Technical Study on Smart Borders – Cost Analysis

Final Report

Written by PwC
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Executive Summary

Following the February 2014 meeting with Member States, the decision was taken to launch a new Technical Study to explore and assess various options for the Smart Borders (SB) Package and prepare a revised cost analysis.

The main objective was to provide up-to-date, reliable cost estimates of the EES and RTP systems to be borne at the European Commission (central) and Member State (national) level.

The second objective was to assess whether the budget allocated for the SB project package in the Multi Financial Framework (MFF) 2014-2020 (€791 m)[1] would cover the estimated costs.

In addition, other objectives included:

- To estimate the costs of a common development of one single EES/RTP system compared to the development of EES and RTP systems separately;
- To assess the financial impact on the cost estimates when building those systems reusing elements of the existing VIS;
- To explain the main changes compared to the previous calculations in the 2013 Impact Assessment;
- To provide the main differences in cost items between Target Operating Models (TOM) A, B, C; M and N;
- To estimate the costs of the Pilot;
- To offer the Member States a practical toolbox that makes it possible to identify national expenditures;
- To enable better analysis of the options discussed within the Technical Study for which cost was identified as an important assessment criterion.

Starting point for the cost estimation

A cautious approach has been used throughout the report regarding cost estimation. This approach is aimed at avoiding underestimation of the final costs. The assumptions used for this cost assessment are the following:

1. **Financial timeline:** EES and RTP development period is expected to last three years, starting in 2017 and ending in 2019. Both systems are expected to become operational in 2020.

2. **Benchmark with existing systems:** The VIS and the SIS II can provide benchmark data when relevant, as they operate in a comparable environment to that of the future EES and RTP.

3. **National Uniform Interface (NUI):** The assumption is that a NUI will be developed to provide the interface between the Member States (MS) and the Central System. The introduction of the NUI concept is the main architectural change that causes deviation from the original MFF budget allocation. The NUI enables Member States to connect to the Central System without having to develop and deploy their own infrastructure, reducing the complexity and the costs of the project. An envelope of €4 m is provisioned for each MS to cover the integration effort from their existing infrastructure to the central system. This option reduces the costs to be borne on Member States' side (see section 7.2), as the development costs of the NUI are shifted to the central side.

4. **SOA-based BMS:** the assumption is that a new SOA-based BMS serving the needs of VIS, EES and RTP will be developed. BMS costs are therefore the same regardless of the scenario (EES and RTP developed separately or jointly). In the case of EES and RTP developed separately the cost of the BMS is distributed in equal parts on the two systems.

5. **Number of Member States:** 30 countries.

6. **Central Unit / Backup Central Unit (CU/BCU) configuration:** the setup between two nodes is considered to be active/passive.

[1] The original budget allocation of €1.3 billion which covered the period 2014-2021 was reduced to €1.1 billion to be aligned with the duration of the multi-annual financial framework (2014-2020).This financial package was then reduced to €791 million during the MFF negotiations concluded in 2013.

7. **TOM (Target Operating Models) baseline:** TOM C for EES and TOM M for RTP, those TOMs being those that are the closest from the existing legal proposals and the most expensive *(for more information about TOMs, please refer to chapter 3)*.

8. **Data retention baseline:** The data retention option that is the closest to the legal proposal is used, i.e. 181 days for EES and 5 years for RTP.

9. **Implementation:** EES and RTP implementation would happen simultaneously.

Main results

Table 1 summarises the cost estimations presented in this report based on the baseline of TOM C and M. It appears **that the initial MFF budget allocation 2014-2020 (€791 m) can be considered sufficient to cover the new cost estimation for the MFF period 2014-2020**, i.e. three years of development from 2017 to 2019 and one year of operations. The total cost for four years would be €381 m for EES and RTP if developed jointly and €430 m if developed separately.

The other main findings are the following (see Table 1):

1. **€49 m** of total savings over 4 years can be realised if EES and RTP are built as a single system (for more details, please refer to Table 66).

2. At least **four additional years of operations** (i.e. 2021-2023) could be covered by the €791 m budget. [2]

3. Integrating the EES and RTP with the VIS from the beginning of the development would entail an additional cost of **€39 m.**

4. A progressive approach of integration of EES and RTP with the VIS (reusing VIS artefacts to build EES and RTP) would lead to a saving of **€4.5 m on contractor development.**

Table 1: *Comparison between separate systems and jointly developed EES and RTP for the period 2017-2020 and for the period 2017-2023*

		EES and RTP: separate systems				EES and RTP: single system				
	BMS: € 34.5 m NUI: € 3.8 m	EES		RTP		EES / RTP		*Saving compared to separate systems*	*Integrated with VIS*	*Progressive approach*
2017-2020: 3 y dev. + 1 y op.	CENTRAL (total)	€94.81 m	42%	€73.24 m	36%	€130.55 m	34%	€37.5 m	€133.45 m	€126.03 m
	Central IT system									
	Contractor development	€12.98 m	6%	€9.97 m	5%	€16.18 m	4%	€6.77 m	€19.82 m	€11.66 m
	Hardware	€10.14 m	4%	€9.18 m	4%	€17.72 m	5%	€1.61 m	€16.83 m	€17.72 m
	Software	€39.32 m	17%	€24.63 m	12%	€52.2 m	14%	€11.75 m	€49.59 m	€52.2 m
	Administration	€14.94 m	7%	€15.06 m	7%	€22.57 m	6%	€7.43 m	€25.62 m	€22.57 m
	Network	€13.75 m	6%	€10.97 m	5%	€15.21 m	4%	€9.51 m	€13.28 m	€15.21 m
	Training and meetings	€3.19 m	1%	€3.07 m	1%	€6. m	2%	€.25 m	€7.63 m	€6. m
	Office space	€.49 m	0%	€.37 m	0%	€.68 m	0%	€.18 m	€.68 m	€.68 m
	NATIONAL (total)	€131.19 m	58%	€131.19 m	64%	€250.5 m	66%	€11.88 m	€286.54 m	€250.5 m
	Contractor development	€60. m	27%	€60. m	29%	€120. m	31%	€. m	€156. m	€120. m
	Administration	€71.19 m	32%	€71.19 m	35%	€130.5 m	34%	€11.88 m	€130.54 m	€130.5 m
	CENTRAL + NATIONAL TOTAL	€226. m	100%	€204.43 m	100%	€381.05 m	100%	€49.38 m	€419.99 m	€376.53 m
		€430.43 m								
2017-2023: 3 y dev. + 4 y op.	CENTRAL + NATIONAL TOTAL	€326.93 m		€295.39 m		€553.08 m		€69.24 m		
		€622.32 m								

[2] This is theoretical since it will not be possible in practice to commit actions that will take place more than two years after the end of the MFF (i.e. 2022).

Cost differences between TOMs

TOMs C and M were taken as the baseline for the calculation of costs. The main cost items impacted by the choice of TOMs are (i) network, (ii) hardware and (iii) software.

Overall, the cost difference between TOMs is limited (less than 1% between TOM C and B and around 5% between TOM C and A). Concerning the EES, the main conclusion is that TOM A is always the cheapest alternative (approximately -5%) regardless of the scenario. Regarding the RTP, TOM N does not have a significant impact on the cost to be borne at the central level but it could impact national budgets.

The introduction of facial image in all the TOMs, which had not been estimated for the original budget allocation, **increases the overall cost of approximately €6 m for the 2017-2020 period**, as it induces the purchase of an additional licence for the BMS.

Main deviations from the MFF budget allocation (2014-2020)

The table below describes the main deviations compared to the initial MFF 2014-2020 budget allocation, more details are provided in section 7.1.3.

Cost reduction	Cost increase
• Difference in the financial timeline, as the Smart Borders proposal will take later than initially foreseen and therefore three years of development and one year of operation are considered; • Suggested use of the e-MRTD as a single token, representing a total saving of €15 m compared to the previous ad-hoc token solution; • Suggested joint development and maintenance of EES and RTP impacting costs positively; • Shift of the MS infrastructure costs to the central level as result of the introduction of the NUI, which would be developed and deployed centrally, and which reduces the complexity of the systems at Member States' side, which applies on 30 countries and allows savings of resources for maintaining and operating the systems; • Exclusion of the financing of the costs related to the hosting of the Infrastructure in Member States, on the assumption that the systems will be installed in existing premises in Member States and that the EU budget would not be used to support construction or rental of IT premises. • Reduction of initial investment which has an impact on operational costs; • Lowered network costs due to prices offered by the new contractor; • Reduction of administration costs because of lower number of FTEs identified for monitoring the systems at national side.	• Increased number of Member States (30) considered; • Higher software costs than what was in the MFF provisions; • Increased number of training courses and meetings. • Facial image as biometric identifier in combination with FPs. The addition of the software for supporting the facial image in the BMS would increase its cost up to 20-25%.

<u>Other cost options</u>

The Cost analysis also looks into costs linked to various additional options (not included in the baseline) such as:

1. Law enforcement access (LEA): the decision to enable the LEA for the EES and RTP would increase implementation costs due to additional functionalities and transactions. The impact on **the initial**

investment would be of approximately €2.5 m spread over 3 years and distributed mainly across hardware, software and the BMS. **Maintenance costs** are estimated to approximately amount to an **additional €200,000** per year.

2. Active-active setup: Given the lack of technical and functional specifications, the report concludes that further study would be needed to estimate the cost difference with the current - active-passive – setup.

3. Data retention: while a data retention period of 181 days for the EES and up to five years for the RTP is used as a baseline for the analysis, alternative retention periods of one year and five years for the EES are considered. **The cost increase can reach up to €69.6 m for the 5 years data retention for the joint EES and RTP.** This increase can be explained by a bigger database required, more processing power and higher BMS software license costs among others.

4. Information to travellers and carriers: one option considered in the Study, is the possibility for travellers to consult their personal data from a Self-Web-service. Carriers could use the same channel to verify the validity of users' visa. The cost impact of the Self-Web-Service has been **estimated to an initial investment of €4.2 m for the development phase and €1.5 m per year of operational costs** on average.

5. RTP online enrolment: this option would enable travellers wishing to enrol in RTP, to do so via a dedicated online enrolment website. This **possibility would entail an initial investment of €1.2 m followed by average operational costs of €360,000 per year.**

6. EES and RTP integrated with VIS: the possibility to integrate the EES and RTP with the VIS is in line with an integrated process approach. In terms of costs, calculations showed that overall it is a **more costly solution (€39 m, +10% of the total cost over four years)** than the option of building the EES and RTP as a greenfield project.

7. Re-using VIS artefacts for the EES and RTP: the report concludes that **this progressive approach has a positive cost impact (-€4.5 m, - 1% of the total cost over four years)** in terms of contractor development. Further synergies would be achieved only after the full integration with the VIS which would require further investments.

In addition the combination of TOMs selected as baseline introduced the use of the Facial Image and of the systematic identification (1:N) for the TCNVE. The below table summarise the impact on the cost for each variation and option and whether the variant/option was part of the baseline.

Table 2: *Summary of the cost options (included or excluded from the baseline)*

Variants and options not part of the baseline	*In million*	*Included in the baseline*
LEA		
Development	€2.5	✘
Yearly maintenance	€0.2	
Active- active setup	Not available	✘
Data retention		
1 year (until 2023)	€39	✘
5 years (until 2023)	€69.6	
Information to travellers and carriers		
Development	€4.2	✘
Yearly maintenance	€1.5	
RTP online enrolment		
Development	€1.2	✓
Yearly maintenance	€0.36	
EES and RTP integrated with VIS	€39	✘
Re-using VIS artefacts for the EES and RTP	- €4.5	✘
Facial image		
Development	€5.7	✓
Yearly maintenance	€0.5	
1:n identification		
Development	€4.5	✓
Yearly maintenance	€0.9	

Options for the Pilot

The objective of the Pilot, to be carried out in 2015, is to test significant parts or components of the solution and conclude on the results. Costs related to the Pilot are heavily dependent on (i) specifications of the Pilot, (ii) sample size for test items and (iii) inclusion or exclusion of AFIS vendors (buy vs borrow equipment).

For the execution phase, costs in terms of equipment and integration have been estimated to amount to approximately €500,000. Other costs, estimated to amount to approximately €2.3 m, such as meeting, travelling and contractor costs, must be taken into account as well. **The evaluation of the costs for the Pilot concludes that the proposed set of pilot options fits within the €3 m budget.**

MS toolbox

A MS toolbox was created to allow each MS to estimate the expenses that they will have to face, by presenting a list of identified cost components on the national side, and where possible some pricing indications. It includes three main categories of costs: border equipment, human resources, national infrastructure and network. It will be provided to MS once the final specifications of the Smart Borders systems and processes are available.

1 Introduction

1.1 Context

The first estimates of the costs for EES and RTP were performed in 2010. At that time, 20 different costing scenarios were estimated. Three years later, in **2013**, two business scenarios were retained for an **impact assessment**: "Central EES with biometrics added later" to estimate the cost of **EES** and "Token together with central biometric repository" to estimate the cost of **RTP**. This Impact Assessment estimated the cost of the EES (€623 million) and the RTP (€712 million) systems to be **€1.3 billion**[3]. This amount was estimated to cover the **2014-2021** financial period and included the cost of development, hosting, operations and maintenance of the central systems (European Commission (EC)) and the national systems (Member States).

This original budget allocation of **€1.3 billion** was then reduced to **€1.1 billion** to be aligned with the duration of the multi-annual financial framework (**2014-2020**).

During the MFF negotiations concluded in 2013, this financial package was again reduced to **€791 million**.

In this context, the EC, in cooperation with representatives from the Member States and from the European Parliament, carried out a Study called "Technical options for a Smart Borders Pilot" (also called Technical Study or Study). The Study analysed the various options from the processes, biometrics, architecture and data point of view to cover all aspects of the thematic files (TF) agreed with the co-legislators. In order to present feasible combinations of the activities and their choices to be made to effectively operate EES and RTP, the concept of potential Target Operating Model (TOM) was introduced. A TOM representation is used to envision how various systems' components can be assembled in a unique way to operate a system effectively. Five different TOMs have been described in the Technical Study and their cost estimates are provided in the present report.

The cost analysis is made at an early point in the project, when neither technical nor functional specifications exist yet. The cost analysis assesses therefore the cautious options provided in the Study, with cautious being understood as the one that would avoid underestimating the final cost. The overall error rate of the cost estimation should be considered around 15-20%.

Next to the Technical Study and the cost report, a Pilot will be run by eu-LISA in 2015. The options that could be tested during that Pilot phase were identified in the Technical Study.

The different options for the Pilot were combined into sets of options and are based on the following components:

A - Border control processes and use of biometrics

(i) Using novel or developing technology (e.g. enrolment of specific number of fingerprints using contactless fingerprint scanners or enrolment/verification of fingerprints and facial image with handheld equipment at various types of borders);
(ii) Capturing photo from e-MRTD and verifying it against another source;
(iii) Searching VIS based on document number, not using the visa-sticker number;
(iv) Web-interface to the carriers as a technical pilot

B - Process accelerators

(i) Enrolling iris;
(ii) Using self-service kiosks for registering, checking and enrolling biometrics;
(iii) Introducing pre-border checks in the waiting areas of land borders;
(iv) Checking the process and time for Third Country Nationals (TCNs) using ABC gates at exit.

[3] SWD(2013) 47 final and SWD(2013) 50 final

1.2 Objectives

The objective of the revised cost analysis is to **provide up-to-date, reliable cost estimates of the EES and RTP systems**[4] to be borne at the European Commission (central) and Member State (national) level covered by a central envelope (ISF/Smart Borders line). The figure below details the split between the costs to be covered by the central envelope and those to be covered by Member States' budgets (National budgets or ISF/National programs).

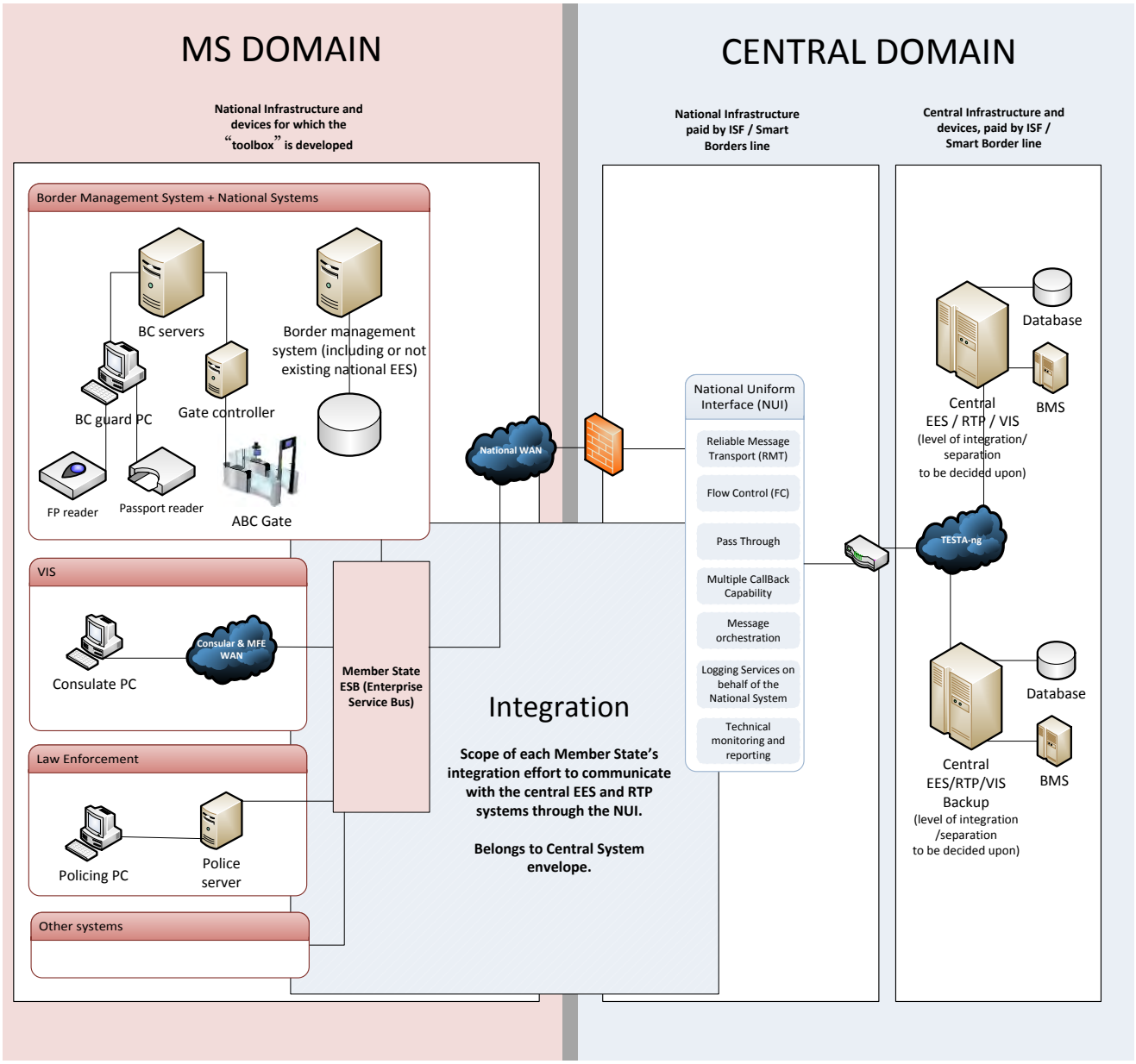

Figure 1: *Split between the Central Envelope and Member States' budgets for the infrastructure of the EES and RTP systems. Blue sections (Central Domain and Integration) would be covered by the Central Envelope; pink sections would be covered by the Member State's own budgets or the National Programmes of the ISF borders/Smart Border Line.*

The second objective of the analysis is to assess whether the budget allocated for the Smart Borders project package in the MFF 2014-2020 (i.e. €791 m) would cover the estimated costs. Therefore, a cost estimate is

[4] Based on the main working assumptions outlined in the Technical Study. At this stage, there is only an outline for the EES and RTP; no detailed functional or technical specifications are available.

made for the upcoming period covered by the MFF 2014-2020 (i.e. 2017-2020, which is 3 years of development and 1 year of operations).

Thirdly, the analysis assesses how many additional years of operation, if any, can be covered by this envelope (i.e. €791 m).

Additionally, the cost analysis addresses the following objectives:

- To estimate the costs of a common development of one single EES/RTP system compared to the development of EES and RTP systems separately, and assess the financial impact on the cost estimates when building those systems reusing elements of the existing VIS (see TF16);
- To explain the main changes compared to the previous calculations in the 2013 Impact Assessment;
- To provide the main differences in cost items between Target Operating Models (TOM) A, B, C; M and N;
- To estimate the costs of the Pilot;
- To offer the Member States a practical toolbox that makes it possible to identify national expenditures;
- To suggest alternatives for sharing the amount identified to cover national costs;
- To enable better analysis of the options discussed within the Technical Study for which cost was identified as an important assessment criterion.

1.3 Assumptions

1. Financial timeline

Firstly, the current estimates are calculated for the four years investment timeline (i.e. EES and RTP development period spread over three years from 2017-2019[5] and one year of operations (2020)). Secondly, the additional estimates are provided to cover a seven years investment timeline in order to allow comparison with the MFF initial assessment (i.e. €791 m for the period of 3 years of development and 4 years of operations).

2. Systems operating in a comparable environment

Where relevant, the VIS and SIS II systems will be used as benchmarks for the purpose of estimating the costs of the EES and RTP, as they will operate in a comparable environment.

Those systems share a set of comparable characteristics, among which:

- **Implementation/usage location:** The Schengen Area, consular posts, border control points and central national points.
- **Communication:** A central system and national systems communicate relevant data to one another through a centrally-operated network.
- **Infrastructure:** Database servers that provide the processing power for querying the user file database, applicative servers that are dedicated to the efficient execution of procedures for supporting the applications, biometric matching systems; backup servers in passive configuration.
- **Operation:** Operated by eu-LISA.

[5] Provided that the negotiations on the legal framework are finalised by mid-2016.

- **Processes/Data:** VIS, EES and RTP share similarities in terms of processes: user enrolment, biometrics registration, storage, verification and identification of users. Some of the data managed by the systems are common (e.g. biometrics enrolled for the VIS can be reused for the EES).

3. National Uniform Interface (NUI)

The introduction of the NUI concept is the main architectural change that causes deviations from the MFF budget allocation (2014-2020) *(please see Figure 1 for an overview of the general architecture).*

- **Impact on the cost model:** The NUI impacts the costs at the following levels: hardware, software, development and administration.
- **Scope:** The NUI should operate on the network layer, acting as a message broker between the Central System and the Member States.
- **Development and deployment:** The software layer of the NUI should be developed and deployed by the central authority (eu-LISA), to provide a standard NUI to all Member States that would then be integrated by Member States into their National infrastructures.
- **Location:** The NUI should be located in each Member State.
- **Operation:** The NUI should be operated by each Member State (costs covered by the budget envelope).
- **Maintenance:** The changes to the NUI should be developed centrally, and deployed remotely if needed.
- **Integration:** How the NUI is integrated depends on the national architectures. Each Member State will be required to integrate the NUI into its infrastructure. Costs for the integration will be covered by the Central envelope (please see section 2.2.2 for more information on the integration costs).

4. Biometrics Matching System (BMS)

- **Scope:** A SOA-based BMS serving the needs of VIS, EES and RTP will be deployed. Therefore, the price for the BMS will be the same regardless of the scenario (EES and RTP integrated or separated).
- **Costing:** The costing of the BMS varies depending on numerous technical details. Also, it operates in a closed market in which market prices are highly dependent on the vendors. Therefore, to achieve an accurate estimate, it is based on input from vendors and benchmarked against the experience of the VIS BMS.
- **Technical requirements** will have to be investigated and determined in the technical specifications of the systems; however, the following is taken into account for costing purposes:
    a. **Sites architecture**: Two sites should exist: one primary site and one backup site. Automated fail-over processing capabilities are required.
    b. **Required system availability rates:** Synchronous operations: 99.99%, Asynchronous operations: 99.7%.[6]
    c. **Pricing data:** Pricing data has been extrapolated based on other large-scale biometric programs and it is rounded up to the nearest million euros.
    d. **Biometrics:** Facial image only used in TOM A; facial image and fingerprints used in TOM B and C.

[6] Based on the benchmark against the VIS.

e. **1:1 verifications and 1:N identifications:** 270 million transactions per year out of which 23% are 1:N identifications.

f. **Gallery size:**

Data retention period	Corresponding gallery size
181-days for the EES, 5 years for the RTP and VIS	60 m
1-year data retention for the EES, 5 years for the RTP and VIS	150 m
5-year data retention for the EES, RTP and VIS	270 m

For more information please refer to section 7.3.4 of the Technical Study.

g. **Redundancy:** The BMS software will be deployed to the Central Unit (CU) and Backup Central Unit (BCU) sites.

h. **Environments:** The BMS software will be deployed to the production and pre-production environments, as well as playground and test environments. The pre-production environment for the BMS is assumed to be 25%[7] of the production environment. The ratio for the playground and test environment 20% for Playground 1, 15% for Playground 2, and 10% for the test environment.

i. **Building model:** For costing purposes it is conservatively assumed that the BMS will be built as a new system. In case the current supplier of the existing BMS would be selected then technically this BMS could be expanded. Even in that case given technological evolutions a replacement of the complete system could be considered more cost efficient. In case another provider than the current one would be selected, then an extension of the current solution would have more drawbacks than advantages and a complete replacement would be the only viable solution.

5. Number of Member States

The EES and RTP legislative proposals build on the Schengen acquis and its future development. Therefore, the Cost Model includes 30 countries, i.e.

- Schengen EU countries (Austria, Belgium, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Slovakia, Slovenia, Spain and Sweden);
- Schengen non-EU countries (Iceland, Liechtenstein, Norway and Switzerland);
- Accession countries working to implement the Schengen rules (Bulgaria, Croatia, Cyprus and Romania).

6. CU/BCU configuration

In the given cost estimation, the setup between the two nodes on the central system is considered to be Active/Passive. For further considerations, please refer to section 6.2 of the Technical Study. The impact of an Active/Active configuration is further analysed in section 4.2 of this report. The main finding is that the cost of an Active/Active configuration cannot be precisely estimated at this point of time because of the absence of detailed specifications for the architecture.

[7] Based on vendors consultation.

7. TOM Baseline

TOM C (for the EES) and TOM M (for the RTP) are used as a baseline for the cost calculations. Details on TOMs are found in section 8.2 of the Technical Study and in chapter 3 of this report.

8. EES and RTP will both go live in the same period

Both systems will be implemented and will go live in the same period. If that would not happen, the cost of each individual system would be higher as economies of scale would not be achieved and the costs for the BMS and the NUI would have to be allocated differently.

