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EURODAC

MSI/Optical Scan Test Study Summary Report

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Table of Contents

References	4
Reference Documents	4
Annexes	4
Acronyms, Abbreviations and Definitions	4
1 Introduction	8
1.1 The Purpose of the Document	8
1.2 Intended Audience	8
1.3 Description of the Project	8
2 Summary of the Tests	10
2.1 Results	10
2.2 Observations	10
2.3 Constrains	11
3 Project Execution Log	12
3.1 Test execution results	14
3.1.1. PHASE1: Sweden Test Executions	14
3.1.2. PHASE2: Norway Test Executions	15
3.2 The Alternate Method Tests (AMT)	16
3.3 Designed Test Cases and RUNS	17
3.4 PASSED Test Cases	18
3.5 SKIPPED Test Cases	19
3.6 FAILED Test Cases	19
3.7 Documentation Issues	20
3.7.1. Test Plan Errata	20
4 Quantitative Metrics	21
4.1 Acceptance/Rejection Response Time by Central Unit	21
4.2 CU Processing Response Time of Central Unit	22
4.3 Ten Print Matching Accuracy	23
5 Conclusions	25
5.1 Recommendations	25
5.2 Action Plan	25

References

The following listed documents are referenced through the current report:

Reference Documents

Ref	Date	Ver.	Name	Observations
MOSTS	05/12/2014	2.2	EURODAC MSI/Optical Scan Test Strategy	
MOSTP	30/04/2015	1.0	EURODAC MSI/Optical Scan Test Plan	
EDPS-MSI	25/11/2015	Case 2015-0082	EDPS Opinion (Case 2015-0082) ... on "Eurodac MSI/Optical Scan Tests Study"	https://edps.europa.eu/sites/edp/files/publication/15-11-25_eurodac_msi_optical_scan_test_study_eulisa_en.pdf

Annexes

- Annex 1 – Consolidated Report on Member States transactions

Acronyms, Abbreviations and Definitions

The following table provides a list of acronyms and abbreviations used in the document and their definitions.

Acronyms and Abbreviations	Definition
Acceptance / Rejection Response Time	The time used by the Central System to accept (fully process, providing an answer back to the MS) or reject a transaction (i.e. due to low quality of images).
Accepted / rejected transactions	Transactions that pass (or not) the quality filter of the Central System and that they are processed (passed the quality threshold) or not (due to the low quality).
AFIS / CAFIS	Automated Fingerprint Identification System - an automated, minutiae-based identification system that may consist of two or more distinct databases comprising two-finger identification records and ten-finger latent cognizant records. (nist.gov)
AG	Eurodac Advisory Group
AMT	Alternate Method Tests. The tests are executed in alternate sequence (Optical transactions, then MSI transactions).
BCU	Backup Central Unit (part of Central Eurodac System)

Acronyms and Abbreviations	Definition
CAT ₁ – CAT ₉	Categories of persons or requests processed by Eurodac. Categories 1-9 mean 1=International Protection [Art.9 of recast regulation], 2=Irregular border crossing [Art.14], 3=Illegally staying in MS [Art.17], 4=Law Enforcement MS [Art.19, 20], 5=Law Enforcement Europol [Art.19, 21], 9=Data subject query [Art.29].
CS	Eurodac Central System
CU	Central Unit (part of Eurodac Central System)
CU Processing Time	The time used by the Central System to provide an answer to the transaction.
DB	Eurodac Central Database - the collection of data of a particular type, organized for efficient storage and retrieval (e.g., fingerprint minutiae data, fingerprint image data, or mugshot image data).
DFP	Delete Fingerprint transactions - used to delete the already registered fingerprints from the CS database (i.e. in case of previous human mistake).
EDPS	European Data Protection Supervisor
EEA	European Economic Area
Fingerprint	An impression of the friction ridges of all or any part of the finger.
EU	European Union
eu-LISA	European Union Agency for the Operational Management of Large-Scale IT Systems in the Area of Freedom, Security and Justice
EURODAC system	European Dactyloscopy – Automated Fingerprint Identification System that enables Member States to identify asylum applicants and persons who have been apprehended while unlawfully crossing an external border of the Community.
Failed	Test Case that did not match the expected results (as described in the Test Plan).
FPS	Finger Print Set (Ten Print scans from the same individual)
ICT	Information and Communications Technology
IRQ	Image Request transaction – transactions used to request the images saved by the CS (i.e. to verify previously sent NPS).

