FRONTEX
EUROPEAN BORDER AND COAST GUARD AGENCY

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Results of **Research & Innovation** activities

2020
2021
2022

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This is a Frontex staff working document elaborated to inform Member States, the European Parliament and the European Commission on the results of Frontex research and innovation activities in 2020. Also, this report makes the information on research project budgets and partners public, as required by Regulation 2019/1896.

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1. Foreword

"Innovation should be seen as a strategic tool to counter current threats and to anticipate both future risks and opportunities. Innovative technologies can bring new tools to help law enforcement and other security actors."

Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions on the EU Security Union Strategy

Frontex is continuously developing the capabilities of the European Border and Coast Guard. Research and innovation is part of this process, steering the EU border security research, guiding the identification of new solutions for border management, testing their relevance, and relative advantage against current technologies. Frontex also supports the operational implementation of the tested solutions, their interoperability and continuous performance.

This report is an overview of results of Frontex's research and innovation activities in 2021.

In the coming years, the way people cross borders will change with the implementation of the Entry Exit System (EES), and the related advent of new technologies, for example advanced biometric systems. Research and innovation activities help EU Member States and EU institutions prepare for these challenges and modernise border management processes.

Last year, we focused on technologies that will make crossing borders easier for both travellers and border guards and supported the Member States in implementing these. This included conducting a research study on technology foresight on biometrics for the future of travel, in which we identified priority biometric technologies for research, planning, and decision-making purposes. Another example are the Entry Exit System Land Border Pilot Projects, which delivered comprehensive simulations of the EES processes and applied novel technological solutions to facilitate seamless border crossings. The lessons learnt during these projects will allow Member States and EU agencies to adjust the solutions for the entry into operation of the EES and prepare for the challenges ahead.

In 2021, Frontex also tested how tethered aerostats can be used for maritime surveillance. The tested solutions have the potential to deliver high performance, reliable and cost-efficient maritime surveillance services, separately or together with other surveillance solutions.

We also continued our activities within the EU Innovation Hub for Internal Security and offered other EU Justice and Home Affairs agencies privileged access to our research and innovation activities.

Frontex firmly believes that cooperation with the Member States and other partners is key to understanding the needs of the European Border and Coast Guard (EBCG) community.

In this report, you will find out how we engaged with Member States and Schengen Associated Countries on research and innovation. Further, you will also have the opportunity to read about Frontex's dialogue with industry during our thematic industry days, which allowed companies to share state-of -the-art solutions with the wider audience of the EBCG community.

Last but not least, please note that the commercial partners we are working with are registered in the EU. This contributes to the objective to strengthen the EU's strategic autonomy.

Frontex thanks everyone who contributed to the research and innovation activities included in this report. The European Border and Coast Guard Agency hopes to continue working with you and for you, for ever secure and safe EU external borders.

2. List of acronyms

AI	Advance Information
API	Advance Passenger Information
BCP	Border Crossing Point
BoMIC	Border Management Innovation Centre
CIR	Common Identity Repository
CIRAM	Common Integrated Risk Analysis Model
CMS	Common Minimum Standards
CONOPS	Concept of Operations
CRT	Cosmic Ray Tomography
DG HOME	The Directorate-General for Migration and Home Affairs
DG JRC	European Commission's Directorate-General Joint Research Centre
EBCG	European Border and Coast Guard
EBCGA	European Border and Coast Guard Agency (Frontex)
EES	Entry/Exit System
EIBM	European Integrated Border Management
ESP	European Search Portal
ETM	Earliest Time to Mainstream
ETIAS	European Travel Information and Authorisation System
EU-ANSA	EU Agencies Network on Scientific Advice
Eu-LISA	EU Agency for the Operational Management of Large-Scale IT Systems
EURODAC	European Asylum Dactyloscopy Database
HCG	Hellenic Coast Guard
ICAO - NTWG	International Civil Aviation Organization - New Technologies Working Group
ICBB	International Conference on Biometrics for Borders
IPA	Instrument for Pre-accession Assistance
IMO	International Maritime Organisation
Interpol	The International Criminal Police Organization
IOM	International Organisation for Migration
ISGS	Interservice Group on Space
ISO	International Organisation for Standardisation
KTC	Key Technological Clusters
MSs / SACs	Member States / Schengen Associated Countries
MTS	Methodology for Development of Technical Standards
OSCE	Organization for Security and Co-operation in Europe
REA	Research Executive Agency
R&I	Research and Innovation
RTO	Research and Technology Organisation
sBMS	Shared Biometric Matching Service
SSS	Self-Service Systems

TRL Technology Readiness Levels[1]
Where a topic description refers to a TRL, the following definitions apply, unless otherwise specified:

- TRL 1 – basic principles observed
- TRL 2 – technology concept formulated
- TRL 3 – experimental proof of concept
- TRL 4 – technology validated in lab
- TRL 5 – technology validated in relevant environment (industrially relevant environment in the case of key enabling technologies)
- TRL 6 – technology demonstrated in relevant environment (industrially relevant environment in the case of key enabling technologies)
- TRL 7 – system prototype demonstration in operational environment
- TRL 8 – system complete and qualified
- TRL 9 – actual system proven in operational environment (competitive manufacturing in the case of key enabling technologies; or in space)

UNOCT United Nations Office of Counterterrorism
VTOL Vertical Take Off and Landing
WCO World Customs Organisation

1 Source: HORIZON 2020 – WORK PROGRAMME 2016-2017, available here: https://ec.europa.eu/research/participants/data/ref/h2020/wp/2016_2017/main/h2020-wp1617-intro_en.pdf

3. Executive Summary

Regulation 2019/1896 requires that Frontex inform Member States, the Commission and the European Parliament on the results of its research and innovation activities, and make public information on its research projects, including demonstration projects, the cooperation partners involved and the project budget. In the same vein as the *Report on results of research and innovation activities 2020*,[2] this report intends to complement and compile in one document the information on the results of research and innovation projects and activities which, in many cases, have already been made publicly available in the course of 2021.

The report is structured to present the results of Frontex activities obtained during the reporting period in the following clusters:

i. research activities, to which a technical readiness level (TRL) of 1 to 5 is assigned (in a scale of 1 to 9 of technological maturity);
ii. technology innovation activities, at a TRL of 6 to 9, referring to the testing of new technologies for border checks and border surveillance;
iii. activities ensuring interoperability and consistent performance.

The main results of Frontex activities on research and innovation in 2021 include:

- the continued input of Frontex as Senior User to the EU's framework programme on research & innovation;
- the research study on Technology Foresight on Biometrics for the Future of Travel;
- the pilot project on Maritime Surveillance Aerostat II, hosted in Greece;
- the pilot project testing and simulating the implementation of solutions relevant for the Entry/Exit System at Land Borders, hosted in Spain and Bulgaria;
- the first iteration of technical standards for equipment to be deployed in Frontex activities;
- the third edition of the International Conference on Biometrics for Borders, focusing on interoperability at the EU's external borders, considering a future vision of biometrics;
- the study on Advance Information on land and sea borders.

The activities which were ongoing and whose final results were not yet available at the beginning of 2022 will be presented in the next iteration of the report. In the meantime, regular updates on research and innovation activities will be shared via the Frontex website.

In addition, in 2021 Frontex implemented its research and innovation activities in the context of the setting up of the EU Innovation Hub for Internal Security. Specifically, two of the activities listed above were implemented as quick-win projects of the EU Innovation Hub.

The total amount of Frontex budget spent for contracts relevant for the implementation of specific research and innovation projects presented in this report reaches almost EUR 5 million.[3]

2 Results of Research & Innovation activities 2020 (europa.eu)

3 This amount does not include the cost of meeting logistics (other than the International Conference on Biometrics for Borders), reimbursement of participation of Member State experts, or Frontex staff missions. Details are available in Annex II. Further, this amount does not correspond to the budget allocation for research and innovation in Frontex budget 2021, as some of the activities presented were committed in previous years.

4. Introduction – Note on report's content and structure

In accordance with Article 66(1) of Regulation 2019/1896, Frontex 'shall disseminate the results of … research [and innovation activities relevant for border management] to the European Parliament, to the Member States and to the Commission.' Further, pursuant to Article 66(5), Frontex 'shall make public information on its research projects, including demonstration projects, the cooperation partners involved and the project budget.'

This report focuses on presenting the results obtained or completed in the year 2021. Thus, activities performed totally or partly during previous years that have led to a result in 2021 are also in scope. This approach reflects the complexity of research and innovation processes, whose preparation and implementation runs, in many cases, over several years. While information on specific and general activities contained herein has been shared with the public via news releases and publications available on websites,[4] or shared with experts through presentations in meetings and technical documents, this report offers a unique compilation. References to information available online are included where relevant.

In addition to the activities and projects whose results are included in the report, other activities, typically contributing to projects managed by other Frontex entities, are briefly mentioned. In a similar manner, activities ongoing or under preparation are listed in the final chapter, even if not completed within the reporting period.

The Annexes include a list of key reports on topics relevant to research and innovation as well as information on the budget and cooperation partners of the projects for the report's timeframe. The report's structure reflects the components of Frontex research and innovation activities, following the Agency's mandate as expressed in Article 10(z) and Articles 64 and 66.

