,559	12,523,940
Benefits for Customs (incl. 20% risk factor)				57,500	345,000	460,000	575,000	690,000	1,150,000	1,380,000	1,495,000	1,610,000	1,725,000	9,487,500
Total Benefits (incl. 20% risk factor)				356,500	2,139,000	2,852,000	3,565,000	4,278,000	7,130,000	8,556,000	9,269,000	9,982,000	10,695,000	58,822,500
Discounted Customs Benefits (incl.risk factor)				52,154	298,024	378,443	450,528	514,889	817,284	934,038	963,690	988,400	1,008,572	6,406,022
Discounted Overall Benefits (incl.risk factor)				323,356	1,847,749	2,346,347	2,793,271	3,192,309	5,067,158	5,791,038	5,974,880	6,128,082	6,253,145	39,717,335
ROI for Customs														-49%
Overall ROI														217%
Cash Flow for customs		-1,682,082	-2,127,882	-1,307,612	-536,825	-528,538	-1,224,369	-1,115,494	124,712	342,462	451,337	660,800	769,675	-6,173,817
Overall Cash Flow		-1,682,082	-2,127,882	-1,008,612	1,257,175	1,863,462	1,765,631	2,472,506	6,104,712	7,518,462	8,225,337	9,032,800	9,739,675	43,161,183
Discounted CF		-1,682,082	-2,026,555	-914,841	1,085,995	1,533,075	1,383,418	1,845,022	4,338,505	5,088,791	5,302,125	5,545,355	5,694,586	27,193,395
Net present value														27,193,395

Table 62. Costs, benefits, eTIR Carnets registered gradually, IaaS implementation, half usage

A.7.2.6 SaaS implementation, eTIR Carnets distributed gradually, half usage

		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Total
Costs	Development													0
	Initial		7,500	7,500										15,000
	Oper. + Hosting			50,000	300,000	400,000	500,000	600,000	1,000,000	1,200,000	1,300,000	1,400,000	1,500,000	8,250,000
	Sub-total	0	7,500	57,500	300,000	400,000	500,000	600,000	1,000,000	1,200,000	1,300,000	1,400,000	1,500,000	8,265,000
	Help Desk			128,630	128,630	128,630	128,630	128,630	128,630	128,630	128,630	128,630	128,630	1,286,300
	National App	0	450,000	450,000	450,000	750,000	1,500,000	1,500,000	750,000	750,000	750,000	600,000	600,000	8,550,000
Total Costs		0	457,500	636,130	878,630	1,278,630	2,128,630	2,228,630	1,878,630	2,078,630	2,178,630	2,128,630	2,228,630	18,101,300
Total Costs (incl. 20% risk factor)		0	549,000	763,356	1,054,356	1,534,356	2,554,356	2,674,356	2,254,356	2,494,356	2,614,356	2,554,356	2,674,356	21,721,560
Discounted Costs (incl. risk factor)		0	522,857	692,386	910,792	1,262,318	2,001,405	1,995,646	1,602,129	1,688,278	1,685,237	1,568,153	1,563,641	15,492,843
Benefits for Customs (incl. 20% risk factor)				57,500	345,000	460,000	575,000	690,000	1,150,000	1,380,000	1,495,000	1,610,000	1,725,000	9,487,500
Total Benefits (incl. 20% risk factor)				356,500	2,139,000	2,852,000	3,565,000	4,278,000	7,130,000	8,556,000	9,269,000	9,982,000	10,695,000	58,822,500
Discounted Customs Benefits (incl.risk factor)				52,154	298,024	378,443	450,528	514,889	817,284	934,038	963,690	988,400	1,008,572	6,406,022
Discounted Overall Benefits (incl.risk factor)				323,356	1,847,749	2,346,347	2,793,271	3,192,309	5,067,158	5,791,038	5,974,880	6,128,082	6,253,145	39,717,335
ROI for Customs														-59%
Overall ROI														156%
Cash Flow for customs		0	-549,000	-705,856	-709,356	-1,074,356	-1,979,356	-1,984,356	-1,104,356	-1,114,356	-1,119,356	-944,356	-949,356	-12,234,060
Overall Cash Flow		0	-549,000	-406,856	1,084,644	1,317,644	1,010,644	1,603,644	4,875,644	6,061,644	6,654,644	7,427,644	8,020,644	37,100,940
Discounted CF		0	-522,857	-369,030	936,956	1,084,029	791,866	1,196,664	3,465,029	4,102,759	4,289,643	4,559,929	4,689,504	24,224,492
Net present value														24,224,492