Acronyms and Abbreviations	Definition
LT	Latent fingerprint – the reproduction of the friction ridges on an item that is touched when the ridges are exposed to any contaminant.
Minutiae	Friction ridge characteristics that are used to individualize the print and that occur at points where a single friction ridge deviates from an uninterrupted flow. Deviation may take the form of ending, dividing into two or more ridges, or immediately originating and terminating (nist.gov)
MS	Member State(s) of the European Union (EU) and/or of the European Economic Area (EEA); also referred to as Users of EURODAC
MSI / MSI Scan	Fingerprint image scan based on Multispectral Imaging technology
NAP/FIT	National Access Point / Fingerprint Image Transmission
Negative matching accuracy	Number of transactions (expressed in percentage) that returned only the expected candidate and no “intruders” (false positives); Also see: Ten Print Matching Accuracy.
NIST	Refers to national standards (in the context of this specification, fingerprint formatting and communications standards) developed by the National Institute of Standards & Technology and published by the American National Standards Institute. In Eurodac: formatted file used to store and submit fingerprints.
NO	Norway (ISO code)
NPS	Non-Criminal Print-to-Print Search – ANSI/NIST formatted electronic ten-print submissions, that contain ten rolled and four plain impressions ¹⁰ of all ten fingers, as well as information relative to the asylum application.
OPT / Optical Scan	Fingerprint image scan based on Optical technology.
Passed	Test Case that match the expected results (as described in the Test Plan).
PMA	Programmable Matching Accelerator (part of Eurodac Central System).
Positive matching accuracy	Number of transactions (expressed in percentage) that returned all expected candidates; Also see: Ten Print Matching Accuracy.
PROD	Production Environment
Repeated	Test Case that was repeated due to human mistake of the previous execution
RUN	A collection or set of Test Cases with similar purpose
SE	Sweden (ISO code)

Acronyms and Abbreviations	Definition
Skipped	Test Case that was never executed
Target	Expected value (as described in the Test Plan / Test Strategy).
TC	Test Case – a set of specifications, conditions (or variables) and expected results under which the system under test is determined whether satisfies the requirements or works correctly.
Ten Print Matching Accuracy	Hit Accuracy on Ten Print fingerprint searches (also see: Positive matching accuracy and Negative matching accuracy).
TP	Ten-Print Fingerprint – A fingerprint card (or fingerprint card equivalent) containing rolled and plain impressions from the ten fingers of an individual. The standard format contains 14 impressions: one rolled fingerprint impression of each finger, plain fingerprint impressions of each thumb, and plain impressions of the four fingers of each hand simultaneously.
TSSR	Test Study Summary Report – the document that contains the summary of test activities and final test results.
TST	Test Environment – a setup of software and hardware components for the testing teams to execute test cases. It supports test execution with hardware, software and/or network configured.

1 Introduction

The European Union Agency for the Operational Management of Large-Scale IT Systems in the Area of Freedom, Security and Justice (eu-LISA) operates IT systems hosted in its data centre in Strasbourg, France, and in a backup data centre in Sankt Johann Im Pongau, near Salzburg, Austria.

Starting the 1st of April 2019, for a maximum duration of 2 months, as per the mandate received from the Eurodac Advisory Group (AG), eu-LISA with the support of two Member States had coordinated tests study related to the usage of a new fingerprint scanning technique in the context of Eurodac.

MSI Imaging acquires multiple images of the surface and subsurface characteristics of the finger. MSI is believed to have advantages over conventional technologies:

- multiple anatomical features below the surface of the skin that have the same pattern as the surface can be imaged by MSI;
- MSI sensors are designed to collect usable biometric data under a broad range of conditions and compensate for poor quality or missing surface features;
- MSI also measures physiological matrix of a fingerprint and can thus tell if it comes from a living finger or some other material (spoof proof). Customized algorithms fuses multiple raw MSI Images into one composite image.
- MSI fingerprints scans are backwards compatible and can be used with existing databases.

The purpose of this study was to assess if the use of Multispectral Imaging devices, for the scanning of fingerprints, affects the performance of the Central Eurodac System (matching accuracy etc.). Based on the outcome, it is determined whether such devices should be allowed for general use within the scope of application of Regulation (EU) No. 603-2013 (the "Recast Regulation"). To do this, eu-LISA had tested the new scanners with real fingerprints provided by competent national authorities of the Member States of the European Economic Area (EEA).

1.1 The Purpose of the Document

The present document describes the Test Study Summary Report (TSSR) for the tests performed during the execution of the MSI/Optical Scan Project. Starting the 1st of April 2019 until the 15th of May 2019, eu-LISA supervised the execution of the MS tests in order to evaluate if the use of Multispectral Imaging devices, for the scanning of fingerprints, affects the performance of the Central Eurodac System. This TSSR aggregates the findings of the different tests and ends with eu-LISA's conclusions.

1.2 Intended Audience

This report is for immediate distribution to the Eurodac Advisory Group as well as for eu-LISA. It shall also serve as a basis for decisions taken by other stakeholders and institutions and should be annexed to them.

1.3 Description of the Project

The project was initiated in Q2-2014 by eu-LISA after the request of European Commission during the Eurodac Advisory Group (AG) as the outcome of the problem raised by some Member States about incoming MSI hits on records owned by Sweden and Norway. This was shortly before the beginning of the migratory crisis. Given the nature of the tests and the lack of usable data, it is the first eu-LISA project where it is allowed to make-use of live data for testing purposes. To this avail, eu-LISA obtained a positive opinion from the EDPS on 25

November 2015 [EDPS-MSI].

After collecting the data with the consent of the data subjects, in Q4-2018 (so four years after initiating the request), Sweden and Norway achieved in collecting the necessary dataset consisting out of 6000 finger print sets from 2000 individuals (both optical and MSI scans).