2 EES and RTP Cost Analysis

The following chapter outlines the overall methodological approach and then the cost estimations for each of the following components:

1. Contractor development
2. Administration
3. Network
4. Hardware and Software
5. Training courses and meetings
6. Office space

2.1 Overall approach

As no detailed functional and technical specifications exist at this stage of the project both top-down and bottom-up estimation methodologies are used. The top-down approach is used when the technical specifications remain at a high-level and detailed cost items cannot be identified. When the cost elements are more detailed, the bottom-up approach is used. The table below presents the method used per main cost item.

Table 3: *Description of the approaches used in the Study*

Top-down estimates	Bottom-up estimates
• **Contractor development** (development of the central system, BMS, NUI and integration of the NUI) • **Assessment of EES/RTP** developed as one system	• **Administration** costs (e.g. project management, grants management, monitoring of the systems) • **Network** costs • **Hardware** costs (central system, BMS, NUI) • **Software** costs (central system, BMS, NUI) • **Training** courses and meetings • **Office space** (setup and operational costs of backup central site)

2.1.1.1 Top-down

Objective:
To ensure that the current cost estimates of the EES and RTP are based on a comparison with **real data** from **existing systems** that were developed and are currently in operation, such as the Visa Information System (VIS) and similar large-scale trans-European systems (e.g. developed by DG TAXUD).

Method:
The method used is developed by DG TAXUD to estimate the development of central systems. This method is used for systems where a high-level design is available but where there are no detailed functional and technical specifications yet (which is the case for EES and RTP).

The method is based on three main components:

1. **Historical data from large-scale trans-European IT systems:** real data provides the benchmark for comparison.

2. **Assumptions:** the assumptions are documented and detailed in order to ensure the estimates are in line.

3. **System parameters:** common characteristics of a large-scale system such as:
    1. Number of processes
    2. Number of updated processes
    3. Number of tasks per process
    4. Number of new/updated information exchanges/messages in those processes
    5. Number of new or updated interfaces with other existing systems or process areas

Based on these components, the model calculates the **development costs** at Central and Member State level.

For the **other types of costs** (like maintenance, project management, infrastructure, network, and quality assurance) the method uses historical percentages in addition to the development efforts.

Outcome:
The outcome of this approach provides estimates based on real figures of systems already developed and operating across Europe.

2.1.1.2 Bottom-up

Objective:
To perform a detailed analysis of the **specific cost components** where possible as

- these cost components are used by existing systems;
- the Study has enough information to make reliable estimates.

Method:
This method encompasses the detailed compilation of cost items for the selected main cost components for which a bottom-up approach can be used at this stage of the design of the systems.

Outcome:
The outcome of this approach provides estimates based on compilation of unit costs and quantities of cost items based on similar systems such as VIS.

The BMS and the NUI are two specific cost items that must be present on the same scale regardless of the scenario (EES and RTP integrated or separated). They are also cost items that span several cost categories (e.g. development, hardware and software).

When relevant, they will be analysed in each section separately from the rest of cost category-specific cost items (e.g. servers for hardware and operating systems for software). In the scenario where EES and RTP would be set up as two separated systems, these costs would be shared equally by both systems.

2.2 Contractor development costs

2.2.1 Cost components

Contractor development costs cover the four following cost items:

- Central system
- EES/RTP BMS
- National Uniform Interface (NUI)
- Integration of NUI (handled by each MS, cost included in the budget envelope)

The contractor development efforts include preparation of functional and technical system specifications, design, build, test activities, deployment and rollout as well as project management and quality assurance

contracting. The percentages of those cost elements are provided in the table below on the basis of the method used by DG TAXUD to estimate development costs.

***Table 4**: Cost elements computation methods used by the methodology of DG TAXUD*

Cost elements (central level)	Computation method
1. Deploy-rollout	**20%** of the Design-Build-Test (DBT)
2. Conformance Test activities	**20%** of the Technical System Specifications (TSS)
3. Project Management	**15%** of all above costs (DBT, TSS, deploy-rollout and conformance test activities)
4. Quality Assurance	**20%** of all above costs (DBT, TSS, deploy-rollout, conformance test activities and project management)

2.2.2 Methodology

Development costs of the central system

The development costs of the central system are estimated through a top-down approach. The development cost estimation is built on the following assumptions:

- Applying a categorisation of processes defined by DG TAXUD, all processes are defined at a level of detail where a process solves a particular issue by transforming a defined business input into a defined and measurable business output via the execution of one or more process steps (i.e. tasks). This allows assigning the right estimate of development work per process. Updates to tasks and to messages lead to the same implementation effort;
- All tasks are assumed to be automated tasks, i.e. to be implemented by an IT system.

Development costs of the BMS for EES and RTP

The development costs of an EES/RTP BMS are estimated based on the experience of developing similar systems. The costs are the same for both scenarios: EES and RTP developed together or separately. However in the scenario that EES and RTP are developed as separate systems, half of the common BMS costs are assigned to the EES envelope and the other half is assigned to the RTP envelope.

Development costs of the National Uniform Interface

The costs of NUI are determined by benchmarking them against the Interconnection Box in use for the needs of the SIS II. The benchmark is relevant based on the following:

- The benchmarked solution is already in use for systems of comparable scope and therefore learning from previous roll-outs can be used to increase the degree of certainty of the costing.
- The Interconnection Box provides the services that are also provided by the NUI.
- It is possible to obtain the actual price for the solution, including the vendors' margin, which further increases the correlation between the estimation and reality.
- The solution is being used in several countries, thus it is possible to obtain precise estimates of maintenance costs thanks to the available historical data.

Integration costs of the National Uniform Interface with the MS systems

The development costs also cover integration costs of the NUI. The integration provision will cover the work necessary to enable the link between the NUI and the national border management systems already

existing within the MS. The MS systems will have to be put in condition to comply with the standard created by the NUI and to pass communication and compliance tests as defined by the Interface Control Document (ICD).

The effort necessary to achieve these objectives and to perform all the necessary testing would vary depending on the level of maturity of the IT infrastructure of the different MS. For instance, MS that have adopted a Service Oriented Architecture (SOA) with an Enterprise Service Bus can add new services to their current infrastructure more easily than those that have not implanted such architecture.

The budget is determined based on a cautious extrapolation of the integration costs of the Interconnection Box in use for the needs of the SIS II, as communicated by the relevant contractors. To this end, a **budget of up to 4 million euros for each Member State is provisioned**.

2.2.3 Sizing

Central system development

The estimation model is based on the following sizing parameters:

1. Number of processes is assumed to determine the effort for **Functional System Specifications** (FSS) activities.

2. Number of processes where a change occurs is assumed to determine the effort for the **Technical System Specifications** (TSS) activities. Since both EES and RTP will be newly developed systems, as opposed to upgraded ones, a change will occur in all of the processes, therefore the number of processes and the number of processes where a change occurs is the same.

3. Number of unique tasks in those processes: The number of tasks is assumed to determine the effort for the **Design-Build-Test** (DBT) activities.

4. Number of unique tasks where a change occurs is also assumed to determine the effort for the **Design-Build-Test** (DBT) activities. Since both EES and RTP will be newly developed systems, the number of tasks and the number of changed tasks coincide.

5. Number of new information exchanges (messages/services): The number of new or updated information exchanges (messages) is assumed to also determine the effort for the **Design-Build-Test** (DBT) activities.

6. The number of new interfaces **adds an effort percentage to the DBT activities**. The DBT effort is increased by an additional 3% per changed interface to another existing system (e.g. if the project needs to change 3 interfaces to other systems for instance, the effort is increased by 9%).

7. The number of impacted interfaces to other systems (or other process areas) is also used to determine an effort percentage compared to the DBT activities.

The parameters identified in the methodology are common to any large-scale trans-European systems and help gauge the systems' magnitude. The model benchmarks the system parameters against baseline values (for further information, please refer to the pricing parameters in Appendix F). These baseline figures come from two large-scale trans-European systems (e.g. Regular Shipping Service authorisation (RSS) and anti-Counterfeit and anti-Piracy Information System (COPIS)).

The table below summarises the sizing parameters for both EES and RTP systems. The lists of parameters are provided in Appendix A of the Report.

Table 5: *Values of sizing parameters for EES and RTP developed separately and as a single system*

Sizing parameter	Number		
	EES	RTP	EES/RTP developed as a single system
1. Number of processes	10	8	12
2. Number of changed processes	10	8	12
3. Number of tasks	65	58	84
4. Number of changed tasks	65	58	84
5. Number of messages	114	90	142
6. Interfaces to systems	2[8]	2	3[9]
7. Impacted interfaces to systems	32	32	32

Operations

The costs related to the upgrades of the Central System, BMS and NUI (i.e. costs of contractor operations) are estimated as a percentage (7.5%) from the initial development.

2.2.4 Synergies for developing one single system

The joint development of EES and RTP would likely reduce the technical complexity of the development by the following aspects:

- Less vendors and different software solutions.
- Gain in overall project management (i.e. only one project to manage would reduce the overall complexity and the resources and efforts for project management.
- More simple to re-use of the existing artefacts (i.e. source code).
- Similarities of tasks such as reporting, notifications and attachments among other things (see Appendix A for the full list of processes and tasks).

A separate development would likely entail separate procurement and would make it difficult to achieve any of the potential synergies.

According to the estimations more than €6.5 m could be saved throughout the first three years of development, by choosing to build the EES and RTP jointly on a shared technological platform. In addition, as the operational costs are expressed as a percentage of the initial investment, when the investment diminishes by 1/3rd the same ratio applies to the operational costs.

[8] The effort for the development of a NUI is considered to equate to the development of 2 interfaces, taking into account its higher complexity.
[9] If EES and RTP were implemented as a single system, the effort for the development of a National Uniform Interface is considered to equate to the development of 3 interfaces, taking into account its higher complexity.

2.2.5 Results

The tables below summarise the estimations for the development costs for the Central System and National Systems.

Table 6: *Results of development costs estimations for the Central System (costs comparison)*

NEW ESTIMATION 2014(2017) – 2020 MFF			
	Development phase (3 years)	**Operational phase 2020 (1 year)**	**Total (4 years)**
EES	€12.1 m	€0.9 m	€13.0 m
RTP	€9.3 m	€0.7 m	€10.0 m
EES and RTP as separate systems	€21.4 m	€1.6 m	€23.0 m
Joint EES and RTP	€15.1 m	€1.0 m	€16.1 m
Savings from the joint development	€6.3 m	€0.6 m	€6.9 m

Table 7: *Results of development costs (integration) estimations for National Systems (costs comparison)*

NEW ESTIMATION 2014(2017) – 2020 MFF			
	Development phase (3 years)	**Operational phase 2020 (1 year)**	**Total (4 years)**
EES	€60.0 m	-	€60.0 m
RTP	€60.0 m	-	€60.0 m
EES + RTP as separate systems	€120.0 m	-	€120.0 m
Joint EES and RTP	€120.0 m	-	€120.0 m
Savings from the joint development	€0 m	-	€0 m

2.3 Administration costs

2.3.1 Cost components

Administration costs consist of:

- **Administrative expenditure** that includes:
  - Information campaigns to inform the general public about the implementation of the EES and RTP;

- Reception of the meetings, conferences;
- Translations;
- Feasibility studies to assess the IT maturity across MSs (see section 7.4 for further details).

- **Administrative expenditure** that includes the expenditure of contractual and temporary staff to coordinate the contractor development, external quality assurance services, grant management and also staff to operate the systems. The exhaustive list of profiles is provided in section 2.3.3.

The administration costs to be borne by the Member States are related to the integration of the national infrastructure to the NUI.

2.3.2 Methodology

The bottom-up approach is used for the estimate of administration costs, taking into account that the VIS will remain in use. First of all, the sizing parameters are determined and then multiplied with pricing parameters.

2.3.3 Sizing

The main sizing parameter for administration costs is a full-time equivalent (FTE). The estimated need of FTEs per profile is provided in the table below, highlighting the differences if EES and RTP were developed separately.

The need for FTEs from the Management Authority's side has been defined based on DG Home and eu-LISA experience with the VIS and the SIS II. The need for FTEs at MS level has been determined on the basis of consultation with the experts who are experienced in developing and operating national systems in such a scale.

The FTEs expected to be required to support operations of systems take into account the need to provide a 24/7 service, i.e. an uninterrupted service at all times. A 24/7 helpdesk support factor amounting to 5 is calculated based on the assumption that there are 220 working days per year and 8 working hours per day.

Table 8: *Components and sizing parameters of administration costs*

	Unit	EES	RTP	EES/ RTP	Source
Management Authority (MA)					
Development phase					
MA Program/ project management	FTE	3	3	5	eu-LISA
MA Quality assurance[10]	FTE	2	2	3	eu-LISA
MA Financial management (including budget and Grants)	FTE	9	9	9	DG Home
MA Contract management	FTE	3	3	5	eu-LISA
MA Technical experts (Solution Architect, System Architect, SOA Architect, Database Designer, Application Administrator, System Administrator, Network Administrator, Test Engineer, Security Officer)	FTE	6	6	10	eu-LISA
MA Testing and operating various playgrounds[11]	FTE	4+0.5[12]	4+0.5	6+1	eu-LISA
Operations phase					
MA System management	FTE	0.5	0.5	1	eu-LISA
MA Support contractors	FTE	1	1	1	eu-LISA

[10] MA quality assurance includes overall coordination of quality assurance contracts and review of their deliverables.
[11] MA testing and operating various playgrounds covers validation of the test design and reports, preparation/refreshment of the test database, supervision of Unit Testing and overall coordination of the User Acceptance tests.
[12] The number of FTEs for one MS test/playground environment + efforts in FTEs for additional MS test/playground environments

MA Helpdesk support (1st line, 24*7)	FTE	10	5	5	eu-LISA
MA Technical staff (2nd line, 24*7)	FTE	10	10	10	eu-LISA
MA Operators monitoring the central system (24*7)	FTE	10	10	10	eu-LISA
Member States[13]					
Development phase					
Technical system managers	FTE	1	1	2	Market Intelligence
Technical experts	FTE	2	2	4	Market Intelligence
Operations phase					
Operator support contractors (24*7 helpdesk support)	FTE	5	5	10	Market Intelligence

2.3.4 Synergies for developing one single system

If EES and RTP were developed as one single system, synergies in administration costs would be achieved thanks to the lower number of FTEs needed for Program/Project management and contract management of the central system development. The lower number of FTEs would be needed because the system would be most likely developed as a single project, implemented by a single contractor.

2.3.5 Results

The tables below provide the results of the administration cost estimations for Central System and for National systems.

Table 9: *Results of administration costs estimations for the Central System (costs comparison)*

NEW ESTIMATION 2014(2017) – 2020 MFF			
	Development phase (3 years)	**Operational phase 2020 (1 year)**	**Total (4 years)**
EES	€11.4 m	€3.5 m	€14.9 m
RTP	€11.4 m	€3.6 m	€15.0 m
EES + RTP as separate systems	€22.8 m	€7.1 m	€29.9 m
Joint EES and RTP	€18.1 m	€4.3 m	€22.4 m
Savings from the joint development	€4.7 m	€2.8 m	€7.5 m

[13] The figures are provided for one MS.

Table 10: *Results of administration costs estimations for National Systems (costs comparison)*

NEW ESTIMATION 2014(2017) – 2020 MFF			
	Development phase (3 years)	**Operational phase 2020 (1 year)**	**Total (4 years)**
EES	€51.5 m	€19.7 m	€71.2 m
RTP	€51.5 m	€19.7 m	€71.2 m
EES + RTP as separate systems	€103 m	€39.4 m	€142.4 m
Joint EES and RTP	€91.1 m	€39.4 m	€130.5 m
Savings from the joint development	€11.9 m	€0	€11.9 m

2.4 Network costs

2.4.1 Cost components

Based on existing network data for the VIS, two types of costs have been identified:

1. One-time costs (OTC) to create the line
2. Monthly costs (MRC) to operate and maintain the line

Three types of lines have been identified:

1. MS lines (uniform interface)
2. Central Unit / Backup Central Unit (CU/BCU) lines
3. Support Operation Centre / Central Services Domain (SOC/CSD) lines

Additional other costs (e.g. setup, security) need to be taken into account.

More information on the cost variance for each network component can be found in Appendix C.

2.4.2 Methodology

The objective of the network bottom-up approach is to estimate the network cost of EES and RTP based on existing VIS data. The current VIS legal basis provides that the VIS data are conveyed over a separate network. Even though it is not foreseen to be used for the purpose of the EES and RTP system, data from the different systems could technically be sent. The structure of that network can serve as a blueprint for the network of the EES and RTP systems, namely for the following reasons:

1. **Location**
   Both VIS and the EES and RTP systems exchange information through a network consisting of the following data emission/reception centres.

   At MS level:
   - Consulates and administrations
   - BCPs
   - NUI

At EC level:

- Central Unit and Backup Central Unit

2. **Nature**
   The nature of the data transmitted through the network is similar in both the VIS and the EES and RTP systems. It consists of:
   - Fingerprint data
   - Facial image data
   - Alphanumerical data

3. **Relationship**
   The relationship between the centres where data is sent and received is very similar as far as expected data exchange is concerned. In both systems, the main communications occur between the MS-level centres and the EC-level centres. Typically, data is created at MS-level, and then transferred to the EC-level, either for storage in the case of data originating from the consulates (visa application) or for verification in the case of past border data (verification and identification).

General assumptions:

1. **Testing requirements:** The EES and RTP systems will require an operational network for testing purposes starting from the beginning of the development phase (2017). This network will be used for the purpose of operations starting from 2020.
2. **Operation period:** The requirements of the EES and RTP systems will grow between 2020 and 2023. It will be assumed that the system will be sized for the two following years, and be upgraded every two years, if needed.

The costing of the network is estimated in four phases.

Phase 1: Identification of cost components and their variables (Section 2.4.1)

Phase 2: Sizing of the network requirements (Section 2.4.3)

Phase 3: Results (Section 2.4.4)

2.4.3 Sizing

The model takes into account each country to provide a precise estimate of the needs and the costs. First, VIS bandwidth usage will be increased by the factor found in table 9 to accommodate the bandwidth requirements of the network during the different phases of the project. Then, this data will be checked against the bandwidth requirements identified below.

The current VIS uses the sTESTA network which is going to be soon replaced by TESTA-ng (for new generation). The costing of the network for EES and RTP (or EES/RTP) is based on the figures and tariffs applicable under this new framework contract for network services for TESTA-ng.

Assumptions:

1. The lines of the TESTA-ng network are currently proposing four levels of bandwidth capacity: 10 mbps, 34 mbps, 100 mbps, and 1,000 mbps. A contractual agreement has been reached for these levels and their costs are known, therefore they represent the most precise basis for computation available and will be kept for the cost model.

2. 1000 mbps is the current maximum bandwidth capacity available in the price catalogue of the current provider. Therefore for the purpose of the calculation, it will be assumed that lines requiring more than 1000 mbps of bandwidth will be split into as many 1000 mbps lines as necessary. It should be noted that this split might have an impact on the infrastructure.

3. Lines between CU and BCU are working in pairs, and should be identical in the event that the BCU needs to replace the CU during an incident.

4. The benchmark network SLA will be the one that has been agreed upon for the TESTA-ng network.

5. The SLA for EES and RTP applications in terms of business service should be at least as high as that of the VIS. Since it is critical for the application to provide a fast answer at border crossing points, the network will aim to cover the peaks in bandwidth usage to avoid response delays.

6. TAPs (turnkey access points) are not shared between systems, except in case the EES and RTP are developed as a single system. These TAPs are not shared with the VIS.

7. It is assumed that 5-minute peak utilisation should not exceed 70% of the maximum bandwidth, to allow for leeway in the case of a surge in requests, an incident or a change to the system. Therefore, the minimum bandwidth requirement is the following:

   Dec. 2013 **Peak Bandwidth usage** x Increase in bandwidth requirement / 0.7

   Actual line bandwidth required is calculated by rounding up the theoretical bandwidth required obtained above to the line sizes identified under point 1.

8. It is assumed that additional security will be required as compared to the current state of the VIS, in the form of a second layer of encryption, for which an overhead of network usage will be taken into account.

9. The development phase will require a scaled-down network as compared to the operation phase. The development phase will be split into two phases in which the network will be progressively scaled up.

10. The network will be scaled on a yearly basis to fit the requirements of the network during the development phase, to allow for savings on operational costs.

11. SOC and CSD line requirements will not increase compared to the VIS. These lines are used for control and security purposes and growth in business usage should not have an impact on their bandwidth requirements.

12. The bandwidth of every line is shared between production and pre-production. Production bandwidth can be used during the development phase for testing purposes, and during operation, pre-production bandwidth will have to be used for testing purposes.

13. Since pre-production bandwidth is lower than production bandwidth, a provision will be made to temporarily (for a period of one-year) increase the pre-production bandwidth during the operation phase, to allow for potential extensive testing after the system is released. The overhead cost is assumed to be 10% of the yearly cost, for a one-year period in 2022.

Findings:

1. Network usage increase

It should first be noted that an increase in network usage compared to the VIS does not necessarily mean a similar increase in network sizing. Indeed, the current network in usage for the VIS is oversized compared to the usage, and therefore the increase in bandwidth usage of 3000% is translated by a much lower increase in bandwidth requirements.

The increase in network usage from 2013 (last full year for which data are available) to the entry into operations (2020) can be explained by the changes presented in Appendix C and summarised below:

a. Roll-out of the VIS to every target territory (increase by ~300%)

b. Increased number of VIS users until 2020 (increase by ~25%)

c. Roll-out of biometric checks at border crossing points (increase by ~185%)

d. Change of scope between VIS and EES (increase by ~306%)

   i. TCNVE fall within the scope of the system

   ii. Depending on the TOM, fewer biometrics are enrolled

   iii. Addition of a second encryption layer

   iv. Biometric checks are performed at exit

   v. Image will be stored from e-MRTD or live capture

e. Additional encryption layer (addition of ~15% of total network needs)

f. Addition of RTP (addition of ~25% of EES)

g. Yearly growth rate of border crossings and travellers of 4% (increase by ~50%)

h. Addition of pre-production bandwidth during testing phases of EES and RTP after entry into operation (addition of ~10% of total network needs for the testing period)

The detailed calculation can be found in Appendix C - Network sizing.

2. Roll-out

The following table summarises the yearly sizing used for the cost computation of the network. The baseline (100%) is the bandwidth required on 1 January 2020.

The yearly growth rate used is 4%. This represents the estimated growth rate of the gallery size (TCN travellers and border crossings). This means that for the year 2020, the bandwidth required will be 104% of the baseline (100% of January 2020 + 4% growth rate until the end of the year).

For the purpose of the cost estimate, it will be assumed that the network will be resized once during the development phase, and will subsequently be sized to serve the requirements of the two following years during operation.

Table 11: *Network bandwidth requirements and deployment*

Year	2017	2018	2019	2020	2021	2022	2023
Bandwidth required	50%	50%	100%	104%	108.6%	112.9%	117.5%
Bandwidth deployed	**50%**	50%	**100%**	**112.9%**	112.9%	**122.2%**	122.2%

2.4.4 Synergies for developing one single system

Should the EES and RTP systems share the same network, important savings would accrue on the following items:

- Less number of TAPs and new lines for each system: The majority of lines of the EES could be reused for the RTP. The TAPs and lines for one system could be upgraded to fit the needs of the two systems. Up to 50% of the one-time costs would be saved.

- Reduction in overall maintenance costs: Part of Member States lines that are provided for the EES would be sufficient to handle RTP network load as well.

- The costs for other services could be shared by the two systems, reducing the overall cost of other services by 50%.

The savings are presented in section 2.4.5 below.

2.4.5 Results

The EES and RTP network costs as separate systems are computed assuming a specific network for each system, while single EES/RTP is assumed to be able to share the same network.

Table 12: *Results of network costs estimations for the development of central System (costs comparison) Summary of EES and RTP network costs*

NEW ESTIMATION 2014(2017) – 2020 MFF			
	Development phase (3 years)	**Operational phase 2020 (1 year)**	**Total (4 years)**
EES	€11.2 m	€2.6 m	€13.8 m
RTP	€9.2 m	€1.7 m	€10.9 m
EES + RTP as separate systems	€20.4 m	€4.3 m	€24.7 m
Joint EES and RTP	€12.2 m	€3.0 m	€15.2 m
Savings from the joint development	€8.2 m	€0.3 m	€8.5 m

Findings:

Linearity between bandwidth requirements and costs

Bandwidth requirements have a non-linear impact on cost:

a. One-time costs are required to create the line, the cost being the same regardless of the bandwidth requirement.

b. The smallest line capacity considered for the TESTA-ng network (10 mbps) is oversized compared to actual requirements. This allows for growth of network requirement for an important proportion of MS lines, without having to upgrade the line. Therefore these lines present little sensitivity to increase in bandwidth requirements.

2.5 Hardware and software costs

2.5.1 Cost components

Two types of costs have been identified:

1. One-time costs (OTC) to acquire the hardware and software licences
2. Monthly costs (MRC) to operate and maintain the hardware and software

The cost calculation takes into account the following environments:

1. Production environment (applicable to CU and BCU)
2. Pre-production environment (applicable to CU and BCU)
3. Playgrounds and testing environments (only applicable to CU)

2.5.1.1 Categories of hardware components

Nine types of hardware have been identified:

1. Database servers
2. Application servers
3. Other servers
    a. Search engine servers
    b. Virtualisation Servers (ESX)
    c. Management Servers (MGT)
4. Enclosures and racks
5. Network hardware
    a. Core Switches
    b. Front-End Switches
    c. F5 Load Balancers
    d. Firewalls MGT
    e. Firewalls Front-End and P2P
6. Miscellaneous (e.g. UPS)
7. Storage
8. BMS
9. NUI

2.5.1.2 Categories of software components

The table below lists the categories of software licences necessary for the functioning of the IT infrastructure.

Table 13: *Overview of the categories of software licences and of their impact on the overall cost of the IT system*

	Category of software licences	Impact on the overall software cost
1	BMS	Very high
2	Search Engine	Very high
3	Database software	High
4	Application and Messaging software	High
5	Virtualisation server	Medium/low
6	Storage	Medium/low
7	Helpdesk and support	Medium/low
8	Operating System	Low
9	Security	Low
10	Directory Server software	Low
11	Monitoring and administration software	Low
12	Other licences	Low

2.5.2 Methodology

The estimation of the hardware and software costs of EES and RTP has been carried out following a bottom up approach by using existing VIS data to estimate the sizing of the two new systems.

The comparison is supported by strong similarities between the purposes of the systems, which intervene in the same business processes (border control processes) and by strong similarities in the respective service catalogues.

The costing of hardware and software is estimated in several phases.

Phase 1: Identification of cost components and of the pricing parameters

Phase 2: Sizing of the hardware and software requirements

Phase 3: Results

Assumptions:

1. **Testing requirements:** The EES and RTP systems will require some IT infrastructure for testing purposes starting from the beginning of the development phase (2017). This hardware and software will be used for the purpose of operations starting from 2020, at which date playground and testing environments will be added.

2. **Location:** The location of the hardware – whether in the CU, in the BCU site or in the Member States in the case of the NUI – will not be considered to have an impact on the acquisition and maintenance prices.