Table 63. Costs, benefits, eTIR Carnets registered gradually, SaaS implementation, half usage

A.8. REFERENCES

A.8.1. *Referenced Documents*

The following documents are not contractually binding but they provide useful information for the successful outcome of this Project.

	Title	Date	Version	Author(s)
R1	eTIR Reference Model – Version 3.0 • Revision of the Convention – Preparation of Phase III of the TIR revision process	June 2011	ECE/TRANS/ WP.30/2011/ 3	Economic Commission for Europe Inland Transport Committee Working Party on Customs Questions affecting Transport
R2	eTIR Reference Model – Version 3.0 • Reference Model of the TIR Procedure Design	March 2011	ECE/TRANS/ WP.30/2011/ 4	Economic Commission for Europe Inland Transport Committee Working Party on Customs Questions affecting Transport
R3	eTIR Reference Model – Version 3.0 • Reference Model of the TIR Procedure XML	September 2011	ECE/ /TRANS/WP. 30/GE.1/201 1/10	Economic Commission for Europe Inland Transport Committee Working Party on Customs Questions affecting Transport
R4	eTIR Reference Model – Version 3.0 • Amendment proposal on the introduction of international declaration mechanisms	September 2011	ECE/ /TRANS/WP. 30/GE.1/201 1/09	Economic Commission for Europe Inland Transport Committee Working Party on Customs Questions affecting Transport
R5	Findings of the Ankara meeting (19–20 October 2010)	October 2010	ECE/ /TRANS/WP. 30/GE.1/201 0/05	Economic Commission for Europe Inland Transport Committee Working Party on Customs Questions affecting Transport
R6	The International Road Transport Union's contribution to the assessment of the financial implications of the introduction of the eTIR international system	September 2011	ECE/ /TRANS/WP. 30/GE.1/201 1/11	Economic Commission for Europe Inland Transport Committee Working Party on Customs Questions affecting Transport
R7	Financial implications of the introduction of the eTIR international	March 2011	Informal document GE.1 No. 2	Economic Commission for Europe Inland Transport

	system; informal input paper of UNCTAD ASYCUDA programme to the 18th session of the UNECE Informal Ad-hoc Expert Group on Conceptual and Technical Aspects of Computerization of the TIR Procedure		(2011)	Committee Working Party on Customs Questions affecting Transport
R8	Report of the Informal Ad hoc Expert Group on Conceptual and Technical Aspects of Computerization of the TIR Procedure on its seventeenth session (8–9 March 2010)	8–9 March 2010	ECE/TRANS/ WP.30/GE.1/ 2010/4	Economic Commission for Europe Inland Transport Committee Working Party on Customs Questions affecting Transport
R13	French Customs IT system : recent developments concerning TIR and transit	March 2011	GE1 08/03/2011	French Customs
R14	SEED Project – Cost of Implementation	March 2011		Serbian Customs
R15	TR-eTIR Computerization of TIR Procedure TCA approach	March 2011	V01	Turkish Customs Administration
R16	TR-eTIR Computerization of TIR Procedure TCA approach	September 2011	V02	Turkish Customs Administration

A.8.2. *Applicable Documents*

This refers to the list of existing or future documents, binding in the project, by order of seniority:

- Invitation to Tender (with all annexes);
- SIVECO Offer submitted on December 2011;
- Purchase Order ps-17976 /16 12 2011;
- Inception Report.

A.8.3. *Bibliography*

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[AC] Amazon.com - Amazon clouds documentation.

[GC] Google.com – Google clouds documentation.

[MC] Microsoft.com - Microsoft Azure documentation.

[OC] Oracle – Oracle clouds documentation.

[DGTAXUD] NCTS documentation.

TABLE OF FIGURES

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