Due to high volume of transactions per minute, as a side effect, the project is also partially validating the Volume tests. While the TST environment has only one PMA server without clustering or BCU, the PROD environment has three PMAs, two of which are load balanced for TP/TP searched and the third is used exclusively for LT/TP searches) and it implements clustering and BCU environment.

All technical, statistical, administrative and project management activities are coordinated by the eu-LISA Test Sector in close cooperation with all other teams of the Agency, including first, second and third level support for the participating Member States (MS). The study is conducted on the Eurodac Test Systems, which has been segregated for the duration of the campaign to prevent all unauthorized access. eu-LISA statutory staff have the rights to access the environment on a “need-to-do” basis.

2 Summary of the Tests

Project	EURODAC MSI/Optical Scan Test Study	Test Plan Version/Date	1.0 – 30/04/2015
Environment	Test Environment (TST)	Software Versions	CAFIS Version 1.40
Execution Dates	01/04/2019 – 15/05/2019		
Test Managers	SE: Swedish Migration Agency NO: Norwegian Police ICT Services		
eu-LISA Supervisor	Test and Integration Services Sector		
Test execution status	REPEATED and PASSED WITH REMARKS		
Number of issues/incident found	9 failed test cases (out of total 8000)		

2.1 Results

The following table summarises the aggregated results for all tests executed by the Member States (MS) during the EURODAC MSI/Optical Scan Test Study:

Number of... \ Status	Status					Remarks
	TOTAL PASSED	PASSED with REMARKS	REPEATED and PASSED	SKIPPED	FAILED	
RUNS	16	5	5	0	0	Total: 16 RUNS (8 / MS)
Tests	7991	0	50	0	9	Total: 8000 tests (4000 / MS)

2.2 Observations

The tests have been executed by the two participating Member States (Sweden and Norway) according to the Test Plan [MOSTP]. Each Member State, executed eight RUNS (batches of 500 tests). Each single test consisted of a single transaction with the following characteristics:

- Transaction type: **NPS** - "Non-Criminal Print-to-Print Search", ANSI/NIST formatted electronic ten-print submissions, that contain ten rolled and four plain impressions¹⁰ of all ten fingers, as well as information relative to the asylum application;
- Category: **CAT1** - Asylum applicants for international protection of at least 14 years of age (Art 9 of the Regulation (EU) 603/2013);
- The test data consisted of real fingerprints that were collected and submitted by the provided by competent national authorities of the Member States of the European Economic Area (EEA);
- Total number of individuals: **1000 individuals** per participating MS (**total 2000 individuals**);
- Total number of fingerprint sets: **3000 per participating MS (1000 optical scans, 2000 MSI scans – two times for the same person); total 6000 fingerprint sets**;
- Total number of transactions: **4000 transactions** per participating MS (**1000 optical scans sent twice and 2000 MSI scans**); **total 8000 transactions**.

2.3 Constrains

The following constraints were met before and during the tests executions:

- The existing MS data and the configuration was backup before the initiation of the project;
- Access to all MS was restricted to the Eurodac TST CS through the entire duration of the project, only the execution MS access was granted (transactions were blocked at the email server level as long at the application level);
- All MS were informed to abstain in sending transaction during the execution of the project. Any transaction that was sent to the Eurodac TST CS from a MS that did not participate was automatically sent to the rejected mailbox to be deleted;
- The eu-LISA staff, that usually has access to the Eurodac TST CS, was asked to avoid accessing the system through the duration of the projects. Access was allowed only on the need-to-access basis (i.e. technical issues fixes); Contractors access was strictly prohibited. No restricted access incidents were registered.
- The execution of the MS tests were performed in two completely separated phases.
- Before each MS phase, the CS was prepared by eu-LISA:
 - The CS database, storage and fingerprint matches (PMAs) were cleaned: the data was completely erased;
 - A background database consisting of 1890 records was installed with NIST27 publically available fingerprints (some records were duplicated for volume purposes);

3 Project Execution Log

The project was executed according to the schedule that was communicated to the MS during the 2019 February's Advisory Group (AG). The following table shows the log of the project execution as requested in the EDPS Opinion¹:

Execution Dates		Activity	Scheduled Dates	
Begin	End		Begin	End
01/03/2019		Notice ² of processing published on eu-LISA public website, including the link to the European Data Protection Supervisor's Opinion.	01/03/2019	
19/03/2019		MS informed about the restrictions to access the Eurodac TST Central System environment due to the activities in EURODAC MSI/Optical Scan Test Project	19/03/2019	
01/04/2019	05/04/2019	Preparation of TST environment for the 1st MS <ul style="list-style-type: none"> • Backup of existing data and configuration • MS traffic stopped • System cleaning (MS existing data) • Upload background database • Open traffic for 1st participating MS 	01/04/2019	05/04/2019
05/04/2019		Notice sent to eu-LISA staff informing about the exclusive access restrictions that shall apply during the execution of the tests	N/A	
08/04/2019	15/04/2019	PHASE1: Sweden Test Executions <ul style="list-style-type: none"> • Executed 8 RUNS, 4000 Tests • Sent 4075 transactions (4046 NPS, 29 DFP), 21 rejected transactions • 75 transactions are ignored for this study (human error NPS or DFP transactions) 	08/04/2019	12/04/2019