3. **SLA:** The SLA required will vary depending on the type of environment, so as to save on the overall cost. Production and pre-production servers, being business-critical environments, should require a high SLA, while playground and testing environments should require a low SLA. Also, playground and testing environments will not be redundant as opposed to production and pre-production environments. For the new systems, EES and RTP, it is assumed a similar SLA as to the VIS.

4. **Availability:** EES and RTP share comparable or more stringent availability requirements than the VIS, as they intervene in a similar manner in the same business processes. If higher availability was to be required, this would increase the cost of the overall IT infrastructure, depending on the desired requirements. Section 4.2 of the cost analysis addresses the implications of a change of architecture between CU and BCU from active-passive to active-active, which could be necessary to ensure higher levels of availability and higher SLA.

5. **Ratio between production and pre-production needs:** The pre-production environment should be similar to the production environment in terms of size and SLA, so as to allow testing and deploying of new releases under conditions virtually identical to the production environment itself.

6. **Ratio between production and playground environment needs:** Two playgrounds will be considered for this calculation. Playground 1 will be used for load/stress/performance tests, while Playground 2 will be used for functional testing. Playground 1 is assumed to represent 20% of the cost of the production environment, and Playground 2 is assumed to represent 15% of the cost of the production environment.

7. **Testing environment needs:** Learning from the experience of SISII and VIS, 16 testing environments will be considered for this calculation to allow for timely execution of tests by Member States. These environments will be provided by virtualisation technology. Hardware required for the 16 testing environments is estimated to be 4 blade servers for the purpose of EES and RTP each when considered separately, and 8 blade servers if EES and RTP can share the same hardware.

8. **NUI:** The Central Authority would retain the source code of the software developed for the NUI; hence there would be no licence costs per NUI deployed, as opposed to the case of adopting a commercial solution.

2.5.3 Sizing

This section describes how the sizing and roll-out of the IT infrastructure (hardware and software) has been estimated. The EES-RTP BMS has been sized separately, as it represents a significant fraction of total hardware and software costs.

2.5.3.1 IT infrastructure

For the estimation of the IT infrastructure the VIS system was used as reference. The number of required CPU/cores and the required amount storage space have been adjusted to account for the differences in scope (i.e. TCNVEs in addition to TCNVHs, biometric checks at exit and record of data at both entry and exit). Three metrics have been used in order to measure the three systems (VIS, EES and RTP):

- The sizing parameters identified in Appendix A (i.e. the number of processes, number of tasks), have been used to assess the development efforts
- The number of border crossings and individuals that will be handled by the three different systems
- The number of individuals in scope of the three systems.

Table 14: *Summary of the benchmarking against the VIS for the estimation of the hardware for the new systems*[14]

Comparison against the VIS hardware			
	Database servers[15]	Application servers[16]	Other servers[17] (i.e. management, virtualisation servers)
EES	+287%	+307%	+217%
RTP	-2%	+21%	+13%
Joint EES and RTP	+369%	+393%	+217%

The results for the sizing of the hardware, presented in the table above, do not take into account the technological progress on performance. Yet, the estimated costs in 2020 have been reduced by 40% for all the hardware and by 25% for the storage cost. These percentages have been estimated on the basis of historical trends and of the studies[18] on the evolution of the price/performance over the time.

The sizing of the hardware has been used for the estimation of the number and cost of software licences. Among these, the search engine software has, together with the BMS, the highest impact on the overall software costs. Its cost has been estimated through consultation with the vendors analysing different scenarios for the database size. Annex F present an overview of the pricing parameters used for the cost estimation.

2.5.3.2 EES-RTP BMS infrastructure

The size of the database is one of the main variables that impact the cost of the BMS, together with the type of functionalities (e.g. facial image verification/ identification) and the throughput in terms of proportion of identifications vs. verifications to be performed.

In addition, the sizing of the BMS hardware will depend on the selected algorithm, as better performing algorithms are more resource intensive and require enhanced hardware to provide the same SLA. Various scenarios of BMS infrastructure, presented by the vendors, differ in terms of accuracy requirement, processing power and scale of the system *(see Appendix E for further details).*

[14] The estimation presented does not include the BMS. The percentage do not include any reduction to account of the technological progress, such reduction has applied directly to the cost of the hardware (the price of the hardware in 2020 has been reduced by 40% and by 30% for the storage).
[15] The parameter considered for the benchmark of the database servers was: (number of border crossings + number of people in the scope) * number of processes of the system
[16] The parameter considered for the benchmark of the application server: (number of border crossings) * number of processes of the system
[17] The parameter considered for the benchmark of the other servers was the median of the increase of the number of border crossings in scope, of the number of people in scope, of the parameters for the database server sizing and of the parameters for the application server sizing.
[18] Sources: (i)Server Trends, Gartner, http://regions.cmg.org/regions/stlcmg/files/Download/Presentations_2013-02/Server_Performance_Trends-CMG-Bowers-Feb2013-ForCopies.pptx; (ii) Storage Pricing Trends & Outlook 2014, Everest group, http://www.everestgrp.com/2014-07-storage-pricing-trends-outlook-2014-market-insights-14744.html

The estimation took into consideration a common, newly developed, SOA based BMS, which would serve all three systems (EES, RTP and VIS). The sizing was done according to the baseline scenario of 181 days of data retention for EES, which is estimated to correspond to approximately a database size of 60 million of travellers. Further information on the impact of different data retention can be found in section 4.3.

It is assumed that hardware can cost up to 20%[19] of the total cost of the BMS, which includes systematic 1:N identification[20].

2.5.4 Synergies for developing one single system

By sharing the same IT infrastructure the EES and RTP could achieve significant cost savings, up to 5% (i.e. €1 m) of the combined cost (see 2.5.5). Several assets could be shared, achieving not only an initial saving and higher cost effectiveness, but also reducing the overall complexity and fragmentation of solutions to be maintained.

If the system were built separately, all the software licences would have to be acquired at least twice, whereas the combined development would only require a marginal increase due to the extra CPUs and servers to cover the additional workload for the RTP on top of the EES.

2.5.5 Results

The tables below provide the results of the hardware and software cost estimation for the two systems built independently and for the case of the joint implementation.

In the case of two separate systems the cost of the common BMS has been divided equally between EES and RTP.

Table 15: *Results of hardware costs estimations for the development of central System (costs comparison)*[21]

	NEW ESTIMATION 2014(2017) - 2020 MFF		
	Development phase (2017-2020) (3 years)	**Operational phase 2021 (1st year)**	**Total (4 years)**
EES	€9.0 m	€1.1 m	**€10.1 m**
RTP	€8.2 m	€ .96 m	**€9.2 m**
EES + RTP as separate systems	€17.2 m	€2.1 m	**€19.3 m**
Joint EES and RTP	€15.9 m	€1.8 m	**€17.7 m**
Savings from the joint development	€1.3 m	€ .3 m	**€1.6 m**

[19] Source: vendor and expert consultations
[20] Only for TCNVEs, please refer to chapter 8 of the Technical Study for further information.
[21] Operational costs are computed based on the sensitivity of the related item. High-SLA environments have higher operational costs (20% of initial investment) than low-SLA environments (10% of initial investment).

Table 16: *Results of software costs estimations for the development of central System (costs comparison)*[22]

	NEW ESTIMATION 2014(2017) - 2020 MFF		
	Development phase (2017-2020) (3 years)	**Operational phase 2021 (1st year)**	**Total (4 years)**
EES	€33.9 m	€5.4 m	**€39.3 m**
RTP	€21.4 m	€3.2 m	**€24.6 m**
EES + RTP as separate systems	€55.3 m	€8.6 m	**€63.9 m**
Joint EES and RTP	€45.4 m	€6.8 m	**€52.2 m**
Savings from the joint development	€9.9 m	€1.8 m	**€11.7 m**

2.6 Training courses and meetings

2.6.1 Cost components

Meeting costs include:

- MA meetings for grant management and missions for auditing grants at MSs;
- MA monthly progress meetings during the development phase of the system and quarterly when the system is operational[23];
- Committee/sub-group meetings with national experts to discuss issues specific to MSs;
- Advisory groups.

Training costs cover handover of the EES and RTP to eu-LISA during which the functionalities of the systems should be introduced as well as business trainings for MA and MSs delegates.

The Cost Model excludes the expenditure related to national meetings, as well as training of national authorities.

2.6.2 Methodology

The training costs are calculated as a 4% ratio from initial and yearly recurring development costs.

The meeting costs are estimated based on a bottom-up approach, i.e. the need for the meetings is determined based on DG Home and eu-LISA experience. Once the number of meetings was determined, it was multiplied by the number of participants and costs for one participant.

2.6.3 Sizing

The main sizing parameter for meeting costs is the number of meetings per year. It is assumed that the same number of meetings will be needed for both the EES and RTP developed separately and the EES and RTP developed as a single system. It is also assumed that there will be one expert per MS in the meetings (i.e. 30 participants).

[22] Operational costs are computed based on the yearly price of the licences.

[23] Excluding holiday periods and the end of year season

The sizing parameter for training courses is the percentage (i.e. 4%) from the development costs that has been defined based on handover and training experience of large-scale IT projects.

The sizing parameters are presented in the table below.

Table 17: *Components and sizing of training and meeting costs*

		EES	RTP	EES and RTP
Management Authority				
Title 2 Administrative expenditure				
Meetings related to programming of the grants to be provided to Member States	*# per year*	3	3	6
Missions for auditing grant management at MSs	*# per year*	4	4	8
MA Monthly Progress meetings	*# per year*	10	10	20
Committee/sub-group meetings with national experts	*# per year*	25	25	50
Advisory groups	*# per year*	4	4	8
Trainings courses for MA	*% from initial development costs*	4%	4%	4%

2.6.4 Synergies for developing one single system

A joint development would reduce the overall need of training hours as, for instance, only one handover to the MA would be necessary instead of two in the case of separate developments. A single development is likely to reduce the fragmentation of software solutions and therefore the need of specific trainings.

2.6.5 Results

The table below provides the results of the meetings and trainings costs estimations.

Table 18: *Results of trainings and meetings costs estimations for the development of central System (costs comparison)*

NEW ESTIMATION 2014(2017) - 2020 MFF			
	Development phase (2017-2019) (3 years)	**Operational phase 2020 (1 year)**	**Total (4 years)**
EES	€2.9 m	€0.3 m	**€3.2 m**
RTP	€2.8 m	€0.3 m	**€3.1 m**
EES + RTP as separate systems	€5.7 m	€0.6 m	**€6.3 m**
Joint EES and RTP	€5.4 m	€0.6 m	**€6.0 m**
Savings from the joint development	€0.3 m	€0	**€0.3 m**

2.7 Office space

2.7.1 Cost components

According to the study *"....it will be possible to introduce an additional two full future systems into the C-SIS data hall beyond the deployment of EURODAC, and the introduction of relevant IT hardware infrastructure for both Entry/Exit and RTS systems."*[24] Therefore, the assumption is made that there will be enough datacentre space to host the EES and RTP at the central site in Strasbourg, France. To this end, no costs are expected to be incurred for acquiring or renting additional facilities – only hot/cold aisle insulation costs are included in the model.

The backup central site in Sankt Johann im Pongau, Austria has enough space to host the system; however, it lacks the baseline facility environment suitable for equipment installation, i.e. electricity, cooling, security and other infrastructure. Therefore, the model includes setup and operational costs of the backup central site.

The Deloitte study also determined future requirements for the office space development *"…all ECOM staff and external contractors will be located in the new office accommodation that is to be constructed".* Therefore, the Cost Model includes the costs of office space rent to host the development team only during the first year of development.

The Cost Model excludes costs for renting or acquiring datacentre space for hosting national systems as well as costs for renting or acquiring office space for national authorities. The assumption is made that existing datacentre and office spaces will be used to host national systems and accommodate the internal and external development team as well as helpdesk staff during system operations at MS level.

2.7.2 Methodology

The setup and operational costs of the datacentre space are estimated in the paragraphs below by multiplying the need for datacentre space in square metres with the setup and operational costs per square metre.

2.7.3 Sizing

The datacentre space of the backup central site in Sankt Johann im Pongau, Austria is determined based on the Statement of Minimum Future Requirements developed by Deloitte.

The need for the office space for the first year of development is estimated by multiplying the number of FTEs (please refer to Table 8 for further information) by office space requirement for 1 person, i.e. 2 square meters.

Table 19: *Sizing of office space costs*

		BMS	EES	RTP	EES and RTP
Management Authority					
Datacentre space of the backup central site (in Sankt Johann im Pongau, Austria)[25]	m^2	17.28	54	36	70
Office space (for the first year of development)	m^2	-	276	276	420

[24] IT Agency – Assessment of C.SIS Strasbourg - Statement of Minimum Future Requirements - 2012, Deloitte

[25] IT Agency – Assessment of C.SIS Strasbourg - Statement of Minimum Future Requirements - 2012, Deloitte

2.7.4 Synergies for developing one single system

Synergies would be achieved if EES and RTP were developed as one single system, as it would occupy smaller datacentre space due to lower number of racks (8 racks less than in the case of separate systems).

2.7.5 Results

The results of the office space cost estimations are presented in the table below.

Table 20: *Results of space costs estimations for the development of central System (costs comparison)*

NEW ESTIMATION 2014(2017) - 2020 MFF			
	Development phase (2017-2019) (3 years)	**Operational phase 2020 (1 year)**	**Total (4 years)**
EES	€0.4 m	€0.09 m	**€0.49 m**
RTP	€0.3 m	€0.06 m	**€0.24 m**
EES + RTP as separate systems	€0.7 m	€0.15 m	**€0.85 m**
Joint EES and RTP	€0.55 m	€0.13 m	**€0.68 m**
Savings from the joint development	€0.15 m	€0.02 m	**€0.17 m**

3 Cost differences between TOMs

The study defines three TOMs (Target Operating Models) for EES and two TOMs for RTP.

EES:

- TOM A – Photo from e-MRTD (Machine Readable Travel Document) as biometric identifier and relying on MRZ (Machine Readable Zone) (plus visa number for Visa Holders (VH)) as data for EES. Absence of systematic 1:N identification at first entry for TCNVE.
- TOM B – Photo from e-MRTD and 4 fingerprints as biometric identifiers and relying on MRZ (plus visa number for VH) as data for EES. Systematic 1:N identification at first entry for TCNVE.
- TOM C – Photo from e-MRTD and 8 fingerprints as biometric identifiers and relying on MRZ (plus visa number for VH) as data for EES. Systematic 1:N identification at first entry for TCNVE.

RTP:

- TOM M – Fingerprints (live)-only for VE- and photo (from e-MRTD) as biometric identifier for RTP. For VH, the FP used in the VIS will be used as the basis for verification and identification. In this TOM the enrolment of an RTP follows the process from the current legal proposal, which is very close to a visa application process: RT status is requested by the applicant (and this can be done via internet), interview with applicant takes place where his/her biometrics are captured (the number is equal to what the TOM A, B, C requires) and this cannot be done via internet, MS instructs the request and grants/refuses RT (this can also happen over internet).
- TOM N – No biometrics taken at enrolment (i.e. no physical visit necessary), existing biometrics (EES and VIS) used for verification purposes. In this TOM the enrolment of an RTP is only possible when the TCN has already travelled to EU Schengen area and is therefore recorded in the EES. The RT status is requested by the applicant via internet, no face to face meeting is necessary anymore as the applicant can provide all evidences via internet and the biometrics are in the EES personal file. Finally MS instructs the request and grants/refuses RT (this can also happen over internet).

TOM C and M are taken as the baseline for the calculation of the costs of the EES and RTP projects, as they are the most cautious in terms of costs as well as the closest to the existing legal proposals. In this section, the study evaluates the cost impact of the other TOMs on the overall project.

The general impact of TOMs is split between the cost components of the project. The study looked into each impacted cost component to provide an estimate of the cost impact of each TOM. The results will be presented as a fixed figure where possible, or as a percentage of the cost component.

As can be seen in this summary table, there is a cost impact depending on the TOM on the following cost components:

1. Network (Section 2.4)
2. Hardware (Section 2.5)
3. Software (Section 2.5)

It should be considered that TOM N is based on a draft proposal for an alternative RTP process and it needs to be further elaborated on. The assumptions used for the cost estimation of TOM N are outlined for each cost component impacted in the chapters below.

Table 21: *Cost impact depending on selected TOM*

	Enrolment of 4 FPs	Enrolment of 8 FPs	Discretionary 1:few identification using FI (+additional alphanumeric criteria)	Systematic 1:N identification (only VE)	1. Contractor development	2. Network	3. Hardware	4. Software	5. Administ-ration	6. Trainings, meetings	7. Other
TOM A			✓		-	Decreased network traffic because of absence of fingerprint data	Decreased processing power of BMS because of absence of 1:N identifications Decreased gallery size (data stored)	Decreased license costs due to absence of fingerprints	-	-	-
TOM B	✓			✓	-	Decreased network traffic because of reduction of fingerprint data	Decreased gallery size (data stored)	-	-	-	-
TOM C (baseline)		✓		✓	**Baseline**	**Baseline**	**Baseline**	**Baseline**	**Baseline**	**Baseline**	**Baseline**

price decrease of more than 10%
price decrease up to **10**%

Table 22: *Cost impact depending on selected TOM*

	VE 1:N identification using FP against the RTP	VE: enrolment of 4 FPs	EES individual file created at the end of the application process	Verification using photo (ABC), FP (ABC or manual)	RTP enrolment procedure based on the EES	1. Contractor development	2. Network	3. Hardware	4. Software	5. Administration	6. Trainings, meetings	7. Other
TOM M (baseline)	✓	✓	✓	✓		**Baseline**	**Baseline**	**Baseline**	**Baseline**	**Baseline**	**Baseline**	**Baseline**
TOM N		**EES FP are used**	**EES file is present**	✓ **EES process used**	✓	-	Decreased network traffic because of absence of biometric data in RTP	Decreased storage requirements because of absence of biometric data in RTP	Negligible reduction of gallery size, not guaranteed to have an impact on the price of the software	-	-	-

price decrease of more than 10%
price decrease up to **10**%

3.1 Network

3.1.1 EES - TOMs A, B and C

TOMs A, B and C are impacting network usage by modifying the amount of biometric data that will be exchanged through the network.

Looking at the impact of the TOMs, the following parameters impacting the bandwidth requirement calculation can be identified.

VIS			
	Maximum amount of fingerprints used for BCP checks	4	Cautious assumption based on current usage
	Amount of fingerprints used for visa applications	10	VIS regulation
	Amount of facial images used	1	VIS regulation
Tom A		Value	Source
	Maximum amount of fingerprints used for BCP checks	0	Cautious assumption based on TOM requirements
	Amount of fingerprints to be used at first entry (VE only)	0	Technical options for a Smart Borders Pilot
	Amount of facial images to be used	1	Technical options for a Smart Borders Pilot
Tom B			
	Maximum amount of fingerprints used for BCP checks	4	Cautious assumption based on TOM requirements
	Amount of fingerprints to be used at first entry (VE only)	4	Technical options for a Smart Borders Pilot
	Amount of facial images to be used	1	Technical options for a Smart Borders Pilot
Tom C			
	Maximum amount of fingerprints used for BCP checks	4	Cautious assumption based on TOM requirements
	Amount of fingerprints to be used at first entry (VE only)	8	Technical options for a Smart Borders Pilot
	Amount of facial images to be used	1	Technical options for a Smart Borders Pilot

When comparing the three TOMs from a costing perspective, the results are the following:

Table 23: *Comparison of network costs for TOMs A, B and C for the 2017-2020 period (3 years development and 1 year operation)*

	TOM A (% out of baseline)	**TOM B** (% out of baseline)	**TOM C** (baseline = 100%)
EES	**€11.8 m** (86%)	**€12.9 m** (94%)	**€13.8 m**
RTP	**€10.9 m** (99%)	**€11 m** (100%)	**€11 m**
EES + RTP as separate systems	**€22.7 m** (92%)	**€23.9 m** (97%)	**€24.7 m**
Joint EES and RTP	**€13 m** (85%)	**€13.8 m** (91%)	**€15.2 m**
Savings from the joint development	**€9.7 m**	**€10 m**	**€9.5 m**

The savings provided by TOM A and B are the result of the reduction of biometric data that is exchanged through the network. As the majority of RTP network lines are oversized to allow for scaling and handle peaks, thus the reduction in bandwidth usage does not translate in a similar reduction in bandwidth requirements for the RTP system, amounting only to a 1% saving for RTP. For the EES, the cost reduction is linear with the reduction of biometric data exchange.

3.1.2 RTP - TOMs M and N

TOM N impacts network usage on two levels:

1. **Biometrics:** There would be no exchange of biometric data through the RTP network, as the biometric matching would be done through either the VIS or the EES, depending on the status of the TCN (VE or VH).

2. **Application file transfer: TOM N considers as an option to** make the online application for RTP compulsory. As such, an increase in the transfer of application files for RTP membership to the load of the network could be anticipated. This increase however is already considered in the option of a website for RTP enrolment.

1. **Biometrics:**

TOM N would rely on the existing biometrics of the EES (VE). No enrolment of biometrics would be made in the RTP application process. Identifications and verifications in the border control process would be made using the EES. As such, RTP would no longer require network usage for biometrics.

Also, in TOM N, the RTP membership status would be written in the EES individual file, on which the membership check would be made.

Finally, the RTP application would not require biometric enrolment, as biometric data would already be present in the EES file.

Therefore, there would be no biometric transaction made from either the consular post or the border-crossing point to the RTP system.

When comparing the 2 TOMs from a costing perspective, the results are the following:

Table 24: *Comparison of network costs for TOMs M and N*

	TOM M (baseline)	**TOM N** (% out of baseline)	**Difference**
EES (no impact)	**€13.8 m**	**€13.8 m** (100%)	**€0 m**
RTP	**€11 m**	**€10.9 m** (99%)	**€0.1 m**
EES + RTP as separate systems	**€24.7 m**	**€24.6 m** (100%)	**€0.1 m**
Joint EES and RTP	**€ 15.2 m**	**€13.8 m** (91%)	**€1.4 m**
Savings from the joint development	**€9.5 m**	**€10.8 m**	

The majority of RTP network lines are oversized to allow for scaling and handle peaks, thus the reduction in bandwidth usage does not translate in a similar reduction in bandwidth requirements for the RTP system, amounting only to a €91,200 saving for TOM N.

When considering EES and RTP together, the reduction of bandwidth usage has a bigger impact on the cost, as one less PTP connexion between the CU and the BCU would be required.

3.2 Hardware

3.2.1 EES - TOMs A, B and C

TOMs A, B and C impact hardware usage on three levels:

1. **Data storage:** The amount of biometric data that will be stored in the central system, at both CU and BCU, will vary depending on the selected TOM.

2. **Biometrics:** The workload for the biometric matching system could differ.

3. **Absence of systematic 1:N identification in TOM A:** The workload for the biometric matching system will be lower if systematic 1:N identification is replaced with discretionary 1:few identification.

It should be noted that – regardless of the scenario or the TOM – the BMS is assumed to be an SOA-based BMS serving the needs of VIS, EES and RTP.

1. Data storage

The greater the number of fingerprints that would be enrolled per TCN for identification purposes, the greater the amount of data storage space required.

The difference in biometric data storage between TOMs is the following:

Table 25: *Biometric data storage differences (TOMs A, B and C)*

	TOM A	TOM B	TOM C
Fingerprints stored	0	4	8

The difference between each TOM is 4 fingerprints. Therefore, to evaluate the difference between TOMs in terms of data storage, the difference in storage for 4 fingerprints should be evaluated.

The table below highlights the difference of data storage space required for different options of fingerprints enrolment and their impact on costs.

Table 26: *Impact of biometric options on data storage*

Biometric identifier	Size of data storage	
	Min. size	Max. size
8 FPs (no FI)	96.6 kb	140 kb
4 FPs(no FI)	48.3 kb	70 kb

Assumptions

1. The expected amount of data storage space required is calculated based on the maximum size.
2. The cost is assumed to be €2,100 per terabyte (including maintenance) for the MFF (2017-2020) period.
3. The same storage space needs to be used for the CU and the BCU.
4. Storage space is shared between the production and the pre-production environment

Findings

1. The EES is estimated to contain 60 million individual files in 2020 (end of the MFF period) 60 million individual files x 70kb = 4 Terabytes of data are required to store 60 million times 4 fingerprint data.
2. The difference in storage costs between TOM A and TOM B, and between TOM B and C, for the MFF period and for the CU and the BCU, is approximately €17,000.
3. The yearly cost of maintenance for storage is estimated to be 20% of the initial cost.
4. Overall, the cost impact of TOMs A, B and C on storage is negligible compared to the rest of the envelope (0.004%).

2. Biometrics

Following consultation of the leading vendors, it has been assessed that the increase in number of fingerprints would not have a noticeable impact on the hardware sizing.

3. Absence of systematic 1:N identification in TOM A

Assumptions:

1. Systematic 1:N identification only applies to TCNVEs, and only at first entry. Gallery size for this kind of identification is therefore between 30 million and 40 million per year, which is the estimated number of first entries for a 181-day data retention period.

2. Discretionary 1:few identification can apply to both TCNVEs and TCNVHs, at any time.

A pricing simulation has been requested from BMS vendors with the scenarios which can be found in Appendix E, and that are summarised below:

1. 1:N identification:

    a. 1 million per year (covering a limited number of LEA requests) (TOM A)

    b. 30 million per year (covering a limited number of LEA requests + systematic 1:N identification at first entry for VE) (TOM B and C)

2. 1:few identification:

    a. 125 million per year (covering half the entries) (TOM A)

    b. 50 million per year (TOM B and C)

Following consultation with leading vendors, it was assessed that a scenario in which there would be no systematic 1:N identification at first entry, coupled with the absence of finger print data, would lead to a situation in which the BMS system would not be in a position to accurately perform 1:N or 1:few identifications at entry. Indeed, the latest NIST Facial Recognition Vendor Tests show NEC as the leading ranked vendor with approximately 4% 1:N error rate in a test database of 1.6 million. Even with a candidate list of 50 million, the likelihood that a true match is not in the top 50 matched candidates returned is sufficiently high as to render the search unproductive in real-time operational scenarios.

However, it was acknowledged by vendors that the absence of systematic 1:N identification could lead to a significant downsizing of the hardware component of the BMS, as this kind of transactions represents the heaviest load on the system (search and match on the whole database instead of on one single individual file), and that up to 60% of the hardware cost is represented by these 1:N identifications.

Findings:

Overall impact:

There is only a very limited difference between TOM B and TOM C, as the only impact is on the storage. However for TOM A, the absence of systematic 1:N identification greatly reduces the sizing of the BMS hardware, resulting in significant (up to 40%) decrease of overall hardware costs.