The research and innovation activities presented in this document were implemented in parallel and, in specific cases, in direct cooperation with the EU Innovation Hub for Internal Security.[5] Since its launch, Frontex has strongly supported the establishment of the Hub with both financial and human resources contributions, participating in the Hub discussions. In 2021 the Agency was in the lead of two out of the five Hub's projects: The Technology Foresight on Biometrics and the Entry-Exit System Pilot Project,[6] sharing with the Innovation Hub members[7] information and fresh insights as these activities were implemented in the course of 2021.

4 For example: (i) information on research and innovation activities on Frontex website: Announcements (europa.eu) or (ii) information on tenders launched and tender results available on EU tendering website Contracts awarded by EU Institutions – https://ted.europa.eu/TED/search/canReport.do, or other reports such as Consolidated Annual Activity Report or Annual Implementation Report.

5 The EU Innovation Hub for Internal Security is a coordination instrument set up to support the participating entities in sharing information and knowledge, setting up joint initiatives, and disseminating findings and technological solutions: https://data.consilium.europa.eu/doc/document/ST-7829-2020-INIT/en/pdf.

6 The results of these projects are included in this report.

7 Entities participating in the EU Innovation Hub for Internal Security: Europol, Frontex, eu-LISA, Eurojust, the EU Agency for Fundamental Rights, the European Monitoring Centre for Drugs and Drug Addiction, the European Institute for Gender Equality, the European Asylum Support Office, the European Union Agency for Law Enforcement Training, Member States and the Commission.

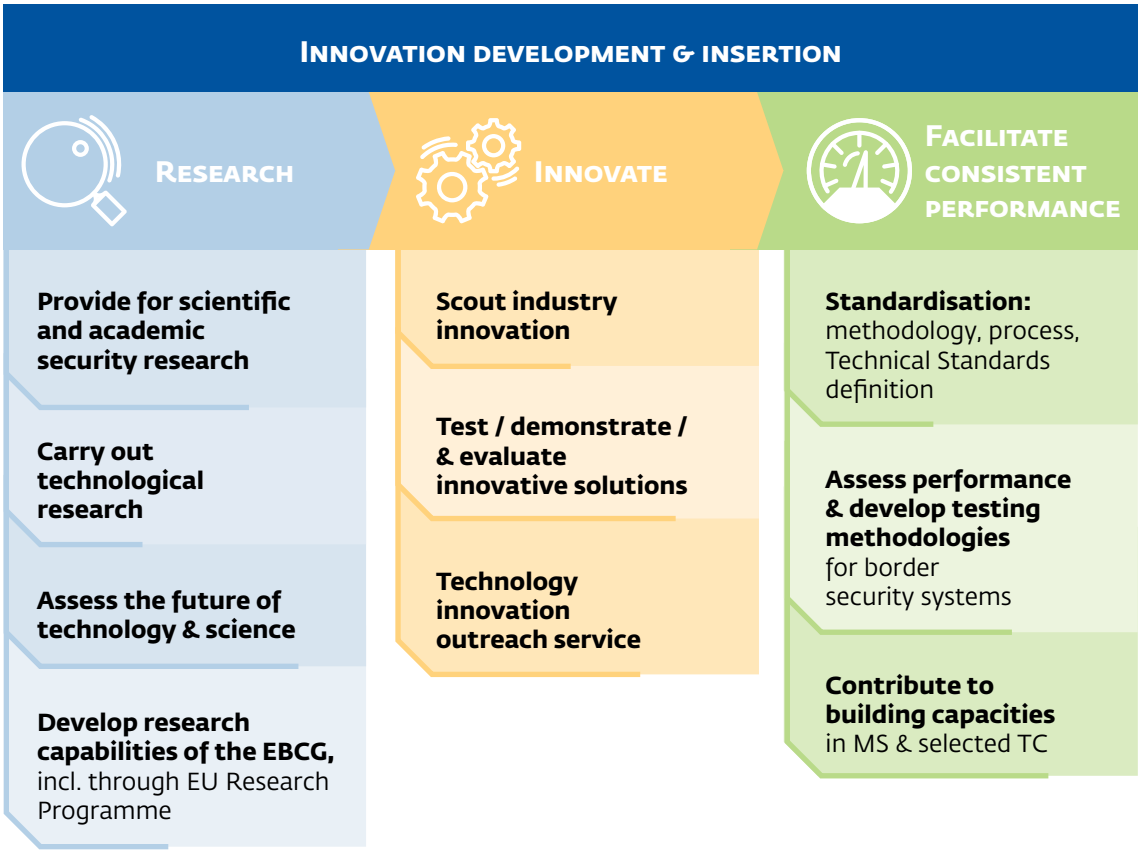
5. Supporting EU border security research

EU Research & Innovation Programmes and Frontex Involvement

In February 2020, Frontex and the Commission's Directorate-General for Migration and Home Affairs (DG Home) co-signed the Terms of Reference[8] regarding Frontex's role in the EU's Research & Innovation programmes, which laid the foundation for a closer partnership and an enhanced Frontex contribution to maximising EU research as a joint goal-oriented effort.