¹ EDPS Opinion (Case 2015-0082) 25/11/2015 – https://edps.europa.eu/sites/edp/files/publication/15-11-25_eurodac_msi_optical_scan_test_study_eulisa_en.pdf

² Eurodac MSI/Optical Test Study notice on eu-LISA public website – <https://www.eulisa.europa.eu/Newsroom/News/Pages/Eurodac-MSI-Optical-Test-Study.aspx>

Execution Dates		Activity	Scheduled Dates	
Begin	End		Begin	End
12/04/2019		Article published in the internal eu-LISA newsletter for all staff members about the evolution of the project, its access restrictions and link to the EDPS opinion (section: NEWS FROM THE TEAMS / News from the Test Sector)	N/A	
16/04/2019	25/04/2019	Preparation of TST environment for the 2nd MS <ul style="list-style-type: none"> • Backup of system logs and extraction of initial set of statistical values • MS traffic stopped • System cleaning (MS existing data) • Upload background database • Open traffic for 2nd participating MS 	15/04/2019	23/04/2019
25/04/2019		Reminder notice sent to eu-LISA staff informing about the exclusive access restrictions that shall apply during the execution of the tests	N/A	
29/04/2019	06/05/2019	PHASE2: Norway Test Executions <ul style="list-style-type: none"> • Executed 8 RUNS, 4000 Tests • Sent 4050 transactions (4026 NPS, 21 DFP, 3 IRQ), 10 rejected transactions 50 transactions are ignored for this study (human error NPS, DFP or IRQ transactions)	24/04/2019	30/04/2019
07/05/2019	10/05/2019	MS activities wrap up & contingency <ul style="list-style-type: none"> • MS traffic stopped • Backup of system logs and extraction of initial set of statistical values 	02/05/2019	10/05/2019
13/05/2019	15/05/2019	Restoration of the TST environment <ul style="list-style-type: none"> • System cleaning (MS existing data) • Restoration of the system backup • System and database configuration • Minutia unload • Open traffic for all MS 	13/05/2019	17/05/2019

Execution Dates		Activity	Scheduled Dates	
Begin	End		Begin	End
15/05/2019		Project closure <ul style="list-style-type: none"> MS informed about the restoration of access Agency's staff members informed about the closure of the project and about the lifting of access restrictions 	N/A	

3.1 Test execution results

The project was executed in two phases (one independent phase for each MS). The following tables show the total number of transactions sent to the CS, the transaction types (NPS, DFP and IRQ) and the distribution of Optical finger print sets and MSI fingerprint sets. The percentage values indicate the ratio out of the total. The Target values represent the expected results as described in the Test Plan [MOSTP]. The difference is computed between the total values and the expected results.

3.1.1. PHASE1: Sweden Test Executions

Total Number of Transactions

Result	Total	Optical trans.	MSI trans.	Target	Difference
Total number of transactions	4075	2029 (49.97%)	2046 (50.03%)	4000	+75 (+1.88%)
Total number of NPS transactions	4046	2018 (49.88%)	2028 (50.12%)	4000	+46 (+1.15%)
Total number of DFP transactions	29	11 (37.93%)	18 (62.07%)	0	+29 (+0.73%)

Out of the **4075** transactions, **4046** were NPS transactions used for the execution of the tests as described in the Test Plan, the rest where DFP transaction used to correct the human mistakes (deviations to the Test Plan).

There were no other types of transactions.

System Accepted Transactions

Result	Total	Optical trans.	MSI trans.	Target	Difference
Total number of accepted transactions	4054	2022 (49.88%)	2032 (49.87%)	4000	+54 (+1.35%)
Total number of accepted NPS transactions	4027	2011 (49.94%)	2016 (49.83%)	4000	+27 (+0.68%)

Result	Total	Optical trans.	MSI trans.	Target	Difference
Total number of accepted DFP transactions	27	11 (40.74%)	16 (59.26%)	0	+27 (+0.68%)

The numbers of accepted transactions indicate the results without any system error.

The **27** DFP transactions were used to erase the **27** NPS human mistake sent transactions. The tests were repeated. All mistakes were immediately reported by the MS, reviewed by eu-LISA and the corrections were accepted. The mistaken transactions were excluded (ignored) for this study.

System Rejected Transactions

Result	Total	Optical trans.	MSI trans.	Target	Difference
Total number of rejected transactions	21	7 (33.33%)	14 (66.67%)	0	+21 (+0.53%)
Total number of rejected NPS transactions	19	7 (36.84%)	12 (63.16%)	0	+19 (+0.48%)
Total number of rejected DFP transactions	2	0 (00.00%)	2 (100.00%)	0	+2 (+0.05%)

The 21 transaction were rejected by the Central System as the result of human error, but they are not take into consideration for this study, as they were repeated by sending the corrected transactions.