The overall impact of TOMs A, B and C on the cost of hardware is presented in the following table:

Table 27: *Overall impact on the cost of hardware (TOMs A, B and C)*

MFF Period (2017-2020)	TOM A (% out of baseline)	TOM B (% out of baseline)	TOM C (baseline)
EES	**€6 m** (59%)	**€10.1 m** (100%)	**€10.1 m**
RTP	**€5.1 m** (55%)	**€9.2 m** (100%)	**€9.2 m**
EES + RTP as separate systems	**€11.1 m** (57%)	**€19.3 m** (100%)	**€19.3 m**
Joint EES and RTP	**€9.4 m** (53%)	**€17.7 m** (100%)	**€17.7 m**
Savings from the joint development	**€1.7 m**	**€1.6 m**	**€1.6 m**

3.2.2 RTP - TOMs M and N

TOM N impacts hardware usage by removing the requirement to store biometric data for the RTP. Since biometric data and membership status would be stored in the EES and/or the VIS, the need for an RTP database is limited to the application data.

Assumptions

1. **Biometric checks:** under TOM N, biometric checks of RTP members are done based on the biometric information available in the VIS (TCNVHs) and the EES (TCNVEs). Therefore, no biometric data is stored in the RTP database.

2. **RTP data set:** under TOM N, the RTP database would only hold data related to the application and the status of the RTP membership (data sets described in section 5.2.4 of the Technical Study: RTP application and RTP-related data).

3. **Application file transfer:** By making the online application for RTP compulsory, an increase in the storage of application files for RTP membership should be anticipated. This increase however is already considered in the option of a website for RTP enrolment.

Based on the assumptions above, it can be estimated that the storage space required for the RTP database would be markedly less than TOM M. Biometric data accounts for around 90% of an individual user file, meaning that storage space requirements would be 10 times lower than for TOM M.

Overall impact

The overall impact of TOMs M and N on the cost of hardware is presented in the following table.

TOM M and N do not impact the EES therefore Hardware costs remain the same. For the RTP, the difference is explained by the reduction of storage needs in TOM N.

Table 28: *Overall impact on the cost of hardware (TOMs M and N)*

	TOM M (baseline)	TOM N (% of baseline)	Difference
EES	**€10.1 m**	**€10.1 m** (100%)	**€0 m**
RTP	**€9.2 m**	**€8.7 m** (95%)	**€0.5 m**
EES + RTP as separate systems	**€19.3 m**	**€18.8 m** (97%)	**€0.5 m**
EES and RTP	**€17.7 m**	**€17.2m** (98%)	**€0.5m**
Savings from the joint development	**€1.6 m**	**€1.6 m**	

3.3 Software

3.3.1 EES - TOMs A, B and C

All software licence costs remain the same TOMs A, B and C except for BMS licences. In the case of TOM A, no software license for finger print matching would be required.

It is estimated that the software licence for finger prints, maintenance included, accounts for 50% of the total BMS software cost.

Following consultation with leading vendors, it was identified that there was no licence cost difference between TOM B and TOM C, i.e. between usage of four finger prints or eight finger prints.

Overall impact

The overall impact of TOMs A, B and C on the cost of software is presented in the following table.

The difference between TOM A and B is explained by the absence of BMS fingerprints software licence. There is no difference in software costs between TOM B and TOM C, as the BMS software licence costs are the same if four or eight fingerprints are used.

RTP is as impacted as EES by the reduction in costs of TOM A, as the BMS costs are split between both systems.

Table 29: *Overall impact on the cost of software (TOMs A, B and C)*

MFF Period (2017-2020)	TOM A (% out of baseline)	TOM B (% out of baseline)	TOM C (baseline)
EES	**€33.7 m** (86%)	**€39.3 m** (100%)	**€39.3 m**
RTP	**€19 m** (77%)	**€24.6 m** (100%)	**€24.6 m**
EES + RTP as separate systems	**€52.7 m** (82%)	**€64 m** (100%)	**€64 m**
EES and RTP	**€40.9 m** (78%)	**€52.2 m** (100%)	**€52.2 m**
Savings from the joint development	**€11.8 m**	**€11.7 m**	**€11.7 m**

3.3.2 RTP – TOMs M and N

TOM N impacts software usage on the BMS level, as there would be no longer any biometric matching done on the RTP database.

However, being the RTP population a small subset of the overall population of travellers captured within the EES and VIS, the overall size of the database for the BMS would not vary.

It can be reasonably assumed that no cost reduction can be expected for TOM N, or a negligible one compared to the remaining software costs.

In order to ensure the comparability with the other results presented, the repartition of the cost of the BMS between EES and RTP has been maintained also for TOM N, although in such case RTP would rely on the EES for the biometric verification.

3.4 Conclusions

The following table presents the summary of the impact on the costs of the different TOMs. The percentage below each number represents the percentage of the cost compared to the baseline that is TOM C and M.

It can be seen that TOM A is always the cheapest alternative, regardless of the scenario, and that TOM B does not have a significant cost impact compared to TOM C (less than 1% decrease).

TOM N does not have an important impact on the cost on the central envelope. **The main purpose of TOM N being to rely on the EES for biometric matching of RTP members, and making online RTP enrolment compulsory, the impact is going to be felt on the national side as opposed to the central side, as RTP applications would be received directly online, reducing the need for administrative officers to deal with requests at the consular or administration post.**

Table 30: *Comparative overview of costs per TOM for each impact cost component*

	TOM A		TOM B		TOM C (baseline)	
	TOM M	**TOM N**	**TOM M**	**TOM N**	**TOM M (baseline)**	**TOM N**
Network						
EES	**€11.8 m**	**€11.8 m**	**€12.9 m**	**€12.9 m**	**€13.8 m**	**€13.8 m**
	86%	**86%**	**94%**	**94%**		**100%**
RTP	**€10.9 m**	**€10.9 m**	**€11. m**	**€10.9 m**	**€11. m**	**€10.9 m**
	99%	**99%**	**100%**	**99%**		**99%**
EES and RTP	**€13. m**	**€13. m**	**€13.8 m**	**€13. m**	**€15.2 m**	**€13.8 m**
	85%	**85%**	**91%**	**86%**		**91%**
Hardware						
EES	**€6. m**	**€6. m**	**€10.1 m**	**€10.1 m**	**€10.1 m**	**€10.1 m**
	59%	**59%**	**100%**	**100%**		**100%**
RTP	**€5.1 m**	**€4.6 m**	**€9.2 m**	**€8.7 m**	**€9.2 m**	**€8.7 m**
	55%	**50%**	**100%**	**95%**		**95%**
EES and RTP	**€9.4 m**	**€8.9 m**	**€17.7 m**	**€17.2 m**	**€17.7 m**	**€17.2 m**
	53%	**50%**	**100%**	**97%**		**97%**
Software						
EES	**€33.7 m**	**€33.7 m**	**€39.3 m**	**€39.3 m**	**€39.3 m**	**€39.3 m**
	86%	**86%**	**100%**	**100%**		**100%**
RTP	**€19. m**	**€19. m**	**€24.6 m**	**€24.6 m**	**€24.6 m**	**€24.6 m**
	77%	**77%**	**100%**	**100%**		**100%**
EES and RTP	**€40.9 m**	**€40.9 m**	**€52.2 m**	**€52.2 m**	**€52.2 m**	**€52.2 m**
	78%	**78%**	**100%**	**100%**		**100%**

The following table provides an overview of **the cost of the entire system** (EES and RTP developed jointly or separately), giving an overview of the cost difference between the TOMs.

Table 31: *Comparative overview of total costs of the systems per TOM*

	TOM A		TOM B		TOM C (baseline)	
	TOM M	TOM N	TOM M	TOM N	TOM M (baseline)	TOM N
EES	€214.3 m	€214.3 m	€225.2 m	€225.2 m	€226. m	€226. m
	95%	95%	100%	100%		100%
RTP	€194.6 m	€194.1 m	€204.4 m	€203.8 m	€204.4 m	€203.8 m
	95%	95%	100%	100%		100%
EES and RTP	€359.3 m	€358.8 m	€379.6 m	€378.3 m	€381. m	€379.1 m
	94%	94%	100%	99%		99%

The difference between TOM A vs B and C is around 5% of the total budget independently of which RTP TOM is used. This is due to lower network, hardware and software costs. But mainly hardware is less costly as there is no possibility of systematic identification.

The difference between TOMs B and C is marginal (less than 1%) due almost exclusively to reduced network costs since 8 FPs carry a higher load than 4 FPs at enrolment of VE. All other cost components remain the same.

TOMs M and N have also only a small cost difference, TOM N being slightly less expensive as network and hardware costs are reduced because the RTP relies on the biometrics stored in the VIS or in the EES.

4 Other cost options

The purpose of this chapter is to look at the options that have an impact on the cost compared to the baseline. The objective is to provide an indication of the impact that these options have on the bottom line. At this stage of the project, and without precise functional and technical specifications, the cost impact will be looked at from a high-level perspective, with the aim to provide orders of magnitude of the impact of these options.

For each option, the impacted cost components will be identified and sized compared to the baseline.

4.1 Law enforcement access

Today, without a detailed specification of LEA queries and service level agreement[26], only a rough estimation can be made regarding the additional costs of LEA functionality.

Two types of law enforcement authorities' access are currently in operation. The Eurodac process assumes a search using finger prints only, while the VIS model assumes a search by multiple fields/metadata/finger prints.

For the purpose of the costing exercise, it will be assumed that a process similar to the most complex process currently in use (the VIS process) will be used, so as to provide a cautious estimate on the cost of LEA.

The following cost items would be impacted:

1. The development cost for the additional functionalities

2. The hardware and software costs to support additional queries and transactions both volume and complexity wise

3. The BMS cost to support the search of partial fingerprints (latent fingerprints), the additional identifications and verifications.

4.1.1 Contractor development

Allowing LEA to access EES and RTP would require introduction of additional functionalities and transactions in the EES, which would increase the implementation costs.

Based on the development costs methodology used in section 2.2.2 it could be roughly assumed that the development of LEA is equivalent to the development of one extra task. In particular law enforcement will be a variant (i.e. one fourth each) of the following tasks[27]:

- *Search* by alphanumeric data, which determines the hits, but returns only an abstract about each hit;
- *Retrieval*, which loads the details about a specific hit in the hit list returned by the search operation;
- *Authentication by fingerprint*, which provides the outcome for 1:1 search for verification, using fingerprints;
- *Search by fingerprint,* which provides the outcome for 1:N search for identification, using fingerprints.

The costs of developing one extra task (one-fourth of each of the tasks above) can be estimated as follows (assuming that the functionality would be available since the inception of the system(s)):

[26] The exact purpose for LEA will be defined by the co-legislators in the negotiations of the EES proposal.
[27] The development costs of LEA are estimated based DG TAXUD methodology.

Table 32: *Cost projection for contractor development for the purpose of allowing LEA access (2017-2020-2024)*

Cost of contractor development	2014(2017) - 2020 MFF	2021-2023
Cost of the development of one task	€25,000	€2,000 per year on average (i.e. 7.5% of the initial effort)

4.1.2 Hardware and software

To be able to cope with the numerous fuzzy/inexact searches, the system requires an investment after the initial development (i.e. an increase in the number of CPUs and servers available with repercussions on the software costs).

The number of queries to be made to EES/RTP can be estimated to reach up to 100 searches and 50 retrievals per day[28]. This load can be covered by an additional blade server for the search engine and by an extra server for the database (see table below).

Table 33: *Summary of the additional hardware and software costs for the purpose of allowing LEA access*

Hardware and software costs	2014(2017) - 2020 MFF	2021-2023 *(on average per year)*
Extra cost for hardware (2 additional blade servers)	€18,000	€2,600
Extra cost for software	€140,000	€20,000
Total per environment	€160,000	€25,000
Total for the four environments (production + pre-production on two sites) *(rounded-up)*	**€640,000**	**€100,000**

4.1.3 BMS

The possibility to be able to look up partial fingerprints would require additional licence costs and more powerful hardware. On the basis of information provided by biometric vendors, the license cost for the support of latent/partial FPs could increase by up to €2,000,000 depending on the volumes foreseen and on the gallery size. The hardware should however not be impacted.

Yearly maintenance costs for the BMS are approximately 5% of the total BMS cost, so yearly maintenance would be increased by €100,000.

Table 34: *Licence costs for latents/partial fingerprints*

Cost of BMS	2014(2017) - 2020 MFF	2021-2023 *(on average per year)*
Licences for latents/partial finger prints	€2.1 m	€100,000

[28] The estimation of EES/RTP was based on the fact that on average 11 searches and five retrievals made per day from the VIS regarding the LEA in the first quarter of 2014. A factor 10 is applied to this number to take into consideration the fact that the VIS is not yet fully rolled out, that the system is still in its early years of operations and the scope difference between the VIS and the EES.

4.1.4 Summary

In the event that access would be given to EES data for LEA the impact on initial investment would be €2.7 m spread over 3 years. The additional investment would induce an additional €160,000 maintenance costs per year.

The essential assumptions are:

- LEA searches follow a mechanism similar as the VIS which has a higher technical sophistication than the EURODAC,
- Volume of LEA searches remain small compared to the volumes for enrolment/border control.
- Searches need also to be possible on latent finger prints. This assumption has the highest consequence as it impacts strongly the investment cost (€2 m out of €2.7 m) and the recurrent maintenance costs (€100 k on €160 k).

Table 35: *Summary of the cost impact linked to the implementation of the LEA*

Overall costs	2014(2017) - 2020 MFF	2021-2023 *(on average per year)*
Contractor development	€25,000	€2,000
Hardware and Software	€640,000	€100,000
BMS	€2 m	€100,000
Total (rounded)	**€2.7 m**	**€200,000**

4.2 Active-active setup

The cost report has presented results based on the scenario of an active-passive configuration between the CU and the BCU. An active-active configuration can also be envisaged between the CU and the BCU, with the aim of increasing the SLA of the application.

An active-active scenario would have an impact on the application responsible for routing the traffic from the National Sites to the Central System. It would also have an impact on licence costs for BMS and Search Engine software. It could also possibly have an impact on the Quality of Service (QoS) required for the network between the CU and the BCU.

Since the two nodes would need to be able to manage the whole load of the system in case the other fails, the actual sizing of network between the node and the national systems would remain the same as in an active-passive configuration. The hardware requirements of the node would also remain the same for the same reason.

4.2.1 Contractor development

Active-active configurations are highly specific to the subject that needs to be adapted. In particular in the case of the Smart Borders node configuration, it should be taken into account that the CU and the BCU are located very far away from each other, meaning that data is more likely to be lost in the transfer from one to the other, and that data replication between the two nodes can create bottlenecks that need to be addressed by software solutions.

A good example to highlight the complexity of the undertaking is the VIS, a system that is live and of which all technical and functional details are set and known, which is also considered for switching for an active-active configuration. In its case, it was deemed necessary to launch a full-fledged Technical Study before reaching to a price conclusion. This study is planned to be undertaken in 2015, and could provide insight for the EES and RTP systems.

In the current stage of the project, it is recommended to leverage on the learnings of the study for an active-active configuration for the VIS in 2015 to further assess the cost impact of an active-active configuration.

4.2.2 Software

Following consultation of leading vendors, it is estimated that the impact of an active-active setup between two nodes of search engine and BMS from a software perspective can be up to twice the cost of an active-passive setup. It can be assumed that this price increase could be slightly reduced with the wider uptake and improvements of active-active and it will be assumed that the price of the licences is 15% lower than the one indicated by vendors, reaching a factor of 1.7 compared to the active-passive configuration.

Table 36: *Cost projection of BMS and Search Engine software for the purpose of an active/active configuration (2017-2020-2024)*

Cost of BMS and Search Engine software	**2014(2017) - 2020 MFF**	**2020-2023** *(on average per year)*
Active-passive *(baseline)*	€43.5 m	€9.7 m
Active-active	€74 m	€16.5 m
Difference between the options *(rounded up)*	€30.5 m	€7 m

4.2.3 Network

Since the two nodes would be working simultaneously, a greater need for data replication between the two sites could be a facilitator to ensure that data is properly stored in both sites. Exchange of data between the CU and the BCU could benefit from lower round-trip times, and therefore a higher QoS for the PTP connexion between the CU and the BCU could be facilitator for the active-active setup.

The TESTA-ng network, on which the network cost calculation is based, currently uses the highest round-trip times available on the market. It is reasonable to assume that by the launch of the project (2020), technological advancements will have made it possible to gain efficiency in data transfer and that it will be possible to achieve better QoS. The cost of this reduction in round-trip times would need to be assessed in a further study when a better QoS is available on the market.

4.2.4 Summary

At this stage of the project, without technical and functional specifications available, the Study is not in a position to provide a complete estimate for an active-active configuration between the CU and the BCU.

However, when simply analysing the pricing obtained for the software components, it can be observed that the impact of active-active on the whole project is substantial, reaching an impact of €30.5 million for this sole component on the period covered by the MFF. The applicative component could also have an important cost impact, with a subset of the active-active configuration being estimated at around €5 million for a smaller-scaled project.

The cost impact of this configuration would need to be further assessed in a separate study.

4.3 Data retention

The Technical Study has looked into several options as regards data retention. For the purpose of providing an estimation of the impact on the cost of data retention, the cost difference between the three main options will be estimated. As the data retention schemes are very complex and suggest different data retention durations depending on the RTP status, they will be simplified for the purpose of the costing, to a uniform 181-days, 1 year or 5 years data retention for EES, and 5 years for RTP.

Throughout the cost report, the option that has been estimated is the one closest to the legal proposal, namely 181 days years data retention for EES and up to 5 years for RTP, and the purpose of this paragraph is to look into the impact of the option of one year and five year data retention starting from last exit for EES and up to five years for RTP.

From a data retention perspective, this option has an impact solely on EES, however, as the cost of the common BMS has be distributed on both system, a change of the data retention option for the EES influence indirectly also the cost of the RTP.

The impact of these options on the number of individual files in the EES database is estimated to be the following:

Table 37: *Projection of the number of individual files in EES (rounded)*[29]

Number of individual files in the EES system (*rounded up*)	**2020**	**2025**
181-days data retention (baseline)[30]	35 m	40 m
1-year data retention	65 m	80 m
5-year data retention	65 m	260 m

However, the BMS would serve not only the EES, but also the VIS and RTP both with 5 years data retention, therefore different values had to be taken into account. The below table summarises the different scenarios considered for the gallery size and the sizing of the BMS.

Table 38: *BMS gallery size for different data retention rules*

Data retention	**Number of records considered**
181-days for the EES, 5 years for the RTP and VIS	60 m
1-year data retention for the EES, 5 years for the RTP and VIS	150 m
5-year data retention for the EES, RTP and VIS	270 m

The main impact on the cost would be on the following cost items described further in the sections below:

- BMS costs:
  - Development costs, as the different data retention would have an impact on the overall sizing of the system and therefore on the development efforts.
  - The hardware and software necessary for the BMS, as a bigger database requires more processing power, and entails higher licence costs.
- Hardware and software costs:
  - The database storage, as a higher amount of individual files means higher storage requirements.
  - The software necessary for the search engine, as the pricing of the licence is correlated to the size of the database.

[29] Please refer to section 7.3.4 of the Technical Study for further information.
[30] The figures are estimated from 1-year data retention figures, presented in section 7.3.4 of the Technical Study.

4.3.1 BMS costs

4.3.1.1 BMS development

The below table summarises the differences of cost for the development effort of the common BMS, at the different data retention rules for the EES.

Table 39: *Comparison of the cost projection for BMS development according to the different data retention rules (2017-2019 initial development)*

Data retention	Number of records considered	Development cost[31]	Difference
181-days for EES, 5 years for RTP and VIS	60 m	€3.7 M	baseline
1-year data retention for EES, 5 years for RTP and VIS	150 m	€5.7 M	€2 M (+54%)
5-year data retention for EES, RTP and VIS	270 m	€5.9 M	€2.2 M (+59%)

4.3.1.2 BMS hardware and software

The required processing power increases proportionally with the amount of data that is required to be searched.

The following prices have been obtained following consultation by vendors. It is important to note that for all the figures presented in this section the baseline is TOM C. As the BMS is common to the two systems, whether the EES and RTP are joint or separate, it does not bring any changes to the below results.

Table 40: *Comparison of the cost projection for BMS hardware according to the different data retention rules (2017-2019 initial development)*

Data retention	Hardware cost[32]	Difference
181-days data retention	€6.7 m	baseline
1-year data retention	€11.8 m	€5.1 m (+77%)
5-year data retention	€15.9 m	€9.2 m (+139%)

Table 41: *Comparison of the cost projection for BMS software according to the different data retention rules (2017-2019 initial development)*

Data retention	Software cost[33]	Difference
181-days data retention	€16.3 m	baseline
1-year data retention	€25.0 m	€8.2 m (+54%)
5-year data retention	€36.3 m	€20.0 m (+123%)

4.3.2 Hardware and software

The reduction of the database influence the overall sizing of the IT infrastructure that support the system, however it is important to note that even if the size of the database is reduced, the number of transactions doesn't change as it depends on the number of border crossings.

[31] Does not include hardware or software licenses.
[32] Included only the initial investment. Testing environments and maintenance or operational costs are not computed here.
[33] Included only the initial investment. Testing environments and maintenance or operational costs are not computed here

In this section only the main area of savings will be presented (storage and search software).

4.3.2.1 Storage

Storage needs are proportional to the amount of individual files in the database, on top of the initial infrastructure cost (e.g. tape library robot, specific racks and enclosures). TOMs have a negligible impact on the cost of storage (~€10,000).

The storage has been sized directly to cover the 1 year data retention, as the difference between one year and half year data retention would have not had made a significant difference on the cost.

Table 42: *Comparison of the cost projection for storage according to the different data retention rules (2017-2019 initial development)*

Data retention	EES	Difference	Joint EES and RTP	Difference
181-days data retention (baseline)	€ 0.28 m	Baseline	€ 0.62 m	baseline
1-year data retention	€ 0.28 m	-	€ 0.62 m	-
5-year data retention	€ 0.67 m	+ € 0.39 m (+ 140%)	€ 1 m	+ € 0.38 m (+ %64)

4.3.2.2 Search Engine software

The cost impact of data retention on search engine software is proportional to the amount of individual files.

In the case of a 5-year data retention period, the software license prices for the search engine will raise over the time as the gallery size increase.

Table 43: *Comparison of the cost projection for search engine software according to the different data retention rules (2017-2019 initial development)*

Cost of search engine software	EES / joint EES and RTP	Difference
181-days data retention (baseline)	€ 2.25 m	baseline
1-year data retention	€ 3.75 m	€ 1.5 m
5-year data retention	€ 3.75 m	€ 1.5 m

In addition to the initial development, in the case of 5 years data retention, the database would progressively increase, requiring further investments for the acquisition of software licenses (totalling at € 4.95 M by 2023, more than double of the total of €2.25 M for 181 days of data retention). Yearly costs would consequently rise over the time, as the below table shows. Over the 7 years period (2017 -2023) the difference between 181 days and 5 years data retention can reach a difference of EUR 2.3 million.

Table 44: *Comparison of the yearly cost of the search engine according to different data retention rules for EES and joint EES and RTP*

	2017	2018	2019	2020	2021	2022	2023	*Total*
181 days (baseline)	€ 0.06 m	€0.06 m	€ 0.5 m	€ 0.5 m	€ 0.5 m	€ 0.5 m	€ 0.5 m	***€ 2.6 m***
1-year	€ 0.06 m	€ 0.06 m	€ 0.83 m	€ 0.83 m	€ 0.83 m	€ 0.83 m	€ 0.83 m	***€ 4.3 m***
Difference against 181 days	***€ 0. m***	***€ 0. m***	***€ 0.33 m***	***€ 0.33 m***	***€ 0.33 m***	***€ 0.33 m***	***€ 0.33 m***	***€ 1.7 m***
5-years	€ 0.06 m	€ 0.06 m	€ 0.83 m	€ 0.89 m	€ 0.96 m	€ 1.02 m	€ 1.09 m	***€ 4.9 m***
Difference against 181 days	***€ 0. m***	***€ 0. m***	***€ 0.33 m***	***€ 0.4 m***	***€ 0.46 m***	***€ 0.53 m***	***€ 0.59 m***	***€ 2.3 m***

4.3.3 Summary

This section summarizes the impact of longer data retention for EES of one or five years when compared to the baseline of 181 days. Cost items impacted are solely related to the IT infrastructure and have been aggregate in hardware and software costs. [34]

One year data retention impact

Table 45: *Cost comparison between 181 days and 1 year of data retention*[35]

Software costs	2017-2020 (MFF period)	2021-2023	Total (2017-2023)
181-days data retention (baseline)	€52.2 m	€20.3 m	€72.5 m
1-year data retention	€73.9 m	€28.2 m	€102.1 m
Difference	€21.7 m	€7.9 m	€29.6 m

Hardware costs	2017-2020 (MFF period)	2021-2023	Total (2017-2023)
181-days data retention (baseline)	€17.7 m	€5.5 m	€23.2 m
1-year data retention	€25.5 m	€7.4 m	€32.9 m
Difference	€7.8 m	€1.9 m	€9.7 m

The total impact of 1 year data retention is:

Impact of 1 year data retention	2017-2020 (MFF period)	2021-2023	Total (2017-2023)
Increase in software costs	€21.7 m	€7.9 m	€29.6 m
Increase in hardware costs	€7.8 m	€1.9 m	€9.7 m
Total	€29.5 m	€9.8 m	€39.3 m

[34] The computations presented in this section make reference to the joint EES and RTP configuration
[35] Software and hardware costs for the BMS are aggregated with the rest of the software and hardware

Five years data retention impact

Table 46: *Cost comparison between 181 days and 5 year of data retention*

Software costs	2017-2020 (MFF period)	2021-2023	Total (2017-2023)
181-days data retention (baseline)	€52.2 m	€20.3 m	€72.5 m
5-year data retention	€79 m	€44.4 m	€123.4 m
Difference	€26.8 m	€24.1 m	€50.9 m

Hardware costs	2017-2020 (MFF period)	2021-2023	Total (2017-2023)
181-days data retention (baseline)	€17.7 m	€5.5 m	€23.2 m
5-year data retention	€32.6 m	€9.2 m	€41.9 m
Difference	€14.9 m	€3.7 m	€18.7 m

The total impact of 5 years data retention is:

Impact of 5 years data retention	2017-2020 (MFF period)	2021-2023	Total (2017-2023)
Increase in software costs	€26.8 m	€24.1 m	€50.9 m
Increase in hardware costs	€14.9 m	€3.7 m	€18.7 m
Total	**€41.7 m**	**€27.8 m**	**€69.6 m**

4.4 Information to travellers and carriers

This section refers to the propositions of the technical study, section 6.2.

The study report provides the possibility for travellers to consult the data relating to them from a Self Web-Service. Also, carriers have a legal obligation to verify the validity of a user's visa; given that under the Smart Borders proposal passports and visas would not be stamped anymore, carriers need to have access to this information through another channel. It can be foreseen that carrier request this information through the same Self Web-Service. It should be noted that the website proposed in TOM N for dispatching RTP membership requests is looked into in the next chapter, and is not mentioned in this section.

This Self Web-Service differs from the other regular transmission channels (e.g. request by phone, by email, to the border guards) by the fact that the website does not require access to the data for enrolment or border check.