3.1.2. PHASE2: Norway Test Executions

Total Number of Transactions

Result	Total	Optical trans.	MSI trans.	Target	Difference
Total number of transactions	4050	2031 (50.15%)	2019 (49.85%)	4000	+50 (+1.25%)
Total number of NPS transactions	4026	2017 (50.10%)	2009 (49.90%)	4000	+26 (+0.65%)
Total number of DFP transactions	21	13 (61.90%)	8 (38.10%)	0	+21 (+0.53%)
Total number of IRQ transactions	3	1 (33.33%)	2 (66.67%)	0	+3 (+0.08%)

Out of the 4050 transactions, **4026** were NPS transactions used in the execution of the tests as described in the Test Plan, the rest where **21** DFP transaction used to correct the human mistakes (deviations to the Test Plan) and **3** IRQ transactions used to verify the records saved in the central system. There were no other types of transactions.

System Accepted Transactions

Result	Total	Optical trans.	MSI trans.	Target	Difference
Total number of accepted transactions	4040	2027 (50.17%)	2013 (49.70%)	4000	+40 (+1.00%)
Total number of accepted NPS transactions	4018	2013 (50.10%)	2005 (49.80%)	4000	+18 (+0.45%)
Total number of accepted DFP transactions	19	13 (68.42%)	6 (31.58%)	0	+19 (+0.48%)
Total number of accepted IRQ transactions	3	1 (33.33%)	2 (66.67%)	0	+3 (+0.08%)

The numbers of accepted transactions indicate the results without any system error.

The **19** DFP transactions were used to erase the **19** NPS human mistake sent transactions. Total remaining accepted NSP transactions: 3999 (where 1999 NPS MSI transactions). Even if the threshold for acceptance of the test results is 4000 NPS transactions (i.e. 2000 MSI transactions), the difference of 1 NPS transaction is added to the total of failed test cases (the NO1MSB0973-6 record was a valid transaction that not accepted by the Central System), that validating the phase..

System Rejected Transactions

Result	Total	Optical trans.	MSI trans.	Target	Difference
Total number of rejected transactions	10	4 (40.00%)	6 (60.00%)	0	+10 (+0.25%)
Total number of rejected NPS transactions	8	4 (50.00%)	4 (50.00%)	0	+8 (+0.20%)
Total number of rejected DFP transactions	2	0 (0.00%)	2 (100.00%)	0	+2 (+0.05%)
Total number of rejected IRQ transactions	0	0	0	0	0

The 10 transaction were rejected by the Central System as the result of human error, but they are not take into consideration for this study, as they were repeated by sending the corrected transactions.

3.2 The Alternate Method Tests (AMT)

Total number of tests designed in the Test Pan [MOSTP] is **8000** (4000 test cases per Member State, 8 RUNs for each MS phase, 500 test cases for each RUN).

"The 1000 unique individuals are randomly ordered in a fixed array. Except the FPS scans, no other personal identification must be submitted, but the initial order is to be kept through all the steps of the study. For each 1000 unique individuals, a set of 1000 ten-print FPS should be provided for each scanning technology: 1000

Optical FPS and 1000 MSI FPS. In order to perform the Positive Matching tests and the Negative Matching tests with the same sets of data, each set of 1000 FPS is to be divided into sub-sets of 500 FPS that will be submitted to the CS in an alternate way” [MOSTP, page 14 – Section 4.2 The Alternate Method Tests Phase (AMT)]

- Sets A1 and A2 – Optical Scans
- Sets B1 and B2 – MSI Scans (same individuals)
- Sets C1 and C2 – Additional MSI scans (some individuals)

3.3 Designed Test Cases and RUNs

Total number of tests designed in the Test Pan [MOSTP] is **8000** (4000 test cases per Member State, 8 RUNs for each MS phase, 500 test cases for each RUN)

- **RUN1** - 500 NPS CAT1 Set A1 (**Optical**) with no hit - 1st insertion
- **RUN2** - 500 NPS CAT1 Set B2 (**MSI**) with no hit
- **RUN3** - 500 NPS CAT1 Set A2 (**Optical**) with hits on CAT1 MSI cases (CC1MSAXXXX-2) - 1st insertion
- **RUN4** - 500 NPS CAT1 Set B1 (**MSI**) with hits on CAT1 Optical cases (CC1OPTXXXX-1)
- **RUN5** - 500 NPS CAT1 Set C1 (**Additional MSI**) with hits on CAT1 Optical (CC1OPTXXXX-1) cases and on CAT1 MSI (CC1MSAXXXX-4) cases
- **RUN6** - 500 NPS CAT1 Set C2 (**Additional MSI**) with hits on CAT1 Optical (CC1OPTXXXX-3) cases and on CAT1 MSI (CC1MSAXXXX-2) cases
- **RUN7** - 500 NPS CAT1 Set A1 (**Optical**) with hits on CAT1 Optical (CC1OPTXXXX-1) cases, on CAT1 MSI (CC1MSAXXXX-4) cases and on CAT1 Additional MSI (CC1MSBXXXX-5) cases – 2nd insertion
- **RUN8** - 500 NPS Set A2 (**Optical**) with hits on CAT1 MSI (CC1MSAXXXX-2) cases, on CAT1 Optical (CC1OPTXXXX-3) cases and on CAT1 Additional MSI (CC1MSBXXXX-6) cases – 2nd insertion

RUN	TYPE	FPS	MN1 begin	MN1 end	Hits count / RUN	Hits count / trans.
1	OPT	A1	CC1OPT0001-1	CC1OPT0500-1	0	0
2	MSI	B2	CC1MSA0501-2	CC1MSA1000-2	0	0
3	OPT	A2	CC1OPT0501-3	CC1OPT1000-3	500	1
4	MSI	B1	CC1MSA0001-4	CC1MSA0500-4	500	1
5	MSI	C1	CC1MSB0001-5	CC1MSB0500-5	1000	2
6	MSI	C2	CC1MSB0501-6	CC1MSB1000-6	1000	2
7	OPT	A1	CC1OPT0001-7	CC1OPT0500-7	1500	3
8	OPT	A2	CC1OPT0501-8	CC1OPT1000-8	1500	3

The aggregated results and the results for each MS are listed in the following tables:

Result	Total MS	RUNs								Total	
		1	2	3	4	5	6	7	8		
Designed TCs	Total	1000	1000	1000	1000	1000	1000	1000	1000	1000	8000
	MS	500	500	500	500	500	500	500	500	500	4000
Executed TC	Total	1000	1000	1000	1000	1000	1000	1000	1000	1000	8000
	SE	500	500	500	500	500	500	500	500	500	4000
	NO	500	500	500	500	500	500	500	500	500	4000

3.4 PASSED Test Cases

The total number of **Passed Test Cases** is **7991** (where the expected result indicate 8000). The difference of **nine** test cases is considered **FAILED** as described in the following sections.

Result	Total MS	RUNs								Total
		1	2	3	4	5	6	7	8	
Passed TCs	Total	986	992	994	988	991	996	998	996	7941
	SE	486	493	498	490	491	499	498	500	3955
	NO	500	499	496	498	500	497	500	496	3986
Repeated and Passed TCs	Total	14	8	5	12	7	2	0	2	50
	SE	14	7	2	10	7	1	0	0	41
	NO	0	1	3	2	0	1	0	2	9
Total Passed TC	Total	1000	1000	999	1000	998	998	998	998	7991
	SE	500	500	500	500	498	500	498	500	3996
	NO	500	500	499	500	500	498	500	498	3995

The execution of **Repeated and Passed test cases** consist of NPS transactions that failed or NPS transactions that were sent wrong (compared to the Test Plan), that were deleted using DFP transactions and then resent to the CS, having the result identical to the expected result described in the Test Plan.

3.5 SKIPPED Test Cases

There were no **Skipped Test Cases** for both Member States.

3.6 FAILED Test Cases

The results of **59** Test Cases were not identical to the expected result described in the Test Plan. MS decided that some of the transactions were sent wrong due to human error. Each such transactions was manually validated. Thus, for some of the failed test case, MS deleted the corresponding records from the Central System database, sending DFP transactions and then tried to resent the records again.

50 resubmitted transactions succeeded (**Repeated and Passed Test Cases**) and **1** failed (**Repeated and Failed Test Cases**).

Due to the lack of available fingerprints, **8 Failed Test Cases** were not repeated.

Result	Total MS	RUNs								Total
		1	2	3	4	5	6	7	8	
Failed TC	Total	0	0	1	0	2	1	2	2	8
	SE	0	0	0	0	2	0	2	0	4
	NO	0	0	1	0	0	1	0	2	4
Repeated and Failed TC	Total	0	0	0	0	0	1	0	0	1
	SE	0	0	0	0	0	0	0	0	0
	NO	0	0	0	0	0	1	0	0	1
Final Failed TC	Total	0	0	1	0	2	2	2	2	9
	SE	0	0	0	0	2	0	2	0	4
	NO	0	0	1	0	0	2	0	2	5

The status of the following test cases is considered final FAILED:

Failed TC

- SE-RUN5-SE1MSB0249-5 (MSI) – missing hit on SE1OPT0249-1 (Optical), expected 2 hits
- SE-RUN5-SE1MSB0475-5 (MSI) – missing hit on SE1OPT0475-1 (Optical), expected 2 hits
- SE-RUN7-SE1OPT0249-7 (Optical) – missing hit on SE1MSB0249-5 (MSI), expected 3 hits
- SE-RUN7-SE1OPT0475-7 (Optical) – missing hit on SE1MSB0475-5 (MSI), expected 3 hits
- NO-RUN3-NO1OPT0794-3 (Optical) – missing hit on NO1MSA0794-2 (MSI), expected 1 hit
- NO-RUN6-NO1MSB0794-6 (MSI) – missing hit on NO1MSA0794-2 (MSI), expected 2 hits

- **NO-RUN8- NO1OPT0794-8** (Optical) – missing hit on NO1MSA0794-2 (MSI), expected 3 hits
- **NO-RUN8-NO1OPT0973-8** (Optical) – missing hit on NO1MSB0973-6 (MSI), expected 3 hits

Note that the record **NO1MSB0973-6** was not stored in the Central System as its insertion transaction was rejected. See the Repeated and Failed **NO-RUN6- NO1MSB0973-6** (MSI) Test Case.

Repeated and Failed TC

- **NO-RUN6- NO1MSB0973-6** (MSI) – transaction rejected by the Central System due to fingerprints quality in both attempts.