This specificity raises data protection concerns, which could be addressed by technological propositions. Indeed, the web-service should only have access to the strict minimum of information required. Also, from a security perspective, it cannot be envisaged that the website have any writing access to the central system.

Therefore, specific infrastructure needs to be set up for the needs of this Self Web-Service. A database containing strictly the necessary information should be setup, linked to the central system via a unidirectional network (data diode). A remaining stay duration service should be created to consult this database, and to present it via a website to the relevant travellers. An access layer should be included to prevent unauthorized access to the database, as well as security measures to prevent undesirable requests. Finally, operators and helpdesk support should be added for the operation of the system.

Only the main costs of this service will be analysed in this section, as others costs (e.g. IT room space, procurement) can either be mutualized in the existing infrastructure/manpower or their costs can be assumed to be negligible compared to the overall envelope.

4.4.1 Contractor development

Pushing information from the central system to the Web Self-Service database would require the introduction of a new functionality in the EES (for authorized entry data) and the VIS (for TCNVH visa status data), which would increase the implementation costs.

Also, an applicative layer should be developed to extract the entry-exit and visa data from the Web Self-Service database, and calculate the remaining duration of the stay as well as the amount of authorized entries remaining for the visa holder.

The development effort for such a service could be envisaged as being similar to the effort required for six tasks, using the model used by DG Taxud.

The tasks could be expected to be the following:

- Retrieve VIS record

- Retrieve EES record

- Compute remaining entries

- Compute remaining duration of stay

- Send remaining entries

- Send remaining duration of stay

The costs of developing six extra tasks can be estimated as follows (assuming that the functionality would be available since the inception of the system(s)):

Table 47: *Cost projection for contractor development for the purpose of the information to travellers and carriers service (2017-2020-2023)*

Cost of contractor development	2017-2020 (MFF period)	2021-2023
Cost of the development of six tasks	€160,000	€12,000 per year on average (7.5% of the initial effort)

4.4.2 Hardware

4.4.2.1 Servers and storage

A database containing the relevant information of travellers should be setup for access by the web-service.

This database should not contain any biometric data, which represent most of the database size (up to 80%). Also, the amount of access requests should be sensibly lower than the amount of accesses required for the EES and RTP databases, as there are at least 3 requests for each traveller and for each entry-exit for EES and RTP databases: enrolment, entry, and exit. The access requests to the web-service database are likely to be at least 2 by traveller and by entry-exit (one by the carrier for TCNVH, between two and three per traveller to check the status of the authorised status of stay).

It can therefore be assumed that the database storage can be sized as $1/5^{th}$ of the EES and RTP database storage, and that the database servers be sized similarly to the EES and RTP database servers.

Given the requirement to keep TCNVH data separate from entry-exit data, a second, similar database could be required to address this obligation.

Finally, the application would require to be run on an application server. The load on the system will depend on the selected software architecture, and for the needs of the costing exercise it can be assumed that the load will be similar to the one on the EES and RTP.

It is assumed that the application server can access both databases (for TCNVH and for entry-exit data).

Table 48: *Cost projection for database hardware for the purpose of the information to travellers and carriers service (2017-2020-2023)*

Cost of database hardware	2017-2020 (MFF period)	2021-2023 *(on average per year)*
Storage	€600,000	€80,000
Database Servers	€640,000	€85,000
Application Servers	€500,000	€23,000
Total (rounded up)	**€1.8 m**	**€190,000**

4.4.2.2 Security measures

The service will be connected to the CU and BCU, as well as hold sensitive information about TCN travellers and the status of their travel authorizations in the Schengen area. An important security infrastructure should be setup around the service infrastructure to warrant the integrity of communication and data exchanged for the purposes of the service.

Firewalls should be setup between each node composing the system. Each central system should be heavily protected from exterior intrusion.

Table 49: *Cost projection for Security for the purpose of the information to travellers and carriers service (2017-2020-2023)*

Cost of security	2017-2020 (MFF period)	2021-2023 *(on average per year)*
Setup costs for two central nodes (CU and BCU)	€1.2 m	€300,000
Setup costs for firewalls between the remaining nodes	€600,000	€150,000
Total (rounded up)	**€1.8 m**	**€450,000**

4.4.3 Website

A website acting as a front-end for the application should be developed to receive the requests and present the result to the end-user. The website should follow the usability guidelines in usage for European websites, be fitted with anti-spam protection and be translated in the most widely-used languages in the world (for travellers) in addition to the European languages (for carriers).

A number of assets will be required, such as domain names, DNS servers, mail servers, a CMS etc…to operate the website. It is assumed that the website project will be subcontracted and that a budget envelope of €1,000,000 will be provisioned to cover development, design, translation, project management and infrastructure costs, with a yearly maintenance of 1/10th of the initial cost.

Table 50: *Cost projection for the website for the purpose of the information to travellers and carriers service (2017-2020-2023)*

Cost of website	2017-2020 (MFF period)	2021-2023 *(on average per year)*
Website, subcontracted, including development effort and infrastructure	€1.1 m	€100,000

4.4.4 Network

The database of the Self Web-Service should be separated from the CU/BCU EES and RTP database. It is assumed that the database is set in a location remote from the CU and the BCU, and that the CU and BCU will communicate with the database through the TESTA-ng network.

For security and data protection purposes, a unidirectional network (data diode) is assumed, so as to prevent access to the CU and BCU via the website.

The addition of this network channel can be estimated to be the same as a PTP connexion between the CU and the BCU.

Assuming that the data is transmitted from the CU/BCU to the database once per day, the bandwidth requirement for the purpose of the website would be at most 270,000,000 (number of individual files in 2025) x 20kb (cautious estimate of an individual user file without biometric data) = 5,400,000,000kb per day = 62,500kb per second = 63mb per second. To account for peaks in usage, and to increase the speed of data transfer to the database, a 1,000mbps line will be considered for the costing exercise.

Table 51: *Cost projection for network lines for the purpose of the information to travellers and carriers service (2017-2020-2023)*

Cost of network lines	2017-2020 (MFF period)	2021-2023 *(on average per year)*
Setup costs	€55,000	€0
Operating costs	€80,000	€80,000
Total (rounded up)	**€135,000**	**€80,000**

4.4.5 Administration

The running of this service should be supported by a helpdesk for the purpose of the Self Web-Service public interface and the Self Web-Service for TCNVH visa status check. The additional cost for the helpdesk of the service can be estimated to be 3 FTEs.

As for security, a dedicated SOC of 3 specialist staff FTE that should be available on a 24/7/365 basis is required, as well as a dedicated staff for firewall security of 1 FTE.

Table 52: *Cost projection for Operational staff for the purpose of the information to travellers and carriers service (2017-2020-2023)*

Cost of operational staff	2017-2020 (MFF period)	2021-2023 *(on average per year)*
Helpdesk	€180,000	€180,000
Security staff	€440,000	€440,000
Total (rounded up)	**€660,000**	**€660,000**

4.4.6 Summary

The cost impact of the Self Web-Service for the purpose of carrier and traveller information is summarised below:

Table 53: *Overall cost projection for the Self Web-Service for the purpose of the information to travellers and carriers service (2017-2020-2023)*

Overall cost	2017-2020 (MFF period)	2021-2023 *(on average per year)*
Contractor development	€160,000	€12,000
Hardware	€3.6 m	€650,000
Website	€1.1 m	€100,000
Network	€135,000	€80,000
Administration	€660,000	€660,000
Total (rounded up)	**€5.7 m**	**€1.5 m**

4.5 RTP online enrolment

The study provides the option for travellers wishing to enrol to the RTP to do so via a dedicated online enrolment website. This section refers to the propositions of the technical study, section 6.2.

It is assumed that the website will only serve the purpose of routing RTP requests to the relevant Member States, and that the administrative process following the reception of the application is for the Member State to finalise.

As such, the website will really only serve as a communication channel between the traveller wishing to enrol and the Member State to which the traveller wishes to send the application to.

This option is considered part of the baseline for the cost estimation.

4.5.1 Hardware, operation and security

The website will not be connected to the CU and BCU, but function on the side, purely for administrative purposes[36]. It is indeed assumed that the aim of the website is not to automate the enrolment process, but simply to communicate a membership request to the Member States, for them to process the application like they would do if they received it at the consular post.

[36] The baseline is TOM M. In the case of TOM N a link to a read only copy of the EES database will be necessary to verify that the person is already enrolled in the EES.

Therefore, the whole infrastructure (hardware and security) could be fully outsourced as "cloud as a service" for a monthly fee. In this case, provided that a dedicated team will not be necessary to oversee the security, operation and maintenance of the service, cost savings of up to 50% can be estimated compared to the purchase of a physical infrastructure and in-house maintenance and security.

The total amount of users for the enrolment website will be at most 9.2 million (amount of RTP users estimated in 2025), representing around 10% of the users for the Self Web-Service for information to travellers and carriers.

The cost for hardware, operation and security (outsourced, as cloud-as-a-service) can be estimated to be the following:

Table 54: *Cost projection for hardware, operation and security of the RTP online enrolment service (2017-2020-2023)*

Cost of hardware, operation and security	2017-2020 (MFF period)	2021-2023
Cloud-as-a-service option (rental)	€100,000	€100,000 per year on average
Internal development/operation option (owned)	€1,000,000	€200,000 per year on average

4.5.2 Website

A website acting as a front-end for the enrolment database should be developed to receive the requests and dispatch them to the relevant Member States. The website should follow the usability guidelines in usage for European websites, be fitted with anti-spam protection and be translated in the most widely-used languages in the world in addition to the European languages.

A number of assets will be required, such as domain names, DNS servers, mail servers, a CMS etc…to operate the website. It is assumed that the website project will be subcontracted and that a budget envelope of €330,000 will be provisioned to cover development, design, localisation, project management and infrastructure costs, with a yearly maintenance of 1/10th of the initial cost.

Table 55*: Cost projection for the website of the RTP online enrolment service (2017-2020-2023)*

Cost of website	2017-2020 (MFF period)	2021-2023
Website, subcontracted, including development effort and infrastructure	€360,000	€30,000 per year on average

4.5.3 Network

The impact of this option on the network is in the transmission of the application files to the relevant Member State.

Assumptions:

1. It is understood in this calculation that the files will be sent from travellers from a personal or public computer, and that the data will originally be transmitted to the database via a public network (the internet). It is assumed that the files will then be sent to the Member States via the TESTA-ng network to allow usage of its security, logging and reporting functionalities.

2. Six files will be sent along with the membership request. This corresponds to two of each type of file requested.
3. Users will be allowed to upload files weighing at most 2Mb.
4. The maximum file usage will be considered for the purpose of costing network impact.
5. RTP applicants will be required to provide supporting documents every year of desired membership.
6. There is no requirement to process the files in real time, and waiting times of up to 24 h for transfer from the website to the Member State, are even acceptable.
7. Half of RTP applicants will be using the online application method.

Since it is assumed that there will be a maximum of 9.2 million RTP applications per year, requiring 6 files that weigh 2 Mb, it can be assumed that total bandwidth requirement would be 9,200,000 x 2 x 6 = 110,400,000 Mb per year, or 110,400 Gb of data per year, which corresponds to an average of 3.5 mbps.

This data will be received from the public internet, then sent via the secure TESTA-ng network to the relevant Member State

The lowest bandwidth considered in the TESTA-ng framework contract being 10 mbps, it will be used for the purpose of the website.

Table 56: *Cost projection for network lines of the RTP online enrolment service (2017-2020-2023)*

Cost of network lines	2017-2020 (MFF period)	2021-2023 *(average per year)*
Setup costs	€38,000	€0
Operating costs	€6,000	€6,000
Total (rounded up)	**€44,000**	**€6,000**

4.5.4 Administration

The running of this service should be supported by a helpdesk. The additional cost for the helpdesk of the service can be estimated to be 2 FTEs.

Table 57: *Cost projection for operational staff of the RTP online enrolment service (2017-2020-2023)*

Cost of operational staff	2017-2020 (MFF period)	2021-2023 *(average per year)*
Helpdesk	€120,000	€120,000

4.5.5 Summary

The cost impact of the Self Web-Service for the purpose of carrier and traveller information is summarised below:

Table 58: *Overall cost projection for the RTP online enrolment service (2017-2020-2023)*

Overall cost	2017-2020 (MFF period)	2021-2023 *(average per year)*
Hardware, operation and security (owned)	€1,000,000	€200,000
Website	€360,000	€30,000
Network	€44,000	€6,000
Administration	€120,000	€120,000
Total (rounded up)	**€1.5 m**	**€360,000**

This estimation has been calculated in absence of technical or detailed functional specifications. The choices that will be done in terms of implementation will influence the cost of this option. In particular, the level of integration with the central system might have a significant impact on the final cost, due to the necessity to put in place a strong security.

4.6 Costs of the system if the EES and RTP systems are integrated with the VIS

This section examines the costs of EES and RTP integrated with VIS. The main points underlying the option for "upgrading" the VIS for the EES and RTP purposes are reusing, evolving and/or adapting existing software assets and technical environment, hosting of alphanumeric and biometric data in the same system (adopting a logical separation of the data and a SOA based architecture for the BMS). For more information about this option, please refer to section 6.4.3 of the Technical Study.

The cost analysis does not have the same granularity as the one of building EES and RTP because a lot of the costs are related to the impact on VIS. In order to do this properly the architecture VIS integrated with EES/RTP would have to be defined more precisely.

The table below presents the costs of developing EES and RTP as an upgrade of the VIS. The cost impact is presented, as a deviation from EES and RTP developed jointly, but independently from the VIS, which is the closest alternative. **The comparison shows that such approach would result in an increase of approximately €39 m (+ 10% of the total cost over 4years).**

Table 59: *Costs of VIS upgrade for the purposes of EES and RTP as deviation from the costs of EES and RTP developed jointly, but independently from the VIS*

Cost item	EES and RTP developed jointly, but independently from the VIS	EES and RTP integrated with the VIS	Deviation	Explanation for the deviation
	3 y of development + 1 y of operations			
Administration & development of the central system	**€130,549,369**	**€133,447,370**	**+2%**	
Title 2 Administrative expenditure				
Communication activities during development phase (meetings reception, translations, information campaign)	€3,565,000	€3,707,600	+4%	The costs for hosting meetings reception costs will be higher because of longer development phase and accordingly higher number of meetings.
Training and meetings during development phase	€5,446,197	€7,461,290	+37%	Training and meetings costs will be higher because of 1 year and 3 months longer development phase (please refer to the estimation of contractor development costs for further information) and accordingly higher number of meetings. The increase is estimated by adding annual meeting costs for one year and 3 months.
Setup of datacentre space	€299,472	€299,472	0	No significant impact
Communication activities during operations (meetings reception, translations)	€100,000	€100,000	0	No significant impact
Training and meetings during operations	€557,265	€167,180	-70%	Training cost after upgrades of the system would be significantly lower. There would be one system and therefore one training budget.
Operations of datacentre space	€377,050	€377,050	0	No significant impact

Cost item	EES and RTP developed jointly, but independently from the VIS	EES and RTP integrated with the VIS	Deviation	Explanation for the deviation
	3 y of development + 1 y of operations			
Title 3 Operational expenditure				
Network infrastructure development	€4,838,530	€4,257,906	-12%	Cost savings could be foreseen if the existing lines used for the purpose of the VIS can be reused for the EES and RTP. The cost savings could be realized on the following items: The majority of lines of the VIS could be reused for the EES and RTP. This would mean that instead of having to create new TAPs and new lines, the existing TAPs and lines could be upgraded to fit the needs of the three systems. Up to 50% of the one-time costs would be saved. Part of the one-time costs for other services would not be required, as the lines would already exist. In order to calculate the order of magnitude of this option, TAPs are considered to be upgraded instead of being created.
Hardware during development phase	€13,442,306	€12,770,191	- 5%	The majority of the cost is coming from the BMS, which is assumed to be a SOA-based BMS serving the needs of the VIS, EES and RTP systems regardless of the scenario. For the rest of the hardware, some synergies could be found between systems, however the raw processing power required for the three systems would be very comparable regardless of the scenario. **It is assumed that a NUI serving the needs of VIS, EES and RTP would be deployed on Member States side, which should require slightly more processing power to take into account VIS.**

Cost item	EES and RTP developed jointly, but independently from the VIS	EES and RTP integrated with the VIS	Deviation	Explanation for the deviation
	3 y of development + 1 y of operations			
Software during development phase	€36,581,176	€34,752,117	-5%	The majority of the cost is coming from the BMS, which is assumed to be a SOA-based BMS serving the needs of the VIS, EES and RTP systems regardless of the scenario. Other software licenses depend on the amount of hardware required, which should not change drastically. The costs of software during development phase would be very comparable regardless of the scenario. A single system would benefit from better pricing from volume discounts on the software licenses.
Contractor development of the central system	€14,114,929	€18,208,258	+29%	Upstream 6 months longer design phase, because of legacy matters; Only additional fields are needed and additional processes to be reworked leading to a 6 months shorter development; The development of the single NUI integrating VIS functionalities would be more complex, therefore the development phase would additionally take 3 months; The testing phase would be 1 year longer due to legacy for the testing (based on SIS II experience). To sum up, **the development phase would be 1 year and 3 months longer.**

Cost item	EES and RTP developed jointly, but independently from the VIS	EES and RTP integrated with the VIS	Deviation	Explanation for the deviation
	3 y of development + 1 y of operations			
Network infrastructure operations	€10,372,210	€9,023,823	-13%	Cost savings could be foreseen if the existing lines used for the purpose of the VIS can be reused for the EES and RTP. The cost savings could be realized on the following items: Part of Member States lines that are foreseen for the EES and the RTP would be sufficient to handle VIS network load as well. The cost for the EES and RTP systems would increase slightly, but there would be no more monthly costs for the VIS, resulting in overall savings. Recurring costs for other services could be shared between the systems. In case the VIS and EES/RTP systems can communicate between each other on the central side, this could reduce the bandwidth required at border control points. These savings would be marginal however, as biometric data (which represents the majority of bandwidth usage) would still need to be sent to the central system. In order to calculate the order of magnitude of this option, VIS bandwidth is added to the bandwidth requirements calculation.
Maintenance of hardware	€4,272,727	€4,059,091	- 5%	The hardware sizing will vary little regardless of the scenario, and maintenance costs should not be impacted by the sizing of the hardware.
Maintenance of software	€15,619,269	€14,838,306	- 5%	The software sizing will vary little regardless of the scenario, and maintenance costs should not be impacted by the sizing of the software. However, the likelihood of a homogeneous technical environment would be higher if the EES and RTP would be envisaged as an extension of the VIS, resulting in maintenance cost reduction. This cost reduction could however be offset by the possible gains of efficiency that would be gained by switching to newer, better technology.

Cost item	EES and RTP developed jointly, but independently from the VIS	EES and RTP integrated with the VIS	Deviation	Explanation for the deviation
	3 y of development + 1 y of operations			
Contractor operations of the central system	€2,063,239	€1,609,326	-22%	Yearly incurring changes/ developments would immediately benefit 3 systems so the cost benefits of contractor operations would be improved.
External staff for contract management, grants management	€14,556,000	€18,340,560	+26%	Reduced because of: • 4 FTEs less (2 less for grants management, 1 less for contract management and 1 less for technical support) would be needed during the development phase. Increased because of: • Longer development phase.
External staff for monitoring the system, helpdesk	€4,344,000	€3,475,200	-20%	Savings of 6 FTEs, because less staff would be needed to manage operations.
Development of national systems	**€250,500,000**	**€286,539,960**	**+14%**	
Title 2 Administrative expenditure				
Training and meetings during development phase	€0	€0	0	Costs excluded from the model
Setup of datacentre space	€0	€0	0	Costs excluded from the model
Training and meetings during operations	€0	€0	0	Costs excluded from the model
Operations of datacentre space	€0	€0	0	Costs excluded from the model
Title 3 Operational expenditure				
External staff for contract management, grants management	€91,080,000	€99,003,960	+8.7%	Increased because of longer testing phase.
Hardware during development phase	€0	€0	0	No hardware costs are foreseen on the member states' side during the development phase.[37]
Software during development phase	€0	€0	0	No software costs are foreseen on the Member States' side during development phase.
Contractor development	€120,000,000	€156,000,000	+30%	The integration costs of the NUI will be higher because of: • more complex NUI integrating VIS functionalities; • 1 year longer testing phase.

[37] The assumption is that the NUI would replace the existing national VIS systems. While the NUI would require a slightly stronger hardware, it is considered part of the central domain and covered by the central envelope and therefore no impact appears under the development of national systems.

External staff for monitoring the system, helpdesk	€39,420,000	€31,536,000	-20%	No additional staff to monitor the system. The single system could be monitored by the staff already operating the VIS.
Maintenance of hardware	€0	€0	0	No hardware costs are foreseen on the member states' side during operation phase.[38]
Maintenance of software	€0	€0	0	No software costs are foreseen on the member states' side during operation phase.
Contractor operations	€0	€0	0	No contractor operations costs are expected on the Member States' side during operations, because the NUI will be maintained by eu-LISA.
TOTAL	**€381,049,369**	**€419,987,330**	**+10%**	

4.7 Costs of the system if VIS artefacts are re-used for the EES and RTP (progressive approach)

This section of the report provides estimates for the costs of progressive approach option i.e. EES and RTP development re-using VIS artefacts, the selection of which being subject to a further study. The option of progressive approach seeks to simplify the built of EES and RTP systems by re-using the VIS components and facilitating the development and testing into operations. The options also suggests that EES and RTP should be built in such a way that synergies could be achieved in the future allowing smooth integration of the VIS processes if needed.

Risk mitigation would be the main advantage of this approach, in fact, the implementation of the EES and RTP would be independent from the VIS in terms of legal basis and infrastructure. However, the benefits deriving from the synergies among EES, RTP and VIS would not be available until the completion of the full integration with the VIS, which would require further investments.

More details about this option please refer to section 6.4.4 of the Technical Study.

The costs of EES and RTP development re-using VIS artefacts are presented in the table below as deviation from the costs of EES and RTP development jointly, but independently from the VIS. The estimation is provided for the development phase and the first year of operations. Thus it does not cover future potential of VIS integration into EES and RTP:

- Decrease of network infrastructure operations costs, as only one network for 3 systems will be needed if legislative instrument is adapted;
- One training budget, therefore lower training costs;
- Reduced maintenance costs;
- Reduced contract management and other administrative costs because of only one platform/ network;
- Lower operational costs, as less FTE will be needed for operating the systems.

This approach would allow a reduction of €4.5 m (-1% of the total cost over 4 years) if compared against the option of EES and RTP developed jointly, but independently from the VIS.

[38] The maintenance of the NUI (hardware and software) is assumed to be part of the central domain and to be paid from the central envelope.

Table 60: *Costs of the EES and the RTP development re-using VIS artefacts as deviation from the costs of EES and RTP developed jointly, but independently from the VIS*

Cost item	EES and RTP developed jointly, but independently from the VIS	Progressive approach	Deviation	Explanation for the deviation
	3 y of development + 1 y of operations			
Administration and the central system	**€130,549,370**	**€126,032,593**	**-3%**	**-**
Title 2 Administrative expenditure				
Communication activities during development phase (meetings reception, translations, information campaign)	€3,565,000	€3,565,000	0	No significant impact
Training and meetings during development phase	€5,446,197	€5,446,197	0	No significant impact
Setup of datacentre space	€299,472	€299,472	0	No significant impact
Communication activities during operations (meetings reception, translations)	€100,000	€100,000	0	No significant impact
Training and meetings during operations	€557,265	€557,265	0	No significant impact
Operations of datacentre space	€377,050	€377,050	0	No significant impact
Title 3 Operational expenditure				
Network infrastructure development	€4,838,530	€4,838,530	0	No impact, as network would be developed independently, as legal framework does not allow to use the VIS infrastructure for the purposes of EES and RTP purposes
Hardware during development phase	€13,442,306	€13,442,306	0	No significant impact
Software during development phase	€36,581,176	€36,581,176	0	No significant impact

Cost item	EES and RTP developed jointly, but independently from the VIS	Progressive approach	Deviation	Explanation for the deviation
	3 y of development + 1 y of operations			
Contractor development of the central system	€14,114,929	€9,598,152	-32%	Reduced because of: re-use of the VIS artefacts and therefore faster development phase. The estimation is done by comparing VIS processes, tasks and messages with EES and RTP processes, tasks and messages. Increased because of: cost customisation overhead (40%), as despite the similarities with EES and RTP, the initial design would be more complex and the VIS artefacts will have to be modified. e. g., the task of reporting is similar for all the systems, however additional efforts will be needed to modify the VIS specification of the task for the purposes of the EES and RTP.
Network infrastructure operations	€10,372,210	€10,372,210	0	No significant impact
Maintenance of hardware	€4,272,727	€4,272,727	0	No significant impact
Maintenance of software	€15,619,269	€15,619,269	0	No significant impact
Contractor operations of the central system	€2,063,239	€2,063,239	0	No significant impact
External staff for contract management, grants management	€14,556,000	€14,556,000	0	No significant impact
External staff for monitoring the system, helpdesk	€4,344,000	€4,344,000	0	No significant impact
Development of national systems	**€250,500,000**	**€250,500,000**	**0**	**-**
Title 2 Administrative expenditure				
Training and meetings during development phase	€0	€0	0	Costs excluded from the model
Setup of datacentre space	€0	€0	0	Costs excluded from the model
Training and meetings during operations	€0	€0	0	Costs excluded from the model
Operations of datacentre space	€0	€0	0	Costs excluded from the model

Cost item	EES and RTP developed jointly, but independently from the VIS	Progressive approach	Deviation	Explanation for the deviation
	3 y of development + 1 y of operations			
Title 3 Operational expenditure				
External staff for contract management, grants management	€91,080,000	€91,080,000	0	No significant impact
Hardware during development phase	€0	€0	0	No hardware costs are foreseen on the Member States' side.
Software during development phase	€0	€0	0	No software costs are foreseen on the Member States' side.
Contractor development	€120,000,000	€120,000,000	0	No significant impact
External staff for monitoring the system, helpdesk	€39,420,000	€39,420,000	0	No significant impact
Maintenance of hardware	€ 0	€ 0	0	No hardware costs are foreseen on the Member States' side.
Maintenance of software	€0	€ 0	0	No software costs are foreseen on the Member States' side.
Contractor operations	€0	€0	0	No contractor operations costs are foreseen on the Member States' side during operations, because the NUI will be maintained by eu-LISA.
TOTAL	**€381,049,369**	**€376,532,593**	**-1%**	

5 Member State toolbox

5.1 Introduction

Goal:

The goal of the MS toolbox is to enable each Member State to compare the capacity of its existing systems, infrastructure and administrative resources to the set of requirements to implement the EES and RTP services at national level. Subsequently, Member States should be able to estimate the investment that might be needed. This assessment will take into consideration that several Member States already have national EES and/or RTP systems.

Objective:

The purpose of creating "*a Member State (MS) toolbox*" is to provide the necessary information allowing Member States to estimate the magnitude of the costs that they will need to fund using national budgets. Thus, Member States will be able to better understand the costs that are excluded from the Smart Borders financial package.

The main objective of this MS toolbox is to have a comprehensive overview of the cost items to be expected at Member State level. It does not deal with the funding aspects.

5.2 Approach

The structure of the "MS toolbox" will follow a "building block" approach. This means that average standard costs will be provided, where possible, for components of the complete solution.

The structure of the "MS toolbox" was designed in close cooperation with some Member States that have expressed interest to participate at teleconferences held on 10/07/2014 and on 31/07/2014, during which they agreed on the proposed conceptual structure and provided valuable comments on additional cost components.

Some items in the "MS toolbox" are very Member State specific, such as the customisation or expansion of existing systems and infrastructure, and therefore will require an assessment done by each Member State.

The MS toolbox includes the following information:

Three different categories indicate the main components that are needed for the establishment of EES and RTP systems (e.g. border equipment, national infrastructure and network, human resource costs). These three categories have been classified under three layers (border, consulate and law enforcement access).

- **Border equipment:** indicates the type of border equipment/biometric devices defined in the Technical Study.
- **Human resources**: indicates human resource costs and makes a distinction between in-house staff and external contractor staff.
- **National infrastructure and network**: indicates the cost for the creation of new infrastructures or adaptation of existing ones for implementing the EES and RTP at national level.

- **Quantity:** indicates the required quantity per component item. Member States should make their own assessment and estimate the quantity they need.
- **Unit price**: indicates an average unit price per component item, when it is possible.
- **Unit**: indicates the type of price measurement (e.g. project cost, price/m², man-days)

- **Acquisition and installation cost:** total estimation for the one-time cost of acquisition and installation for each type of component. Depending on the procurement followed, the price of the installation might be already part of the acquisition cost or just added on top of it.

- **% Maintenance per year**: indicates the maintenance cost (e.g. hardware and software) of each component item in % of acquisition cost.

- **Annual costs (i.e. Yearly maintenance costs, Yearly maintenance/operational costs):** indicates the maintenance or operational costs for one year

5.3 How is the MS toolbox expected to work?

Member States will perform their assessment for each type of border (e.g. air, land and sea) based on the "MS toolbox" provided to them by the European Commission once the final specifications of the Smart Borders systems and processes are available.

The "MS toolbox" is a conceptual tool that will provide Member States with a list of cost components and cost items. It will be the responsibility of each Member State to assess its national infrastructure, estimate its needs and perform cost assessments taking into account local factors. Thus, each Member State will:

- Assess the quantity of border/consular equipment that would be needed;
- Assess the costs linked to existing national systems, applications and national communication networks;
- Assess its administrative capacity and whether in-house resources or external contractors will be used to manage and operate national EES and RTP (e.g. IT staff and project management).

Below are a few guidelines for the use of the Excel tool:

- Each country should differentiate between air, land and sea borders where applicable.
- Only the additional costs generated by the introduction of the EES and RTP should be calculated. In several cases, it will be possible to re-use existing infrastructures and devices (e.g. passport readers, workstations and FP readers used for the VIS).
- The one-time set-up costs (acquisition of equipment or project cost) are differentiated from the recurrent yearly costs.
- Costs are attributed to the EES project first and only the marginal cost for adding the RTP system should be added. In other words, costs are attributable to RTP only when these costs only occur when RTP is implemented, like in the case of staff dedicated to processing RTP applications for example.
- The "ABC gates" line includes a fully equipped ABC gate (including passport and biometrics readers)

Cost components covered by the Excel tool:

- Border equipment
  - Border equipment
  - Consulates / Embassies equipment
  - LEA equipment
- Human resources
  - Border control human resources
  - Consulates / Embassies human resources
  - LEA human resources
- National infrastructure
  - Border control national infrastructure
  - Consulates / Embassies national infrastructure
  - LEA national infrastructure

The structure of the "MS toolbox" was presented to the Member States that have expressed interest to participate at teleconferences held on 10/07/2014 and on 31/07/2014, during which they agreed on the proposed conceptual structure and provided valuable comments on additional cost components.

6 Options for the Pilot

The Pilot's objective is to test the potential options in operational and relevant environments in order to decrease the risks related to the development and full implementation of EES and RTP in the Schengen Area. For instance the checks should be made on accuracy, effectiveness, and quality of the solution as well as on the impact on the border crossing duration.

The Pilot would not cover a full end-to-end test of EES and RTP due to time and budget constraints. Hence, the objective would be to test significant parts or components of the solution and conclude on the results.

The results of the Pilot would provide a greater degree of certainty on the feasibility of the options chosen for designing the future system(s) and processes.

The options for the pilot are selected based on the following criteria:

1. Additional evidence is needed to verify the expected impact;
2. Need to test possible process changes;
3. Requirements for specific technical solutions and need to test related constraints or possibilities;
4. Results from TOMs analysis indicating the options that add duration and/or complexity.

The following table lists the proposed options for the Pilot. It is structured by:

1. Border control processes and use of biometrics
2. Process accelerators
3. Other relevant items

For each option, and where applicable, the type of technology to be used, the type of border and the environmental conditions to be tested are identified and marked as '**x**' in the following table.

It should be noted that the main cost drivers of the final budget of the Pilot will depend heavily on (i) specifications of the Pilot, (ii) sample size for test items and (iii) inclusion or exclusion of AFIS vendors, e.g. to borrow or buy their equipment.

The expected timeline of the Pilot and an effort to be made is the following:

Table 61: *Pilot phase planning and duration*

Phase	Duration	eu-LISA's effort
Design	Sep'14 – Feb'15	4FTE + external contractor
Execution	March'15 – Sep'15	4FTE + external contractor
Reporting	Oct'15 – Dec'15	4FTE + external contractor

The following actions should be undertaken during the design phase:

- Analyse the usability of the test AFIS-as-a-service to assess whether the test AFIS can be hosted in MS site and store real data.
- Define a testing strategy to ensure common understanding and approach between key stakeholders for achieving the expected outcome.
- Draft a testing roadmap to further precise the overall approach and its magnitude and include a more detailed planning of the project.
- Provide detailed test instructions (test cases) on what to be tested, under which conditions, on which population, with which device, with what outcome, etc.

The following assumptions can be drawn for the execution phase:

- For the purpose of the test at least two of the best available FP readers should be selected (e.g. one contact FP reader and one contactless FP reader).
- The Pilot should be carried out in waterfall method, i.e. as many items as possible should be tested in one BCP in order to proactively adapt the execution of the testing and minimise additional effort required to set-up and monitor the testing.
- At least six border control points should be included to the Pilot (e.g. two airports, two land and two seaports).
- The number of MS where tests will be carried out should be kept to what is necessary and not increased for courtesy reasons. There should be a good balance between different MS and BCPs to cover the whole of the EU. For example MS with higher capacity – the ones who can provide more BCPs for testing, who have higher traveller flows or who already have relevant suppliers/contracts in place - should be preferred.
- Equipment and integration costs:
    - Possibility to borrow the equipment from the AFIS vendors should actively be looked for. If an AFIS test environment cannot borrowed, €1800 per month per AFIS test suite should be provisioned for leasing the equipment.
    - One of the main cost items of the Pilot is the integration costs of the new devices into the existing systems at BCPs (i.e. to make the existing equipment to work differently). These costs can be refunded by EC through eu-LISA to the participating Member States. The following high level estimation can be made:

Table 62: *Price estimation and list of assumptions for the execution phase*

Item	Number of items and price	Assumptions
Number of FP scanners (for 4 and 8 fingers)	8 x 2	Testing the four types of border twice, across several MS, using devices produced at least by 2 different manufacturers, reaching 16 total devices.
Integration cost per FP scanner per MS	€11,200	16 man-days to work on software (4 man-days to analyse; 5 man-days to develop; 2 man-days to test and 4 man-days to install) at a daily rate of €700
Total	**€179,200**	
Number of facial image scanners	6 x 2	Testing three types of border twice, across several MS, using devices produced at least by 2 different manufacturers, reaching 12 total devices.
Integration cost per facial image scanner per MS	€7,000	10 man-days to work on software (2 man-days to analyse; 2 man-days to develop; 2 man-days to test and 2-4 man-days to install) at a daily rate of €700
Total	**€84,000**	
Searching VIS based on document number, not using the visa-sticker number	2	2 BCPs
	€10,000	Development cost to change existing MS border management system to perform the second line check can be done straight away
Total	**€20,000**	
Number of iris scanners	4 x 2	Testing two types of border twice, across several MS, using devices produced at least by 2 different manufacturers, reaching 8 total devices.

Integration cost per iris scanner per MS	€28,000	40 man-days to work on software (10 man-days to analyse; 15 man-days to develop; 5 man-days to test and 10 man-days to install) at a daily rate of €700
Total	**€224,000**	
TOTAL INTEGRATION COSTS	**€507,200**	

To carry out the Pilot an approximate effort of 11 FTEs of a core team over 16 months[39] can be estimated. The required profiles of the team include Project Managers, Technology Analyst, Business Analysts, Security and Infrastructure Analysts, Test Engineers, Project Support Officer and Biometrics expert.

The assumption for the following calculation is that 4 FTEs out of 10 FTE can be staffed by eu-LISA and the rest need to be outsourced. The latter is calculated as contractor costs in the following table:

Phase (main activities)	**Resource effort**
Design phase (definition of use and test cases)	7 FTE x 120 man-days x €600 = €504,000
Execution phase (setting up, executing and monitoring test cases)	7 FTE x 140 man-days x €600 = €588,000
Reporting phase (analysis and reporting of the results)	7 FTE x 80 man-days x €600 = €336,000

Overall costs of the pilot can be estimated as follows:

Table 63: *Overall cost estimations for the pilot*

Cost items	Cost estimation	Comment
Equipment leasing costs (provisional)	€150,000	In case equipment cannot be borrowed from vendors
Equipment integration costs	€507,200	
Meetings costs (MS experts)	€72,000	The pricing parameter for the meetings is the average cost per expert which is €600; 2 experts from 6 MS to be participate in 10 meetings 600x12X10
Travelling costs (eu-LISA team)	€108,000	Test of Pilot will last 15 months in total. Core team of eu-LISA is 4 FTE Maximum 3 travels per FTE per month 600x4x3x15
Contractor costs	€504,000 €588,000 €366,000	For the design phase For the execution phase For the reporting phase
Total	**€2,295,200**	

[39] The preparation phase of the Pilot started in September 2015

Options for the Pilot	Specific Objective		New technology				Border type						Environmental factors			
		Existing technology	Contactless fingerprint scanner	Hand-held scanner	ABC gates	Manual gates	Air	Land				Sea		Equipment Hardware	Equipment Software	Other requirements
								Train	Bus	Road	People in vehicle			*Minimum requirement to carry out the Pilot*		
Border control processes and use of biometrics																
1. Enrol 4 fingerprints at first-line border check (for EES)	**Check:** the feasibility of this solution 1. Process: 1.1. The potential gain in terms of time 1.2. Enrolment process reader operation, environmental conditions 1.3. Size of the scanning area 2. Reader/ ease to collect. 2.1. Reader: functional and technical specs 2.2. Reader: qualifications/user-friendliness 3. Enrolled result (quality) 3.1. FTE/FTA/FAR/FRR etc. 3.2. Results further usage in BCP	x	x	x			x	x		x	x	x	x	- Hand-held FP readers (new and existing) - AFIS hw	Test AFIS sw + FP test suite	1 x Training to border guards how to carry out the Pilot
2. Enrol 8 fingerprints at first-line border check (for EES)	In addition to the above (reader, process, enrolled result) - evaluate the enrolment time difference between 4FP and 8FP together with human factor - implement the maximum number of quality algorithms as provided by AFIS vendors and NIST	x	x	x		x	x			x				Same readers/AFIS as above + kiosk for unmanned alternative	Test AFIS sw + FP test suite	1 x Training to border guards how to carry out the Pilot
3. Enrol facial image (live)	**Check:** the feasibility of this solution 1. Process: 1.1. The potential gain in terms of time 1.2. Enrolment process reader operation, environmental conditions 2. Reader/ ease to collect. 2.1. Reader: functional and technical specs 2.2. Reader: qualifications/user-friendliness 3. Enrolled result 3.1. FTE/FTA/FAR/FRR etc. 3.2. results further usage in BCP (including fusion) 4. quality of the image you can obtain in the regular border control setting without specific measures (e.g. light or background)	x		x			x	x			x	x	x	4 x hand-held FI scanners + AFIS hw	Test AFIS sw + FI test suite	1 x Training to border guards how to carry out the Pilot
4. Capture photo from e-MRTD and verify it against another source (e.g. live photo or photo in a database)	Check against image taken in the regular border control setting without specific measures (see 3.4) Should address reader/process/outcome. Passive Authentication should be included as a security mechanism. - confirmation about the speed - occurrence of difficulties - number of broken chip, non-connectivity remains low	x					x	x			x	x	x	3 x ABC gates (or required subset) e-MRTD readers	Test AFIS sw	
5. Searching VIS based on document number, not using the visa-sticker number	Test whether this will yield the appropriate match, which would allow to avoid reading the visa sticker and assess the impact on the border control process						x	x	x	x	x	x		- Assumption made that VIS production environment can be used - Existing MRZ readers - MS border management system where the first line check can skip and the second line check can be done straight away		-Analysing what/if VIS must be changed to handle this - Setting up mock-up test with border guards to not to scan/type the visa sticker.
6. Web-interface to the carriers as a technical pilot	Reduce the risk of security in the functionality as it would be the first time when large scale it system will be exposed to outside world (e.g. eu-LISA link to IATA). Study how carriers can retrieve the information from EES.															

Options for the Pilot	Specific Objective		New technology				Border type						Environmental factors			
		Existing technology	Contactless fingerprint scanner	Hand-held scanner	ABC gates	Manual gates	Air	Land				Sea		Equipment Hardware	Equipment Software	Other requirements
								Train	Bus	Road	People in vehicle			*Minimum requirement to carry out the Pilot*		
Process accelerators																
• Enrol Iris	Does iris provide the means to fasten the enrolment? Is it applicable at all the borders?						x			x		x		Iris scanners	Test AFIS sw	
• Use of self-service kiosks • Reading e-MRTD/MRTD • Verify document using PA (and possibly AA) • Capturing fingerprints (4 and/or 8) • Capture photo from MRTD and verify bearer against a live photo • Use of assistance • Make initial checks (or simulate these)	Validate the usefulness, usability and security in relation to using self-service kiosks for registering, checking and enrolling biometrics	x			x		x			x				Self-service kiosk(s) - H/W	Self-service kiosk(s) - S/W	Cabling development of test environment
Using time efficiently in the waiting areas	Validate the feasibility of introducing pre-border checks in the waiting areas of land borders (where such areas exist today). Possibly including self-service kiosks									x						A field visit to Estonia, if necessary a set up of an extra pilot
Exit checks	- Check the process of TCN using ABC gates at exit - Check the time	x			x											Obtain test results from FIN pilot and anlyse it

7 Conclusions

7.1 Final cost estimation

7.1.1 Cost for single EES/RTP and two separate systems

Table 64 below summarises the cost estimations presented earlier in this report. They are presented for the period of four years (2017-2020) and for seven years (2017-2023). The latter is presented in order to obtain the fair comparability with the initial MFF 2014-2020 budget allocation. TOM C and TOM M together with 181-days data retention for EES and 5-years data retention for RTP have been taken as a baseline.

For a four-year period (2017-2020), i.e. three years of development and one year of operations, estimations are:

- Separate development: **€430 m**, i.e. €226 m for EES, €204 m for RTP
- Joint development: **€381 m**

For a seven-year period (2017-2023), i.e. three years of development and four years of operations, estimations are:

- Separate development: **€622 m**, i.e. €326.9 m for EES, €295.4m for RTP,
- Joint development: **€553.1 m**

It appears that the impact of the EES and RTP being developed together would entail a total saving of **€49.4 m** over 4 years **and €69.2 m over 7 years** (for more details, refer to Table 64)[40].

[40] In the previous budget allocation (2014-2020) EES and RTP were only envisaged as separate systems and therefore limited synergies (similar technical platform) of building the systems as one single system was envisaged.

Table 64: *Comparison between EES and RTP as separate systems or developed jointly for the 2017-2020 and 2017-2023 periods*

		EES and RTP: **separate systems**				EES and RTP: **single system**				
	BMS: € 34.5 m NUI: € 3.8 m	**EES**		**RTP**		**EES / RTP**		***Saving compared to separate systems***	***Integrated with VIS***	***Progressive approach***
2017-2020: 3 y dev. + 1 y op.	**CENTRAL (total)**	**€94.81 m**	42%	**€73.24 m**	36%	**€130.55 m**	34%	**€37.5 m**	**€133.45 m**	**€126.03 m**
	Central IT system									
	Contractor development	€12.98 m	6%	€9.97 m	5%	€16.18 m	4%	€6.77 m	€19.82 m	€11.66 m
	Hardware	€10.14 m	4%	€9.18 m	4%	€17.72 m	5%	€1.61 m	€16.83 m	€17.72 m
	Software	€39.32 m	17%	€24.63 m	12%	€52.2 m	14%	€11.75 m	€49.59 m	€52.2 m
	Administration	€14.94 m	7%	€15.06 m	7%	€22.57 m	6%	€7.43 m	€25.62 m	€22.57 m
	Network	€13.75 m	6%	€10.97 m	5%	€15.21 m	4%	€9.51 m	€13.28 m	€15.21 m
	Training and meetings	€3.19 m	1%	€3.07 m	1%	€6. m	2%	€.25 m	€7.63 m	€6. m
	Office space	€.49 m	0%	€.37 m	0%	€.68 m	0%	€.18 m	€.68 m	€.68 m
	NATIONAL (total)	**€131.19 m**	58%	**€131.19 m**	64%	**€250.5 m**	66%	**€11.88 m**	**€286.54 m**	**€250.5 m**
	Contractor development	€60. m	27%	€60. m	29%	€120. m	31%	€. m	€156. m	€120. m
	Administration	€71.19 m	32%	€71.19 m	35%	€130.5 m	34%	€11.88 m	€130.54 m	€130.5 m
	CENTRAL + NATIONAL TOTAL	**€226. m**	100%	**€204.43 m**	100%	**€381.05 m**	100%	**€49.38 m**	**€419.99 m**	**€376.53 m**
		€430.43 m								
2017-2023: 3 y dev. + 4 y op.	**CENTRAL + NATIONAL TOTAL**	**€326.93 m**		**€295.39 m**		**€553.08 m**		**€69.24 m**		
		€622.32 m								

The below table provides the overview of the options that have been considered by this report and whether they have been included in the baseline cost estimation. Further details on these options can be found in chapter 4.

Table 65: *Summary of the cost options (included or excluded from the baseline)*

Variants and options not part of the baseline	*In million*	*Included in the baseline*
LEA		
Development	€2.5	✗
Yearly maintenance	€0.2	
Active- active setup	Not available	✗
Data retention		
1 year (until 2023)	€39	✗
5 years (until 2023)	€69.6	
Information to travellers and carriers		
Development	€4.2	✗
Yearly maintenance	€1.5	
RTP online enrolment		
Development	€1.2	✓
Yearly maintenance	€0.36	
EES and RTP integrated with VIS	€39	✗
Re-using VIS artefacts for the EES and RTP	- €4.5	✗
Facial image		
Development	€5.7	✓
Yearly maintenance	€0.5	
1:n identification		
Development	€4.5	✓
Yearly maintenance	€0.9	

7.1.2 Cost difference between the initial MFF budget allocation and the new estimation for seven year period

It can be observed from (Table 66that the budget allocated for the Smart Borders package in the MFF 2014-2020 (i.e. €791 m) is sufficient to cover the estimated costs for the upcoming period from 2017 to 2020 (3 years of development and 1 year of operations), i.e. €430.43 m if EES and RTP are developed separately and €381.05 m if developed jointly). It also appears that at least four additional years of operation (i.e. 2021-2023) could be covered by the €791 m envelope. [41]

It can be observed that the new estimation is 22% lower (i.e. €791 m - €622.32 m = €168.68 m) than previously when considering the option of development of two separate systems.

If the EES and the RTP are built together, the savings are more substantial, reaching €238 m, i.e. a decrease of 30% compared to the original MFF budget allocation.

Table 66: *Cost difference between the original MFF budget allocation and the new estimation*

	MFF 2014-2020 (7y) *initial*	2017- 2020 (4y)	2021 operational cost	2022 operational cost	2023 operational cost	**2017-2023 TOTAL (7y)**
EES	**€361.3 m**	€226. m	€33.54 m	€33.83 m	€33.56 m	**€326.93 m**
RTP	**€429.7 m**	€204.43 m	€30.28 m	€30.41 m	€30.28 m	**€295.39 m**
EES + RTP as separate systems	**€791 m**	€430.43 m	€63.82 m	€64.24 m	€63.84 m	**€622.32 m**
Joint EES and RTP	**N/A**	€381.05 m	€57.09 m	€57.66 m	€57.27 m	**€553.08 m**
Savings from the joint develop-ment	**N/A**	€49.38 m	€6.72 m	€6.57 m	€6.57 m	**€69.24 m**

The table below presents a more detailed comparison with the original MFF 2014-2020 budget allocation and the new estimation (3 years of development and 4 years of operations) for the EES and RTP developed separately or jointly.

[41] This is theoretical since it will not be possible in practice to commit actions that will take place more than two years after the end of the MFF (i.e. 2022).

Table 67: *Comparison between the original 2014-2020 MFF budget allocation and the new estimate for the period 2014-2020*

	MFF 2014-2020 (7 years) *initial*	**2017-2023 (7 years)** *new estimation*	**MFF 2014-2020 (7 years)** *initial*	**2017-2023 (7 years)** *new estimation*	**2017-2023 (7 years)** *new estimation*
	EES and RTP: separate systems				EES and RTP: single system
	EES		**RTP**		**EES/RTP**
Development Central System	€23.39 m	€57.23 m	€33.64 m	€44.21 m	€82.65 m
Development Member States	€110.4 m	€111.48 m	€126.22 m	€111.48 m	€211.08 m
Maintenance Central System	€7.32 m	€53.49 m	€46.63 m	€40.61 m	€69.31 m
Maintenance National Systems	€169.02 m	€78.84 m	€186.98 m	€78.84 m	€157.68 m
Network	€50.06 m	€21.82 m	€33.37 m	€16.34 m	€24.68 m
Infrastructure Member States	€1.11 m	€4.07 m	€2.86 m	€3.91 m	€7.68 m
Total costs	**€361.3 m**	**€326.9 m**	**€429.7 m**	**€295.4 m**	**€553.1 m**

7.1.3 The main deviations compared to the original MFF budget allocation are:

The table below describes the main deviations compared to the original MFF 2014-2020 budget allocation, more details are provided after the table.

Cost reduction	**Cost increase**
• Difference in the financial timeline, as the Smart Borders proposal will take later than initially foreseen and therefore three years of development and one year of operation are considered; • Suggested use of the e-MRTD as a single token, representing a total saving of €15 m compared to the previous ad-hoc token solution; • Suggested joint development and maintenance of EES and RTP impacting costs positively; • Shift of the MS infrastructure costs to the central level as result of the introduction of the NUI, which would be developed and deployed centrally, and which reduces the complexity of the systems at Member States' side, which applies on 30 countries and allows savings of resources for maintaining and operating the systems; • Exclusion of the financing of the costs related to the hosting of the Infrastructure in Member States, on the assumption that the systems will be installed in existing premises in Member States and that the EU budget would not be used to support construction or rental of IT premises. • Reduction of initial investment which has an	• Increased number of Member States (30) considered; • Higher software costs than what was in the MFF provisions; • Increased number of training courses and meetings. • Facial image as biometric identifier in combination with FPs. The addition of the software for supporting the facial image in the BMS would increase its cost up to 20-25%.

impact on operational costs; • Lowered network costs due to prices offered by the new contractor; • Reduction of administration costs because of lower number of FTEs identified for monitoring the systems at national side.	

Contractor development costs

The main deviations can be explained by:

- The difference in architectural solution – the central development of a National Uniform Interface has been included;
- The different methodology used to estimate contractor development costs.

Administration costs

The main differences can be explained as follows *(for more details please refer to section 2.3)*:

- The coordination of NUI development and grant management have been included; overall, the administration development costs related to the central system development and operations were underestimated in the original budget allocation.
- Administration costs related to the development and maintenance were considerably overestimated in the original budget allocation; consultations with experts having experience with national systems show that if a NUI solution is used and there is no copy of the data at national level, 1 FTE should be enough to operate the system.

Network costs

The difference is mainly explained by the following *(for more details please refer to section 2.4)*:

- The prices offered by the new contractor providing the TESTA-ng network infrastructure are much lower than the ones offered by the previous contractor.
- Every line has been sized to be used as effectively as possible under the constraints of the current contract. Where possible, lines have not been oversized.
- The roll-out of the network is assumed to take place gradually, which helps generating savings on yearly costs.

Hardware costs

The difference is mainly explained by the following *(for more details please refer to section 2.5)*:

- The initial MFF budget allocation expected that Member States would be building national EES and RTP systems. The new approach considers the development and deployment of the NUI, effectively transferring the cost from National side to Central side. The hardware maintenance costs have also been assigned to the Central side.
- The methodology used differs from the one of the original budget allocation: BMS hardware is estimated based on vendor input, NUI hardware is benchmarked on the Interconnection box used for SIS II, and the rest of the hardware is benchmarked on the currently existing VIS hardware, sized to match the requirements of the EES and RTP systems. The original budget allocation was based on self-developed estimates on the basis of the consultant's project experience.

Software costs

The difference is mainly explained by the following *(for more details please refer to section 2.5)*:

- The cost of the BMS software licences has been estimated through consultations with vendors and by looking at the existing BMS cost. It has a very important impact on the overall cost, both in terms of acquisition cost and of operational cost.
- The cost of the Search Engine licence, one of the biggest cost items of the software, has been estimated through consultations with vendors and by looking at the VIS experience. It has high yearly cost, significantly higher that what was in the provisions of the MFF which did not assume this type of Search Engine.
- The cost of the database and application software licences has been estimated by applying the prices of the DIGIT's software framework contract to the number of cores estimated with the hardware sizing.
- For the MS infrastructure, the Central Authority would commission the development of the NUI and retain the ownership of the source code. As a consequence no licence cost is foreseen for the infrastructure at the MS but integration costs are added at national level under the development costs.

Training courses and meetings

The main deviations can be explained by the following *(for more details please refer to section 2.6)*:

- Four more MS have been taken into account;
- Additional meetings for grant management are expected.

Office space

The main deviation from the original MFF budget allocation appears because the updated model includes setup and operational costs of the backup central site, whereas the original MFF budget allocation covered only rental costs of the office space for the external contractor team. For more details please refer to section 2.7.

7.2 Impact of building a NUI as opposed to having Member States build their own infrastructure to connect to the Central System

The Study proposes to add a NUI layer between the Central System and Member States to allow Member States to connect to the Central System without having to deploy additional infrastructure. It will also serve the purpose of having a unified layer that is easier to maintain and presents less risks than having up to 30 different infrastructures.