3.7 Documentation Issues

The following issues were identified by the Member States within the provided documentation during the execution of the tests.

3.7.1. Test Plan Errata

Page 8, Section 2.4.2 The Alternate Method Tests Phase (AMT):

<< *The Alternate Method consists of:*

- **8** Runs of **500** FPS transactions = **4000** transactions
 - **2** Runs of **500** DELETE transactions = **1000** transactions
- Total: **10** Runs of **500** transactions = **5000 transactions** >>

Read as:

<< *The Alternate Method consists of:*

- **8** Runs of **500** FPS transactions = **4000** transactions
 - ~~**2** Runs of **500** DELETE transactions = **1000** transactions~~
- Total: **8** Runs of **500** transactions = **4000 transactions** >>

Reason: while ALL the records sent by the Member States are completely erased at the end of each MS Phase, the DFP transactions used to erase the previous inserted records are not needed in this context.

4 Quantitative Metrics

The purpose of this study is NOT to validate compliance of National NAP/FIT stations by counting the number of passed/failed tests. Its purpose is to check if the usage of MSI devices for taking fingerprints that are stored / searched in the Eurodac system does not compromise the results obtained by the system (compared to the current status and fingerprint taking methods used). Therefore, the following Quantitative Metrics have been defined to evaluate the MSI technology:

4.1 Acceptance/Rejection Response Time by Central Unit

Defined in EURODAC MSI/Optical Scan Test Strategy 2.2 [MOSTS] – page 12, section 3. Quantitative Metrics.

Result	Average MS	Total	Optical trans.	MSI trans.	Target	Difference (Total to Target)
Acceptance Response Time by Central Unit	Average	00:01:21.6	00:02:19.7	00:00:23.3	1 min	+00:00:21.6 (+35.92%)
	SE	00:02:06.2	00:03:54.5	00:00:18.4		+00:01:06.2 (+110.31%)
	NO	00:00:36.8	00:00:45.3	00:00:28.2		-00:00:23.2 (-38.73%)
Rejection Response Time by Central Unit	Average	00:02:09.1	00:05:55.5	00:00:04.6	1 min	+00:01:09.1 (+115.16%)
	SE	00:03:09.8	00:09:18.6	00:00:05.4		+00:02:09.8 (+216.27%)
	NO	00:00:01.7	00:00:00.0	00:00:02.8		-00:00:58.3 (-2.83%)

The values are listed in **hh:mm:ss.ms** format, where **hh** = hours, **mm**=minutes, **ss**=seconds, **ms** = milliseconds.

Depending on the quality of the scanned fingerprint images, the size of the NIST files encapsulated into transactions, as long as the load of the Central System processing other transactions, the response times may vary.

As listed, the response times are higher for the tests executed by Sweden. This is explained by the method used to execute the tests: send all 500 transactions of each RUN at one (without any delay between).

The first observed effect was the increased delay in CS provided replays (**exceeding the target limit in case of Optical transactions**, where **MSI transactions scored** with an average of **41 seconds lower than the target**).

The second observed effect is that, even the Central System managed to cope with the high load, the National System crashed several times due to the heavy reply load. However, this is not in the scope of the current project.

In case of Norway, the chosen method was to send the 500 transactions of each RUNs in smaller batches (up to 20 transactions) with a small delay between each batch. Under these conditions, the Central System provided all the replies very low under the Target threshold. Still, the MSI transactions scored the lowest time scores

(with 31 seconds lower than the Target) with the record of 2 seconds average for rejected transactions.

Overall, the maximum values on Acceptance Response Time are for **Optical = 32 min and 22 sec**, for **MSI = 01 min and 15 sec**. On Rejection Response Time, the maximum values are for **Optical = 21 min and 17 sec**, for **MSI= 9 sec**.

4.2 CU Processing Response Time of Central Unit

Defined in EURODAC MSI/Optical Scan Test Strategy 2.2 [MOSTS] – page 12, section 3. Quantitative Metrics.

Result	Average MS	Total	Optical trans.	MSI trans.	Target	Difference (Total to Target)
Average Processing Response Time (all transactions, including NPS, DFP and IRQ)	Average	00:01:21.7	00:02:20.3	00:00:23.2	3 min.	-00:01:38.3 (-54.59%)
	SE	00:02:06.5	00:03:55.6	00:00:18.4		-00:00:53.5 (-29.72%)
	NO	00:00:36.7	00:00:45.2	00:00:28.1		-00:02:23.3 (-79.62%)
Average Processing Response Time (only NPS Transactions)	Average	00:01:22.2	00:02:21.1	00:00:23.3	3 min.	-00:01:37.8 (-54.33%)
	SE	00:02:07.3	00:03:56.8	00:00:18.4		-00:00:52.7 (-29.25%)
	NO	00:00:36.8	00:00:45.4	00:00:28.2		-00:02:23.2 (-79.53%)

The Average Processing Response Time for other types of transactions (i.e. DFP, IRQ) is not in the scope of the current project, as these kind of transactions do not send any kind of fingerprint images.