The Central Authority will have the responsibility of developing the NUI and to deploy it on the Member States' side. This will ease the new release deployment process, as there will constantly be only one version of the application available for all Member States.

From a cost perspective, the following impact can be foreseen:

1. **Removal of the provision for a national infrastructure:** The national infrastructure, including hardware and software will not be required anymore, as the NUI will overtake this role allowing connecting existing National Systems already existing.
2. **Reduction of the administrative costs:** The administrative costs related to the operation and maintenance of the national infrastructure will be greatly reduced as a single infrastructure will have to be maintained.

3. **Addition of the development costs for the NUI:** The NUI will be developed operated and maintained by the Central Authority.

4. **Provision for an envelope for the integration of MS to the NUI:** Since MSs will still have to connect and adapt their existing border control system for the purposes of the EES and RTP a provision will be made for to encompass these costs. A fixed sum is provisioned for each Member State, out of which an amount will be granted depending on the complexity of the integration. The provisioned budget is therefore not completely representative of the costs, as the cost will depend very much on the needs of each MS.

Overall, it can be estimated that a part of the provisioned envelope for the integration of MS to the NUI will not be granted to the MSs, as the fixed amount provisioned is foreseen to cover the most complex integration cases which should therefore not be encountered for each and every MS.

Table 68: *Comparison between the initial MFF budget allocation and the new estimate considering the MS infrastructure and costs covered by the central envelope*

	MFF 2014-2020 (7 years) *initial*	2017-2023 (7 years) *new estimation*	Difference
EES	**€280.5 m**	**€190.32 m**	€90.18 m
RTP	**€316 m**	**€190.32 m**	€125.68 m

7.3 Budget split between national side and central side

The share of the newly estimated budget that is dedicated to Member States' expenditures and to Central Authority expenditures is presented below.

Table 69: *Budget split between national side and central side*

	Expenses at MS level	Expenses at Central Authority's level	Total
2017-2023 (7 years) *new estimation: separate systems*	**€380.6 m** (61%)	**€241.7 m** (39%)	**€622.3 m**
2017-2023 (7 years) *new estimation: Single system*	**€368.8 m** (67%)	**€184.3 m** (33%)	**€553.0 m**
MFF 2014-2020 (7 years)	**€596.5 m** (75%)	**€194.3 m** (25%)	**€790.8 m**

The budget allocated to the MS and the Central Authority has been reduced. The main difference between initial and new estimation is that the costs of the development and maintenance of the NUI has been attributed to the Central Authority. This removes the burden on the Member States to build their own infrastructure and therefore reduces their costs.

7.4 Distribution key

This section of the Study proposes alternatives for distributing the amount identified to cover national costs. These cost items are:

- Contractor development – external contractor costs relating to NUI integration;

- Administration of hardware and software development – administrative costs relating to NUI integration, such as coordination of the integration project, grants management, etc.;
- Administration of hardware and software operations – external staff costs for systems monitoring.

Two alternatives could be considered for sharing national costs:

- Fixed amount – each MS would be entitled to the exact same contribution amount;
- Distribution based on apportionment formulas – MSs would be entitled to a different contribution amount based on pre-defined criteria.

The table below presents the proposed alternatives for different cost items.

Table 70: *Reasoning of alternatives for distributing national costs*

Cost item	Proposed alternative for sharing the costs	Assumption
Title 3 Operational expenditure		
Administration of hardware and software development	Fixed amount	The majority of administrative functions related to the coordination of NUI integration could be assigned to the current internal staff at MS's authorities without additional costs. If necessary, a fixed amount can be distributed to the MSs to hire additional external staff to cover any competency gaps.
Administration of hardware and software operations	Fixed amount	Additional cost of one FTE is provisioned to operate the system at national level.
Contractor development	Distribution based on the maturity of IT infrastructure	The level of IT infrastructure maturity would be the main factor to determine the required amount of contractor development costs to accurately understand the effort and the cost of integration. To identify the level of IT infrastructure maturity and the contribution required, the feasibility studies /surveys need to be carried out in all the MS beforehand. For instance, in order to reflect the diversity of current IT systems for border controls in the MS (in terms of technology, architecture and status), different types of IT situations in MSs could be determined. As a theoretical indication, criteria such as the following could be used to identify the situation of MSs. Please note that this should be taken as an indication of a possible distinction criteria only, and is subject to change when precise functional and detailed specifications are available for the NUI: • Type 1: The existing IT system has been built using flexible/modular architecture such as Service Oriented Architecture and it will be upgraded to support the new

		functionality (NUI). MSs that have implemented integration buses will need minimal investment, as the buses enable connectivity and transformation in heterogeneous IT environments covering a range of platforms. • Type 2: The existing IT system has been built using older technology (which is monolithic, not modular) and it will be upgraded to support the new functionality. Depending on the attribution model that will be decided in the future, the provision for 5 FTEs will be provided for the duration of the required adaptation of the MSs infrastructure, with the maximum total cost by MS being the size of the provisional envelope for each MS.

Appendix A. – Parameters for the estimation of the development costs

The tables below show the processes, tasks and messages to get numbers of them which are used as parameter for the developed costs estimation based on DG TAXUD methodology. Since both EES and RTP will be newly developed systems, as opposed to upgraded ones, a change will occur in all of the processes, therefore the number of (new) processes and the number of processes where a change occurs is the same.

It should be noted that these processes and tasks are subject to change, and are used in this report for costing purposes only. The final processes and tasks retained will be decided during the drafting of the functional specifications, at a later stage in the project.

Table 71: *Parameters for the estimation of the RTP development costs*

Process	Task	NSRequest	CSResponse
Application	CreateApplication	v	v
	UpdateApplication	v	v
	LinkApplication	v	v
	UnlinkApplication	v	v
	DeleteApplication	v	v
	CreateApplicationWithSearchByFingerprint	v	v
	PaymentsOfApplicationRequests	v	v
Decision	CreateApplicationDecision	v	v
	Variant: CloseApplication, DiscontinueExamination, GrantRTP, RefuseRTP		
	CreateRTPCreationDecision	v	v
	CreateRTPDecision	v	v
	Variant: AnnulRTP, ExtentRTP, RevokeRTP, ShortenValidityPeriodRTP		
	CorrectApplicationDecision	v	v
	Variant: CloseApplication, DiscontinueExamination, GrantRTP, RefuseRTP		
	NotifyApplicant	v	v
	DeleteDecision	v	v
UsageOfData	Search	v	v
	Variant: ApplicationExamination, IdentificationBorder, IdentificationTerritory		
	Retrieval	v	v
	Variant: ApplicationExamination, IdentificationBoder, IdentificationTerritory, VerificationBorder, VerificationTerritory		
	RetrieveBiometricData	v	v
	RetrieveFacialImageData	v	v
	RetrieveApplicationWithFullDecisionHistory	v	v
	ListApplicationsInDossier	v	v

	Variant: ApplicationExamination, Other		
	ListBiometricData	v	v
	ListFacialImageData	v	v
	SearchByFingerprint	v	v
	Variant: ApplicationExamination, IdentificationBorder, IdentificationTerritory		
	AuthenticateByFingerprint	v	v
	Variant: AuthenticateByFacialImage		
	Variant: ApplicationExamination, VerificationBorder, VerificationTerritory		
	CheckFingerprintQuality	v	v
Reporting	DefineReport	v	v
	DeleteReportDefinition	v	v
	DeleteReportExecution	v	v
	ScheduleReportExecution	v	v
	ExecuteAdHocReport	v	v
	ReadReportDefinition	v	v
	ReadReportExecution	v	v
	SearchExecutionByOwner	v	v
	SearchDefinitionByOwner	v	v
	SearchDefinitionByAuthorizedUser	v	v
	UpdateReportDefinition	v	v
	UpdateReportExecution	v	v
Attachments	AddBiometricData	v	v
	DeleteBiometricData	v	v
	CopyBiometricData	v	v
Notification	Notification		
	Variant: Standard, OfReporting		
AutomatedReporting	AutomatedDeletionReport		
	AutomatedLogEntryDeletionReport		
ConsultationMechanism	CreateMessage	v	v
	DeleteMessage	v	v
	LinkMessage	v	v
	UnlinkMessage	v	v
	GroupMessage	v	v
	UngroupMessage	v	v
Total number of processes	**Total number of tasks**	**Total number of messages**	
8	**58**	**90**	

Table 72: *Parameters for the estimation of the EES development costs*

Process	Task	NSRequest	CSResponse
Entry	CreateEntry	v	v
	UpdateEntry	v	v
	DeleteEntry	v	v
	Other (+8) [42]	v (+8)	v (+8)
Exit	CreateExit	v	v
	UpdateExit	v	v
	DeleteExit	v	v
IndividualFile	CreateIndividualFile	v	v
	UpdateIndividualFile	v	v
	LinkIndividualFile	v	v
	UnlinkIndividualFile	v	v
	GroupIndividualFiles	v	v
	UngroupIndividualFiles	v	v
	DeleteIndividualFile	v	v
	PassiveAuthenticationMRTD	v	v
StayDurationCalculation	CalculateStayDuration	v	v
	CreateOverstayersAlert	v	v
	UpdateOverstayersAlert	v	v
	DeleteOverstayersAlert	v	v
	FlagOverstayersAlert	v	v
UsageOfData	Search	v	v
	Variant: IdentificationBorder, LawEnforcement		
	Retrieval	v	v
	Variant: IdentificationBorder, IdentificationTerritory, LawEnforcement, VerificationBorder, VerificationTerritory		
	RetrieveBiometricData	v	v
	RetrieveFacialImageData	v	v
	RetrieveEntryExitHistory	v	v
	ListBiometricData	v	v
	ListFacialImageData	v	v
	SearchByFingerprint	v	v
	Variant: IdentificationBorder, IdentificationTerritory, LawEnforcement		
	AuthenticateByFingerprint	v	v
	Variant: LawEnforcement, VerificationBorder, VerificationTerritory		
	CheckFingerprintQuality	v	v
Reporting	DefineReport	v	v
	DeleteReportDefinition	v	v
	DeleteReportExecution	v	v

[42] Extra number of tasks and messages are foreseen as contingency.

	ScheduleReportExecution	v	v
	ExecuteAdHocReport	v	v
	ReadReportDefinition	v	v
	ReadReportExecution	v	v
	SearchExecutionByOwner	v	v
	SearchDefinitionByOwner	v	v
	SearchDefinitionByAuthorizedUser	v	v
	UpdateReportDefinition	v	v
	UpdateReportExecution	v	v
Attachments	AddBiometricData	v	v
	DeleteBiometricData	v	v
Notification	Notification		
	Variant: Standard, OfReport		
AutomatedReporting	AutomatedDeletionReport		
	AutomatedLogEntryDeletionReport		
ConsultationMechanism	CreateMessage	v	v
	DeleteMessage	v	v
	LinkMessage	v	v
	UnlinkMessage	v	v
	GroupMessage	v	v
	UngroupMessage	v	v
Total number of processes	**Total number of tasks**	**Total number of messages**	
10	**65**	**114**	

***Table 73**: Parameters for the estimation of the EES and RTP development costs (as a single system)*

Process	Task	NSRequest	CSRespons
RTPApplication	CreateApplication	v	v
	UpdateApplication	v	v
	LinkApplication	v	v
	UnlinkApplication	v	v
	DeleteApplication	v	v
	CreateApplicationWithSearchByFingerprint	v	v
	PaymentsOfApplicationRequests	v	v
RTPDecision	CreateApplicationDecision	v	v
	Variant: CloseApplication, DiscontinueExamination, GrantRTP, RefuseRTP		
	CreateRTPCreationDecision	v	v
	CreateRTPDecision	v	v
	Variant: AnnulRTP, ExtentRTP, RevokeRTP, ShortenValidityPeriodRTP		
	CorrectApplicationDecision	v	v
	Variant: CloseApplication, DiscontinueExamination, GrantRTP, RefuseRTP		
	NotifyApplicant	v	v

	DeleteDecision	v	v
Entry	CreateEntry	v	v
	UpdateEntry	v	v
	DeleteEntry	v	v
	Other (+ 7) [43]	v (+ 7)	v (+ 7)
Exit	CreateExit	v	v
	UpdateExit	v	v
	DeleteExit	v	v
IndividualFile	CreateIndividualFile	v	v
	UpdateIndividualFile	v	v
	LinkIndividualFile	v	v
	UnlinkIndividualFile	v	v
	GroupIndividualFiles	v	v
	UngroupIndividualFiles	v	v
	DeleteIndividualFile	v	v
StayDurationCalculation	CalculateStayDuration	v	v
	CreateOverstayersAlert	v	v
	UpdateOverstayersAlert	v	v
	DeleteOverstayersAlert	v	v
	FlagOverstayersAlert	v	v
UsageOfData	Search	v	v
	Variant: ApplicationExamination, IdentificationBorder, LawEnforcement		
	Retrieval	v	v
	Variant: ApplicationExamination, IdentificationBorder, IdentificationTerritory, LawEnforcement, VerificationBorder, VerificationTerritory		
	RetrieveBiometricData	v	v
	RetrieveFacialImageData	v	v
	RetrieveEntryExitHistory	v	v
	ListBiometricData	v	v
	ListFacialImageData	v	v
	RetrieveRTPApplicationWithFullDecisionHistory	v	v
	ListApplicationsInDossier	v	v
	Variant: ApplicationExamination, Other		
	SearchByFingerprint	v	v
	Variant: ApplicationExamination, IdentificationBorder, IdentificationTerritory, LawEnforcement		

[43] Extra number of tasks and messages are foreseen as contingency.

	AuthenticateByFingerprint	v	v
	Variant: AuthenticateByFacialImage		
	Variant: ApplicationExamination, LawEnforcement, VerificationBorder, VerificationTerritory		
	CheckFingerprintQuality	v	v
Reporting	DefineReport	v	v
	DeleteReportDefinition	v	v
	DeleteReportExecution	v	v
	ScheduleReportExecution	v	v
	ExecuteAdHocReport	v	v
	ReadReportDefinition	v	v
	ReadReportExecution	v	v
	SearchExecutionByOwner	v	v
	SearchDefinitionByOwner	v	v
	SearchDefinitionByAuthorizedUser	v	v
	UpdateReportDefinition	v	v
	UpdateReportExecution	v	v
Attachments	AddBiometricData	v	v
	DeleteBiometricData	v	v
	CopyBiometricData	v	v
Notification	Notification		
	Variant: Standard, OfReport		
AutomatedReporting	AutomatedDeletionReport		
	AutomatedLogEntryDeletionReport		
ConsultationMechanism	CreateMessage	v	v
	DeleteMessage	v	v
	LinkMessage	v	v
	UnlinkMessage	v	v
	GroupMessage	v	v
	UngroupMessage	v	v
Total number of processes	**Total number of tasks**	**Total number of messages**	
12	**84**	**142**	

Appendix B. – Hardware and software components

Table 74: *Hardware price list*

Price list	Price estimation	Source
Database Server	€7,500	Market price
Application Server	€12,000	Market price
Search engine Server	€6,000	Market price
Virtualisation Server (ESX)	€3,000	Market price
Management Server (MGT)	€4,000	Market price
Enclosure	€16,000	Market price
Rack	€2,500	Market price
Core Switch	€3,800	Market price
Front-End Switch	€5,500	Market price
Load Balancer	€30,000	Market price
Firewall MGT	€7,500	Market price
Firewall Front-End and P2P	€25,000	Market price

Table 75: *Software price list*

Price list - acquisition	Price estimation	Additional information	Source
Virtualisation (server)	€3,500	Price per server	Estimation based on the market prices and eu-LISA indication
Virtualisation (management)	€3,660		Estimation based on the market prices
Virtualisation bundle (server + management) - Test environment	€7,900		Estimation based on the market prices
Linux based operating system	€ -	Cost per year	
Helpdesk software	€25,000		eu-LISA
Management software	€2,660		Market price
Storage - Backup and recovery software	€97,000		Vendors input based on the VIS benchmark
Storage - Management software	€25,000		
Security	€12,000		Vendors input based on the VIS benchmark
Database software	Price calculated on the basis of a simulation using the number of cores		Digit Framework contract
Application software	Price calculated on the basis of a simulation using the number of cores		Digit Framework contract
Directory services software	€ -	Open source	
Search engine	€2,000,000		Vendor consultation
BMS - production licence	Price calculated on the basis of different scenarios		Vendor consultation
Miscellaneous licences	€100,000		

Price list - yearly operational / maintenance costs	Price estimation	Additional information	
Virtualisation (server)	€700	per server	Estimation based on the market prices
Virtualisation (management)	€700		Estimation based on the market prices
Virtualisation bundle (server + management) - Test environment	€3,000		Estimation based on the market prices
Linux based operating system	€320	per server per year	eu-LISA
Helpdesk software	€5,000	20% of the acquisition cost	Vendor consultation
Management software	€1,830		Market price
Storage - Backup and recovery software	€22,168		Vendors input based on the VIS benchmark
Storage - Management software	€5,500		Vendors input based on the VIS benchmark
Security	€2,640		Vendors input based on the VIS benchmark
Database software	22%	of software licence acquisition cost	Digit Framework contract
Application software	22%	of software licence acquisition cost	Digit Framework contract
Directory services software	€10,900		eu-LISA / market prices
Search engine	22%	of software licence cost	Vendor consultation
BMS	10%	of software licence cost	Vendor consultation
Miscellaneous licences	€20,000	20% of the acquisition cost	

Appendix C. – Network details

C.1. Network bandwidth requirements calculation

1. **Background information**
   The goal of the sizing of the network is to identify what the network requirements will be for EES and RTP during the development and operation phases.

2. **Benchmark**
   The current VIS provides the basis for the calculation of the EES and RTP bandwidth requirements. Current data can be used in conjunction with growth factors to assess the total bandwidth usage for the EES and RTP systems in 2023, after 4 years of operation.

   It is important to note that bandwidth here is taken as a general measure unit. For ease of understanding, the different components of a line will be regrouped in the "line" term. This includes the Local Loop (LL), the Resilient Local Loop (RLL), the Port, the Resilient Port, and the Turnkey Access Point (TAP).

3. **Assumptions**

   a. **Benchmark**
      The sizing of the network is based on corrective factors applied to the benchmark of the VIS. This allows taking into account any historical specificity of the network that will be applied for the purpose of the EES and RTP network (compression, encryption…)

   b. **Message header**
      It has been considered that a header for each message should be considered when sizing network requirements, however given the proportion of the header size (less than 1kb) compared to biometric data size (up to 200kb), it is assumed that the message load will have a negligible impact on the final cost and therefore will not be considered in the calculation.

4. **Quantification**

In order to cover the two scenarios (EES and RTP as a single system or as 2 separate systems), quantification of the bandwidth requirements will take place in a 4-step process. For each step, there is a figure to be obtained, and a process to obtain it.

To summarise, the goal of each step is to calculate the bandwidth usage of:

1. VIS in 2020, based on VIS 2013 figures.

- **a.** Roll-out of the VIS to target territories
- **b.** Growth forecasts
- **c.** Increase in biometric checks at border crossing points

2. EES in 2020, based on VIS 2020 figures (obtained in Step 1).

- **a.** Biometric verifications at exit
- **b.** Addition of TCNVE
- **c.** Addition of the image to be read from e-MRTD
- **d.** Addition of a second encryption layer

3. RTP in 2020, based on EES 2020 figures (obtained in Step 2).

a. RTP registration

b. RTP border crossings

4. EES and RTP in 2023, either as a single system or as 2 separate systems, based on EES and RTP 2020 figures (obtained in Step 2 and 3)

a. Growth forecasts

1 – Estimating the growth of the VIS from 2013 to 2020

To use VIS data as a benchmark, its status in 2020 will first be estimated.

Throughout this calculation, the term "individual user file" will be used to characterise the original file that is created for each individual, relevant to the system in use. For the VIS system, this would be the visa data, for EES, this would be the data requested at the first entry in the Schengen area. For RTP, this would be the data requested for RTP enrolment. This usually consists of alphanumerical data (maximum 5% of the individual user file size), facial image (around 15% of the individual user file size) and the fingerprints (around 80% of the individual file size).

a. **Roll-out**
It needs to be accounted for that the VIS is not completely rolled-out. It can be estimated that VIS usage will increase fourfold when it is rolled-out in every targeted region.

VIS bandwidth usage in summer 2015 = VIS bandwidth in Dec. 2013 x 400%

b. **Growth forecasts relating to visas issued**

The expected growth rate in terms of travellers is 25% for the period 2014 to 2020[44].

VIS bandwidth usage in 2020 = VIS bandwidth in summer 2015 x 125%

c. **Overall magnitude of biometric verifications**

It is assumed that VIS usage at borders for biometric verifications will keep improving until full coverage of border entries for TCNVHs. Biometric verifications are not compulsory at exits and are estimated to be marginal compared to the ones done at entry. Although in practice some BCP controls only check 1 or 2 fingerprints, it will be assumed that the fingerprint border check consists of the capture of data for 4 fingers, to allow scaling of the system.

Data from 10 fingerprints accounts for approximately 80% of the data used for a user registration in the VIS.

Data of an individual user file: 100%

Data of 10 fingerprints compared to a full user file: 80%

Data of 4 fingerprints compared to a full user file: 80% x 4/10 = 32%

Bandwidth usage per user on average in 2013 and in 2020 will now be compared.

a) **2013**
There were an estimated 5.8 crossings[45] per VIS user, and biometric verification was performed on average during 5% of crossings.

[44] Source: Section 7.1 - Smart Borders Study Report v12.2.
[45] Source: Table 87 Summary of estimations for the size of the individual file database - Smart Borders Study Report v12.2.

This amounts to bandwidth usage at BCP equal to: 32% x 5.8 x 5% = 9.28%, meaning that bandwidth usage for each VIS user (including border crossings) accounts for 109.28% of bandwidth usage for the transfer of an individual user file.

b) **2020**
It is estimated that biometric verification will be performed on average during 55% of crossings (100% of entries and 10% of exits).

Thus bandwidth usage at BCP will increase to: 32% x 5.8 x 55% = 102.1%, meaning each VIS user accounts for 202.1% of an individual user file.

Therefore, the total bandwidth per VIS user will increase by a factor of: 202.1%/109.28% = 185%.

VIS bandwidth usage including VH biometric verifications = VIS bandwidth x 185%

Findings of a. b. and c. are cumulated (400%, 125% and 185% increase).

Therefore, **VIS bandwidth in 2020 = VIS bandwidth in Dec. 2013 x 400% x 125% x 185% = 693%**

Also, the bandwidth distribution between the creation of individual files at consulate posts and border crossings can be calculated.

2020 Traffic due to individual user files: 100%

2020 Traffic due to border crossings: 202.1%

Ratio of bandwidth coming from border crossings vs individual user files: 100% / 202.1% = 49.5%

This means that, at this stage, 49.5% of network traffic comes from individual file registration at consulate posts, and 50.5% comes from biometric verifications at BCPs.

2 – EES - Translating VIS network usage into EES network usage

The differences and similarities between VIS and EES are described in the document called Technical options for a Smart Borders pilot, section 3.2.

The key differences in terms of network impact between the VIS and the EES can be analysed and summarised.

Since EES entry/exit records will only contain alphanumerical data (reference number, passport number, data of the entry/exit), which should account for at most 2% of an individual data file, we assume that EES entry/exit record creation has a negligible impact on the calculation and therefore will not be covered.

The VIS system generates network traffic on two occasions.

1. **Visa registration**
   For each TCNVH, the full individual data file is sent from the consulate to the CU when the visa is registered.
2. **Border crossing**
   For each TCNVH entry, biometric verification data is sent from BCP to CU at entry.

That can be compared to the EES:

1. **First EES registration**
   For each TCNVE, the full individual data file is sent from BCP to CU for the first entry. For TCNVHs however, no fingerprints would be transferred as they are already stored in the VIS. For TCNVHs holding an e-MRTD, the image could also be stored in the EES.
2. **Border crossing**
   For TCNVEs, data for biometric verification is sent from BCP to CU at entry and exit. The biometric verification for VHs would be performed by using the VIS.

The biometric verification and related traffic will also take place at exit; however, in the case of VHs, such verification might either be carried out by consulting the VIS or locally (i.e. by the border guard or at an ABC gate), without transmitting the biometric data over the EES network.

Corrective factors:

1 - Change in biometric file size

The VIS is making use of 10 fingerprints for the purpose of visa creation. The EES however uses, depending on the TOM, between zero and eight fingerprints for the first entry. It is also known that the size of 10 fingerprints make for 80% of the size of an individual user file. Finally, it is known that 49.5% of the network traffic originates from operations at the consular post, subject to this reduction of biometric file size. If the baseline of TOM C is applied, meaning that eight fingerprints are used, a corrective factor of 50.5% + (8 / 10 x 49.5%) = 0.90 is obtained.

Therefore a corrective factor of 0.90 can be applied to account for the reduction in size of biometric data in an individual user file.

2 - TCNVEs as opposed to TCNVHs

TCNVHs account for 58% of border crossings in 2020 to 2025, and TCNVEs account for the remaining 42%.

Therefore, a corrective factor of 38% / 62% = 163% can be applied to account for the fact that EES will handle TCNVE data while VIS handles TCNVH data.

3 - Images stored in EES from e-MRTDs or from live capture

Images stored are equivalent to approximately 9% of a full individual data file (20KB[46] of 220KB[47]). Since they will be collected by the EES and stored in the EES database, 9% of the network usage from VIS can be added for individual file creation at consulate post, to cover the fact that the EES will store TCN facial image files.

Network usage for individual file creation at consulate posts was calculated in step 1.c., and is equal to 49.5% of the traffic.

Therefore, a corrective factor of (9% x 49.5%) = 0.04 can be applied to account for image storage in EES.

4 – Addition of biometric verifications at exit

Biometric verifications are performed at exit for TCNVEs and TCNVHs. TCNVH verifications can also be performed by the VIS, in which case the EES trusts this check for identification purposes. However it is optional and in practice it is the exception more than the norm, therefore it will be assumed that all TCNVHs are checked by the EES.

a. Addition of TCNVHs

We know the percentage of VIS traffic related to biometric verifications at entry at the BCP (projected to reach 50.5% of the total traffic). This accounts for biometric verifications at entry of TCNVHs.

We know that the exit/entry ratio is 96%[48].

Therefore, to add TCNVHs network usage at exit, we need to add 50.5% x 96% x 90% = 44% to the total.

[46] Source: Doc 9303 - Machine Readable Travel Documents Sixth edition - 2006 – ICAO.
[47] Table 46 Impact of Biometric options on data storage - Smart Borders Study Report v12.2.
[48] Chapter 7. Statistics and Forecasts - Smart Borders Study Report v12.2.

b. Addition of TCNVEs

We know that the ratio between TCNVEs and TCNVHs is 163%.

Therefore, to add TCNVEs network usage at exit, we need to add 44% x 163% = 71% to the total.

Finally we can add TCNVE and TCNVH impact to calculate total impact of biometric verifications at exit. 44% + 71% = 115%.

5 – Additional security

For the purpose of preventing contractor access to data communicated via the network, a second encryption layer is likely to be considered for the purpose of the EES. This encryption layer should increase all traffic size by 15%. We make the conservative assumption that this encryption layer will be in use for the purposes of the EES, and therefore apply the multiplicative factor to the calculation.

We can simplify these findings for the purpose of the calculation:

EES network traffic = ((VIS network traffic 2020 x 90% x 163%) + 4% + 90%) * 115% = **VIS network traffic 2020 x 306%**

3 - Calculating the impact of the RTP system

The RTP system also needs to be accounted for. In terms of data exchange, the following needs to be considered: a file is created at the consulate and sent to the CU, and is then checked at the border for each entry and exit.

The impact of the RTP on network usage will occur twice:

- RTP registration: At the consulate or administrative post, during RTP registration.
- Border crossing point: For each entry and exit at border crossing points.

RTP, as an addition to VIS and EES, will therefore impact network usage based on the amount of RTP users and border crossings.

a. **RTP registration**

During RTP registration, the full file will be transmitted. It is assumed that it will contain fingerprints, facial image and alphanumerical data and is therefore comparable to the amount of data sent to the EES system during a first border crossing.

b. **Border crossing points**

For each passage at border crossing points, the biometric matching will be done through EES, which has already been accounted for in the calculation. The impact of RTP will therefore be limited to the verification of an existing RTP membership. The size of an individual user file for RTP will be proportional to the size of an individual user file for EES, since the same biometrics will be used for that purpose.[49]

Based on the estimated RTP users and border crossings, it can be estimated that there will be 6 million full data file transactions per year (one for every RTP user)[50] as well as 68 million RTP membership checks per year (one for every crossing).

[49] Table 46 EES and RTP biometric options – Smart Borders Study Report v12.2. Source for Facial Image data: Source: Doc 9303 - Machine Readable Travel Documents Sixth edition - 2006 – ICAO.
[50] Table 88 Summary of estimations for the size of the individual file database - Smart Borders Study Report 7 million is the rounded-up estimation of the maximum demand, which will be rounded down instead for the cost computation.

Finally, full data file transactions in 2020 are estimated to be 24 million, and EES border check transactions are estimated to be 269 million per year.[51]

We compare these findings in order to size RTP network usage, on the basis of EES network usage. For that purpose, we will compare the amount of transactions that will be realised for the purpose of the RTP, and compare them to the transactions that will be realised for the purpose of the EES.

Individual user file transactions for RTP: 7.6 million

Membership check transactions for RTP: 68 million

Membership check transaction size compared to full data file size: 84%

Increase in individual user file equivalent: 6 million + (68 million x 84%) = 65 million

Individual user file transactions for EES in 2020: 24 million

Border crossing checks for EES in 2020: 269 million

Border crossing check for EES transaction size compared to full data file size: 84%

Total individual user file equivalent for EES in 2020: 24 million + (269 million x 52%) = 250 million

Therefore the addition of the RTP system can be compared to EES network usage by adding the difference in amount of individual user file equivalent between EES and RTP: 65 million / 250 million = 25%

Additionally, we know that the EES 2020 network represents 2123% of the VIS 2013 network.

Therefore, **RTP bandwidth usage in 2020 = 25% x 2123% = 550%**

4 – Calculating the bandwidth increase after 3 years of operation

The EES and RTP systems are impacted by the number of TCN travellers and the number of border crossings.

The following parameters are taken into account:

Increase per year in TCN travellers (rounded from 3.92): 4%[52]

Increase per year in crossings (rounded from 4.2): 4%[53]

Years of operation: 4

This results in an overall 4% increase in estimated traffic per year.

Therefore, we can estimate the increase in bandwidth requirement for the 2 scenarios (EES and RTP as integrated systems or as separate systems).

Scenario 1: EES and RTP as integrated systems

We cumulate the findings of Step 2 and 3.

EES + RTP total bandwidth in 2023 = VIS 2013 figures x (2123% (EES) + 550% (RTP)) x 104%^4 (growth) = 2672% x 104^3 = 3126%

EES + RTP total bandwidth in 2023 = VIS bandwidth in Dec. 2013 x 3126%

[51] Table 87 Summary of estimations for the size of the individual file database - Smart Borders Study Report.
[52] Calculated from Table 87 Summary of estimations for the size of the individual file database - Smart Borders Study Report.
[53] Paragraph 7.3.2, p.223 - Smart Borders Study Report

Scenario 2: EES and RTP as separate systems

We use the findings of Step 2 and 3.

a) EES total bandwidth in 2023 = VIS 2013 figures x 2123% (EES) x 104%^4 (growth)

EES total bandwidth in 2023 = VIS bandwidth in Dec. 2013 x 2483%

b) RTP total bandwidth in 2023 = VIS 2013 figures x 550% (RTP) x 104%^4 (growth)

RTP total bandwidth in 2023 = VIS bandwidth in Dec. 2013 x 643%

C.2. Cost variances for each cost component

In addition to the cost components, cost variances have been identified for each cost component.

The goal of analysing cost variance is to identify where the majority of the cost variance lies. The following chapter is made to understand why some cost components have been researched in detail to provide the cost estimate, and the origin of the cost variance between for cost component:

A price factor can be calculated as the difference between the most expensive and the least expensive item.[54] For example, if the same item costs €100 with contractor A and €300 with contractor B, there is a price factor of 1 to 3 on the "Choice of contractor" variable.

Four main variables have been identified for each cost component, presented in the tables below. The comments shown in the table originate from the analysis of current contractual data.

1. **One-time costs (OTC)**

Table 76: *Cost variables for one-time costs*

Variable	Price factor	Comments
Choice of contractor		Current prices for the TESTA-ng network will be used, with the addition of a 50% security buffer to take into account the fact that the current contractor offered lower prices than other bidders.
Country in which the line is set up	1 to 1.2[55]	This variable has very limited influence on the cost. 80% of the OTC comes from the setup of the turnkey access point (TAP) which does not depend on the country in which the line is set up.
Bandwidth capacity of the line	1 to 1.2[56]	The bandwidth capacity of the line has little influence on the one-time cost to deploy the line.
Type of line (MS line, CU/BCU line, SOC/CSD line)	1 to 2[57]	The price difference is mainly explained by the different turnkey access point (TAP) offering selected for CU/BCU lines. MS lines and SOC/CSD lines share similar OTCs.

[54] Where possible, the factor is broken down into several groups to narrow down the estimate. For example, a variable with a factor of 1 to 10 could have 2 groups whose factors go from 1 to 2 for the first group and from 8 to 10 for the second group.
[55] Source: Annex II – List of Services covered by the Contract and Schedule of Prices, T-Systems International GmbH, 11/2013.
[56] Source: VIS Site costs, obtained from DG HOME on 15/07/2014.
[57] Source: VIS Site costs, obtained from DG HOME on 15/07/2014.

2. **(Monthly) maintenance costs**

Table 77: *Cost variables for maintenance costs (monthly)*

Variable	Price factor	Comments
Choice of contractor		Current prices for the TESTA-ng network will be used, with the addition of a 50% security buffer to take into account the fact that the current contractor offered lower prices than other bidders.
Country in which the line is set up	1 to 6[58]	Two types of countries have been identified. Countries with high bandwidth cost (>€0.10 / mbps) and low bandwidth cost (<€0.10 / mbps).
Bandwidth capacity of the line	1 to 10[59]	Bandwidth capacity of the line is directly correlated to the monthly costs for the line.
Type of line (MS line, CU/BCU line, SOC/CSD line)	1 to 30[60]	MS lines and SOC/CSD lines share the same price magnitude, while CU/BCU lines present a much cheaper price/bandwidth ratio.

Findings:

As regards fixed costs:

1. **Bandwidth and country:** The bandwidth capacity of the line and the country where it is set up do not have a noticeable impact on the cost. An average price will be used regardless of the bandwidth capacity and the country in which the line is set up.

2. **Type of line:** The type of line has a noticeable impact on the price range. The lines will therefore be segmented based on type to increase confidence in the cost estimate.

As regards monthly costs:

1. **Bandwidth:** The bandwidth capacity of the line has a very noticeable impact on the cost. The bandwidth requirements for EES and RTP during the 2017-2023 period (development and operation) will be analysed in detail to improve precision and increase confidence in the cost estimate.

2. **Country:** The country in which the line is installed has a noticeable impact on the cost. Lines will therefore be segmented based on the country in which the line is set up to increase confidence in the cost estimate.

3. **Type of line:** The type of line has a very noticeable impact on the cost. Costs for each type of lines will therefore be calculated separately to increase confidence in the cost estimate.

As regards total costs:

1. **Contractor variable:** A correction factor of 50% is used taking into account the lowest and the highest offer of the latest call for tender. This corrective factor is used because the current contract will end in 2020, and to present a cautious estimate in case the next contractor has higher prices.

[58] Source: DG Home Affairs
[59] Source: VIS Site costs, obtained from DG HOME on 15/07/2014
[60] Source: VIS Site costs, obtained from DG HOME on 15/07/2014

Appendix D. – Description of the cost items

Table 78: *Detailed descriptions of the cost items*

OLD title	NEW title	Description of the cost items
Development of the central system		
Title 2 Administrative expenditure		
Administration development	Communication activities and studies during development phase	Cost of meetings reception, translations and information campaign during development phase. Cost of feasibility studies to assess the IT maturity across MSs.
Training/Meetings development	Training and meetings during development phase	Cost of the meetings (excluding meetings reception) related to programming of the grants to be provided to Member States, missions for auditing grant management at MSs, MA Monthly Progress meetings, Committees/sub-group meetings with national experts per year, advisory groups during development phase; Training cost after initial rollout of the system for MA, eu-LISA staff and MS delegates.
Office space development	Setup of datacentre space	Setup cost of datacentre space at the backup central site in Sankt Johann im Pongau, Austria; Cost of hot/cold aisle configuration at the central site in Strasbourg, France.
Administration operations	Communication activities during operations	Cost of meetings reception and translations during operational phase.
Training/Meetings operations	Training and meetings during operations	Cost of meetings related to programming of the grants to be provided to Member States, missions for auditing MS, MA Quarterly Meetings, Advisory groups; Training cost after upgrades of the system for MA, eu-LISA staff and MS delegates.
Office space operations	Operations of datacentre space	Cost of datacentre operations at the backup central site in Sankt Johann im Pongau, Austria.
Title 3 Operational expenditure		
Network Infrastructure development	Network infrastructure development	One-time costs (OTC) to create MS lines (uniform interface), Central Unit / Backup Central Unit (CU/BCU) lines and Support Operation Centre / Central Services Domain (SOC/CSD) lines; Other costs (e.g. setup, security etc.).
Hardware licences development	Hardware during development phase	One-time costs (OTC) to acquire the hardware (database servers, application servers and other servers, enclosures and racks, network hardware, miscellaneous (e.g. UPS), storage, BMS and NUI).
Software licences development	Software during development phase	One-time costs (OTC) to acquire the licence for the software (BMS, Search Engine, Database software, Application and Messaging software, Virtualisation server, Storage, Helpdesk and support, Operating System, Security, Directory Server software, Monitoring and administration software, Other licences).

Contractor development	Contractor development of the central system	Contractor development cost of the central system, BMS and National Uniform Interface, covering preparation of functional and technical system specifications, design, build, test activities, deployment and rollout as well as project management and quality assurance contracting.
Network Infrastructure operations	Network infrastructure operations	Monthly costs (MRC) to operate and maintain MS lines (uniform interface), Central Unit / Backup Central Unit (CU/BCU) lines and Support Operation Centre / Central Services Domain (SOC/CSD) lines.
Hardware licences operations	Maintenance of hardware	Monthly costs (MRC) to operate and maintain the hardware (database servers, application servers and other servers, enclosures and racks, network hardware, miscellaneous (e.g. UPS), storage, BMS and NUI).
Software licences operations	Maintenance of software	Monthly costs (MRC) to operate and maintain the software (BMS, Search Engine, Database software, Application and Messaging software, Virtualisation server, Storage, Helpdesk and support, Operating System, Security, Directory Server software, Monitoring and administration software, Other licences).
Contractor operations	Contractor operations of the central system	Contractor development costs related to the upgrades of the central system, BMS and National Uniform Interface.
Administration development	External staff for contract management, grants management	The expenditure on contractual and temporary staff to support and coordinate the contractor development, external quality assurance services and grant management.
Administration operations	External staff for monitoring the system, helpdesk	The expenditure on contractual and temporary staff to operate the systems including system management, operator support contractors, helpdesk support (1st line), technical staff (2nd line) and operators monitoring the central system.
Development of national systems		
Title 2 Administrative expenditure		
Training/Meetings development	Training and meetings during development phase	No cost items included in the model.
Office space development	Setup of datacentre space	No cost items included in the model.
Training/Meetings operations	Training and meetings during operations	No cost items included in the model.
Office space operations	Operations of datacentre space	No cost items included in the model.
Title 3 Operational expenditure		
Administration Hardware & Software development	External staff for contract management, grants management	The expenditure on contractual and temporary staff for the support and coordination of National Uniform Interface integration.
Hardware licences development	Hardware during development phase	No hardware costs are expected on the Member States' side during development phase.
Software licences development	Software during development phase	No software costs are foreseen on the Member States' side during development phase.
Contractor development	Contractor development	Integration costs of National Uniform Interface.

Administration Hardware & Software operations	External staff for monitoring the system, helpdesk	The expenditure on contractual and temporary staff for 24*7 helpdesk support.
Hardware operations	Maintenance of hardware	No hardware costs are expected on the Member States' side during operational phase.
Software operations	Maintenance of software	No software costs are expected on the Member States' side during operational phase.
Contractor operations	Contractor operations	No contractor operations costs are expected on the Member States' side during operations, because the NUI will be maintained by eu-LISA.

Appendix E. - BMS costing parameters, as sent to vendors

1. Size of the biometric database repository

We understand size of the repository as the number of individual files, regardless of the amount of biometric records for each. As an example: scenario a) means that the biometric records (whether 1 Facial image, 1 Facial image + 4 fingerprints or 1 Facial image + 8 fingerprints as mentioned under point 2) are kept for 60 million individuals.

Please take into account the following scenarios regarding the size of the repository, in addition to the current usage:

a) 60 million
b) 150 million
c) 270 million
d) 450 million

BMS currently supports up to 28 million biometric records. In the context of the current system in use, this ceiling will be sufficient only until 2017.

2. Type of biometric records and retention period

Please take into account the following scenarios regarding the types of biometric records stored, in addition to the current usage:

a) 1 Facial image
b) 1 Facial image + 4 fingerprints
c) 1 Facial image + 8 fingerprints

In the current implementation only fingerprint sets (up to 10 fingerprints per person) are supported. The system should be scalable to all kind of biometric records (notably iris).

Please take into account the following scenarios regarding the retention periods:

a) 181 days
b) One year
c) Five years

Current implementation is 181 days.

Please note that these retention period scenarios were taken into account when estimating the size of the repository.

3. Type of biometric transactions, i.e., 1:N identification, 1:1 verification and 1:K (where K is a relatively small subset of n) executed on the system and Daily workloads and Peak Hour workloads

Please take into account the following scenarios regarding the size of the repository, in addition to the current usage:

1:1 verifications:

a) 100 million per year
b) 250 million per year

System specifications as of March 2015 will be 206.648 million per year, with possible peaks up to 42.250/hour.

1:N identification:

a) 1 million per year
b) 30 million per year

System specifications as of March 2015 will be 96.52 million per year, with possible peaks up to 17.073/hour.

1:K identification (For example searches within a subset of gender, age range, name/date of birth)

a) 50 million per year
b) 125 million per year

Daily workload: The workload throughout the year can be assumed to follow the same trends you have experience with in the global travel industry.

This 1:K type of transaction could be used for law enforcement, where authorities could search within a subset of gender, age range for example. For these transactions, the range could be quite high (half of N) but the expected response times could be high as well, as they are not impacting business operations.

The other application would be de-duplication of records at border controls, within a group of people with the same date of birth, or last name for example. There is no absolute range for K, however based on this information, the biggest value between the frequency of homonymy occurrence and frequency of a similar date of birth occurrence can be assumed, on which you probably have some statistical data to work with. For this kind of transaction, it can be assumed that they will require the same response time as the 1:1 transactions.

The number of transactions is half of the 1:1 verifications. The rationale behind this number is that these checks would be performed only at entry. Please note that this is considered as being an option, and we would appreciate if you could provide a price estimation that would have these 1:K transactions as an option as well.

Peaks: 300% peak increase compared to the average workload can be assumed

4. Required system availability rates

Synchronous operations: 99.99%
Asynchronous operations: 99.7%

5. Sites architecture and failover processing capabilities

Two sites should exist, one primary site and one backup site, and automated fail-over processing capabilities are required

6. Required system response time requirements for each transaction type to be processed under the system

For synchronous channels:

Channel	TTS1	TTS2
Retrieve Channel	95% < 3 sec 97% < 5 sec 98% < 10 sec 100% < 30 sec	97% < 3 sec 98% < 5 sec 100% < 10 sec
Synchronous BMS Channel	90% < 3 sec 93% < 5 sec	95% < 3 sec 97% < 5 sec

	96% < 10 sec 100% < 30 sec	100% < 7 sec

Note: TTS1 refers to the minimum to be achieved. Below TTS1 penalties are applied. TTS2 is the target level to be achieved. Below TTS2 improvements must be proposed.

Asynchronous channels:

Check fingerprint quality: 95% under 1 min, 100% under 2 min
Search by fingerprint: 95% under 10 min, 100% under 15min

We do not have values defined yet fort facial recognition response times, (1:1 if not also 1:n alone or as multimodal) but the idea is to meet high performance and reliability standards given the purpose of the system.

We will welcome any priced recommendations regarding these figures.

7. Service Management capabilities to maintain the solution

For a system with such criticality, these are the requirements for incident resolution:

SLA Item	SLA Objective	Target	Tolerance
Time to resolve the incident reported to the Maintenance Contractor on an incident classified as **blocking** is <2 hours	Measures the elapsed time between incident logging and (accepted) incident resolution. *N.B. The incident will be not considered as resolved if a switchover/failover has been activated as work-around and the main system has not been fixed yet (at least temporarily).*	100%	95%
Time to resolve the incident reported to the Maintenance Contractor on an incident classified as **major** is < **24 hours**	Measures the elapsed time between incident logging and (accepted) incident resolution.	95%	90%
Time to resolve the incident reported to the Maintenance Contractor on an incident classified as **minor** is < 20 days (ready to be accepted in Test contractor environment)	Measures the elapsed time between incident logging and (accepted) incident resolution.	90%	80%

The **Severity Levels** can be defined as:

Blocking or Critical: function for which the impact of a disruption is "Very High"

An error that prevents the operational use of the business critical functions of the central domain and for which there is no viable detour or workaround (Note: a viable detour or workaround shall mean use of function(s) or manual procedures that require a Member State to suffer a minor degradation in service to achieve the same operational results).

Major: function for which the impact of a disruption is "High"
A function of the Central Domain is seriously affected but not completely down.

Minor: function for which the impact of a disruption is "Moderate" or "Low"

Could you provide us with an order of magnitude for this type of cost compared to the whole solution and ideally an average price based on your experience?

8. Training requirements

Training activities must guarantee the transfer of all necessary knowledge to the following persons, depending on the needs:

- The operators of the Agency. Operators are in charge of the continuous operation of the systems, including supervision of monitoring, execution of routine procedures and handling contacts with Users by phone, email or Service Manager tool.
- The technical administrators and personnel on duty of the Agency. Technical administrators and personnel on duty are in charge of the management of the System, in a specific area of competence: network, system, database and application. They are also in charge of troubleshooting of problems;
- The project and testing teams of the Agency. The project and testing teams are in charge of the testing activities under the responsibility of the Operation Centre and for coordination of project activities at the Operation Centre;
- The security team of the Agency;
- MWO contractor

We estimate trainings to be required for support staff (we can assume 20 persons) and for the MWO contractor (assume 10 persons).

9. Project management and reporting requirements

The Contractor must manage the execution of the work assigned to him using a well-known Project Management methodology as PRINCE2 or equivalent.

The contractor needs to set up a project team that will manage the project's implementation according to the requirements set.

The contractor's project team needs to have a clear structure with

- A Project manager, responsible for the whole Contract implementation and a deputy Project manager
- Team Managers responsible for the follow-up of each work package
- The project team members that will implement the project activities and produce the project products.

The Project Manager shall adhere to eu-LISA communication plan which foresees follow-up meetings to be held, at least monthly, in the Agency premises (Strasbourg as the operational site) and shall provide a Quality plan and Risk Management Strategy.

Please indicate a price per year for the project management positions.

10. Project implementation requirements

Please provide us with the average cost in your experience, ideally as a % of the total cost.

Appendix F. – Price parameters

F.1. Contractor development

The key pricing parameter for the estimation of development costs is the average man-day cost which is assumed to be, €600 per man-day. This is a compound rate for all the profiles required in a development team.

To obtain effort values for the parameters, DG TAXUD projects (the Regular Shipping Service authorisation and COPIS) that have accurate estimates and parameters were used. The effort values for the parameters are the following:

- around 50 man-days for 1 process;
- around 50 man-days for 1 process with change;
- around 35 man-days for 1 task with change;
- around 35 man-days for 1 message exchange.

DG TAXUD projects have an availability requirement of 98%. A 30% increase in development costs was applied to match the availability requirement of 99.7%, which is a more likely assumption for the EES and RTP. If the availability requirement was increased from 99.7% to 99.9%, there would be additional increase in costs of 20%.

F.2. Administration

The main pricing parameters for the costs of EES and RTP information campaigns are the equivalent costs of VIS and SIS II projects. The costs of reception and translations are also based on the experience of VIS and SIS II projects. The comparison does not take into account the different sizing of the systems in terms of users, because the costs of information campaigns mostly include templates for posters and other items that could be further used by MSs at the desired scale.

Employment costs of contract staff and temporary agents will depend on their grade, which will be determined at a later stage in the projects. Therefore, average annual employment costs (for EU officials and temporary agents) are anticipated for most of the profiles. However, it is already clear that budget and grant management will be assigned to EU contract staff within Function Group IV; therefore, lower costs are expected for them.

The parameter of average man-day costs for subcontracting IT professionals in the EU is used to estimate temporary staff costs at national level.

Table 79: *Sizing parameters for administration costs*

Parameters	Value	Source
Costs of VIS information campaign	€60,000	DG Home
Costs of SIS II information campaign	€145,000	DG Home
Average annual employment costs for EU officials and temporary agents	€132,000	DG Home
Average annual employment costs for EU contract staff within Function Group IV	€60,000	DG Home
Average man-day costs for subcontracting IT professionals in the EU	€600	Market Intelligence

F.3. Hardware

Table 81 and Table 81 present the parameters used to estimate the cost of hardware and software of the EES and RTP.

Table 80: Hardware pricing parameters

Parameters		Value	Source
Pricing trends			
1	Price reduction to take into account the evolution of server technology until 2019	60% of the hardware costs	Estimation based on Gartner study[61]
2	Price reduction to take into account the evolution of storage technology until 2019	75% of the storages costs	Estimation based on Everest Group study[62]
Maintenance (compared to initial investment)			
1	High-SLA environments (production and pre-production)	20% of the hardware cost	Vendor consultation
2	Low-SLA environments (playgrounds and testing environments)	10%% of the hardware cost	Vendor consultation
Environment costs			
1	Cost of pre-production environment compared to production environment	100% of the hardware for the production env.	
2	Cost of Playground 1 environment compared to production environment	20% of the hardware for the production env.	Vendor consultation
3	Cost of Playground 2 environment compared to production environment	15% of the hardware for the production env	Vendor consultation
4	Cost of Test environments for EES and RTP together	€24,000	EES and RTP Sizing tab
5	Cost of Test environments for EES	€12,000	EES Sizing tab
6	Cost of Test environments for RTP	€12,000	RTP Sizing tab
7	Percentage to apply to the BMS price in the case of EES and RTP as two separated systems	50% of the total BMS hardware cost	The pricing being the same for all scenarios, this percentage makes it

[61] Sources: (i)Server Trends, Gartner, http://regions.cmg.org/regions/stlcmg/files/Download/Presentations_2013-02/Server_Performance_Trends-CMG-Bowers-Feb2013-ForCopies.pptx; (ii) Storage Pricing Trends & Outlook 2014, Everest group, http://www.everestgrp.com/2014-07-storage-pricing-trends-outlook-2014-market-insights-14744.html

[62] Storage Pricing Trends & Outlook 2014, Everest group, http://www.everestgrp.com/2014-07-storage-pricing-trends-outlook-2014-market-insights-14744.html

8	Percentage to apply to the NUI price in the case of EES and RTP as two separated systems	50%	possible to obtain relevant figures when it comes to comparing cost-effectiveness of the scenarios.
Storage			
1	EES Storage needs for TOM A (181 days)	116 TB	
2	EES Storage needs for TOM B (181 days)	120 TB	
3	EES Storage needs for TOM C (baseline) (181 days)	132 TB	
4	RTP Storage needs for TOM M (baseline)	144 TB	
5	RTP Storage needs for TOM N	10%	
6	Cost per terabyte (Production and Pre-production, CU only)	€1,500	

F.4. Software

Table 81: *Software pricing parameters*

Parameters	Values	Source
Environment costs		
Cost of Playground 1 environment compared to production environment	20% of the software cost for the production env.	Vendor consultation
Cost of Playground 2 environment compared to production environment	15% of the software cost for the production env.	Vendor consultation
Cost of Test environments for EES and RTP together - 8 virtualisation servers	€7,900.00	Market prices
Cost of Test environments for EES - 4 virtualisation servers	€7,900.00	Market prices
Cost of Test environments for RTP - 4 virtualisation servers	€7,900.00	Market prices

Further details, including the pricing of each cost item and the relative sources, can be found in Appendix B.

F.5. Training courses and meetings

The pricing parameter for the meetings is the average cost per expert which is €600, based on DG Home Affairs experience.

F.6. Office space

The assumption is made that the setup costs of datacentre space will amount to €2,000 per sq. metre, whereas annual costs of datacentre space operations will be €1,440 per sq. metre. The costs of office space rent will be €250 per sq. metre.

Appendix G. - List of key costs included or excluded from the Cost Model

The table below represents the key cost items that are included or excluded from the Cost Model. Exhaustive list of the items that are excluded from Cost Model is given in the MS toolbox.

Table 82: *List of key costs that are either included or excluded from the Cost Model*

Cost item	Included	Excluded
Development Central System		
Hardware during development phase	v	
Software during development phase	v	
Contractor development of the central system	v	
Communication activities and studies during development phase	v	
Training and meetings during development phase	v	
Setup of datacentre space	v	
Development Member States		
External staff for contract management, grants management	v	
Integration costs of National Uniform Interface	v	
Maintenance Central System		
Maintenance of hardware	v	
Maintenance of software	v	
Contractor operations of the Central System	v	
Communication activities during operations	v	
Training and meetings during operations	v	
Operations of datacentre space	v	
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