As mentioned in the previous section, the response times are influenced by the load of the Central System while processing a high number of transactions. This is observed here too, on the Average times of Sweden **Optical transactions (+57 average seconds above the threshold Target)**. Interesting is that on their MSI transactions the Central System scored very low Average Processing Response Times (**with 2 minutes and 42 seconds lower than the Target**). This can be explained that the Optical scans are bigger in size, due to the big level of noise (i.e. dirty fingerprint images, burned or cut fingerprints) present in the images, while this noise is removed artificially from the MSI images.

For the transactions sent by Norway, the Average Processing Response Times are lower than the Target for both Optical and MSI transactions, while the MSI times are still the lowest (**with 2 minutes and 32 seconds lower than the Target**) for the same reasons.

Overall, the maximum values are for **Optical = 32 min and 22 sec**, for **MSI = 01 min and 15 sec**.

4.3 Ten Print Matching Accuracy

Defined in EURODAC MSI/Optical Scan Test Strategy 2.2 [MOSTS] – page 12, section 3. Quantitative Metrics.

Result	Sum MS	Total	Optical trans.	MSI trans.	Target	Difference (Total to Target)
Total number of transactions IGNORED for the study	Σ	125	60	65	0	125
	SE	75	29	46	0	75
	NO	50	31	19	0	50
Total number of transactions ACCEPTED for the study	Σ	8000	4000	4000	8000	0
	SE	4000	2000	2000	4000	0
	NO	4000	2000	2000	4000	0

125 transactions were ignored in the computation of the Ten Print Matching Accuracy, for several reasons:

- DFP and IRQ transactions do not send fingerprints images
- NPS transactions that were send wrong due to human error, but they were replaced by new records

Only NSP transactions were accepted, even if the corresponding test case failed.

As the number of accepted transactions match the target (for both Member States and for both scanning technologies), the minimum acceptance criteria is met.

Result	Sum MS	Total	Optical trans.	MSI trans.	Target	Difference (Total to Target)
Positive matching accuracy	Σ	7991 (99.89%)	3995 (99.88%)	3996 (99.90%)	7992 (99.9%)	-1 (-0.01%)
	SE	3996 (99.90%)	1998 (99.90%)	1998 (99.90%)	3996 (99.9%)	0 (0.00%)
	NO	3995 (99.88%)	1997 (99.85%)	1998 (99.90%)	3996 (99.9%)	-1 (-0.01%)

The Positive matching accuracy is calculated as the percentage of transactions that received the correct hits out of the total number of transactions. For this study, the minimum Positive matching accuracy is set at 99.9%. The acceptance criteria on **Positive matching accuracy is matched only on MSI transactions for both Member States**, while on Optical transactions is matched only for Sweden (but this is out of scope of the study).

Result	Sum MS	Total	Optical trans.	MSI trans.	Target	Difference (Total to Target)
Negative match accuracy	Σ	8000 (100%)	4000 (100%)	4000 (100%)	7960 (99.5%)	+40 (+0.50%)
	SE	4000 (100%)	2000 (100%)	2000 (100%)	3980 (99.5%)	+20 (+0.50%)
	NO	4000 (100%)	2000 (100%)	2000 (100%)	3980 (99.5%)	+20 (+0.50%)

The Negative match accuracy is calculated as the percentage of transactions that did NOT receive any extra hit that was not expected as designed in the Test Plan [MOSTP] out of the total number of transactions. The acceptance criteria (99.5%) on The Negative match accuracy is matched on both Optical and MSI transactions for both Member States (100%)

5 Conclusions

Considering that the acceptance criteria is matched for all Metrics on MSI transactions, while Optical transactions metrics are out of scope of this study, the execution of the test campaign is validated.

While the failed number of tests is equal for both Optical transactions tests and MSI transactions tests, using the MSI scans with Eurodac Central System, a list of benefits can be concluded from the results of the tests:

- MSI transactions scored faster Acceptance/Rejection Response Time by Central Unit compared with Optical transactions. Thus, by using MSI the response of the Central System on Rejected transactions due to human error can be faster;
- While on Average Processing Response Times the MSI transactions scored under the threshold target, the Optical transactions scored more than the threshold. On high volume of transactions, the use of MSI may decrease the waiting times on hit replies;
- As the valuation of the Ten Print Matching Accuracy on Optical transactions is out of scope of this study, both the Positive matching accuracy and the Negative match accuracy rates are matched by the MSI scan transactions. Therefore, the use of MSI technology may not decrease the current level of accuracy of the Eurodac Central System.

5.1 Recommendations

The use of the MSI scanning technologies in the Eurodac Test environment did not prove to bring any drawbacks or regression to the correct functionality of the system. On the other hand, considering that the MSI scans involve additional processing of the fingerprint images (side that is not examined by this study), eu-LISA cannot certify that the work of the biometric fingerprint experts will be simplified or not. This aspect is to be settled by each Member State with the team of biometric experts of its own.

As the cost / benefits ratio is different from Member State to Member State, eu-LISA recommends that the use of both scanning technologies may be implemented at the same time in parallel, depending on the need and budget of each Member State.

5.2 Action Plan

The results of this study are shared with the members of the Advisory Group that may use them to decide if the use of MSI scanning technologies may or may not be adopted in the production Eurodac system.



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