Under these Terms of Reference, Frontex provides its assistance to DG Home in relation to projects in the border security domain, namely in the areas of programming, evaluation of research proposals, monitoring and assimilation of project results.

Frontex actively participates in a wide range of selected activities of border-security projects, such as tests, trials and demonstrations of technologies.



Main research and innovation areas at Frontex

8 Frontex to provide border security expertise to European Commission's research projects (europa.eu)

With Horizon Europe, the new framework programme for research and innovation covering the period 2021-2027, Frontex's role is further strengthened since the border management research proposals formulated by the consortia of industry and academia should address the priorities of the EBCG community starting from the design and engage with Frontex in the implementation of the projects. The proposals should also give Frontex a key role in validating the project outcomes, with the aim of facilitating future uptake of innovations for the border and coast guard community.

In this context, Frontex provided diverse, numerous and user-perspective contributions to the EU funded border security research projects: feedback on projects, participation in Horizon 2020 project reviews, meetings, workshops and demonstrations, facilitation of interaction with Frontex operational departments and initiation of common endeavours, and dissemination of the projects content and results to the EBCG community (the annual workshop where end users take note of the new EU funded border security projects; or presentations of ongoing projects and their interim progress results to the experts participating in the meetings of Innovation Cells).

Additionally, Frontex has been following a number of border security research projects under the EU research framework programme and aims to share the outcomes of its engagement with the wider EBCG community. Two projects were finalised in 2021: ANDROMEDA and COMPASS2020. Frontex participated in several of their activities and provided feedback.

Concerning the Andromeda project, according to its User Community Final Report, three surveys during the project's trials and one after the Final Workshop and Demonstration Event were run for collecting end-users' and external partners' opinions on topics including the potential of ANDROMEDA. According to the survey results, 'The overall impression of the ANDROMEDA platform was that it was user friendly, easy to use and efficient in most real-life operations. ANDROMEDA solution supports interagency cooperation for land and maritime border surveillance and information sharing between agencies. The platform provides interaction between different operation centres and Command and Control (C2) systems on the available assets. Speed, clarity and reliability impressed multiple respondents.'

In turn, the COMPASS2020 project, led by an end-user (Direcção-General da Autoridade Marítima), demonstrated the combined use and seamless coordination of manned and unmanned assets to achieve greater coverage, better quality of information and shorter response times in maritime surveillance operations.

In addition to the projects listed on the dedicated section of the Frontex website[9] and described in the report *Results of Research and Innovation activities 2020*[10] (MIRROR, PERCEPTIONS, ARESIBO, D4FLY, BorderSense, COMPASS 2020, ILEAnet, MEDEA, ITFLOWS, METICOS, ISOLA, ENTRANCE, BorderUAS, iMARS, EFFECTOR), six new projects were launched in 2021 and will be monitored and supported by Frontex during their lifetime (two to four years):

9 Horizon projects (europa.eu)
10 RI_activities_2020.pdf (europa.eu)

Project CRITERIA will develop a novel risk analysis and vulnerability methodology building upon existing methodologies such as CIRAM and introducing more complex and effective indicators which overcome important limitations of existing models.

Project AI-ARC has the purpose of creating a new system (Virtual Control Room), based on artificial intelligence, which facilitates the creation of a situational picture in the Arctic Ocean region.

Project SilentBorder aims to develop and validate a new high-technology CRT (Cosmic-ray tomography) scanner for border guard, customs and other Law Enforcement Agencies, that enables safe and fast screening, detection and identification of hazardous, illegal and contraband goods as well as persons hidden in containers.

Project MULTISCAN 3D investigates a new all-in-one system for cargo inspection to become simultaneously a user-friendly, flexible and relocatable solution. The main body of the research will be followed by lab validations and real-environment demonstrations.

Project PROMENADE intends to develop new technologies that will provide Border Guard Authorities with a service-based toolkit for automatic vessel detection, tracking and behaviour analysis. These technologies will implement innovative algorithms for Artificial Intelligence and Machine Learning applied to maritime surveillance reporting systems, databases, and other information sources.

Project NESTOR aims to demonstrate a fully functional next-generation holistic border surveillance system providing pre-frontier situational awareness beyond maritime and land borders.

6. Providing research capabilities for EBCG

Logo of the research study on Technology Foresight on Biometrics for the Future of Travel

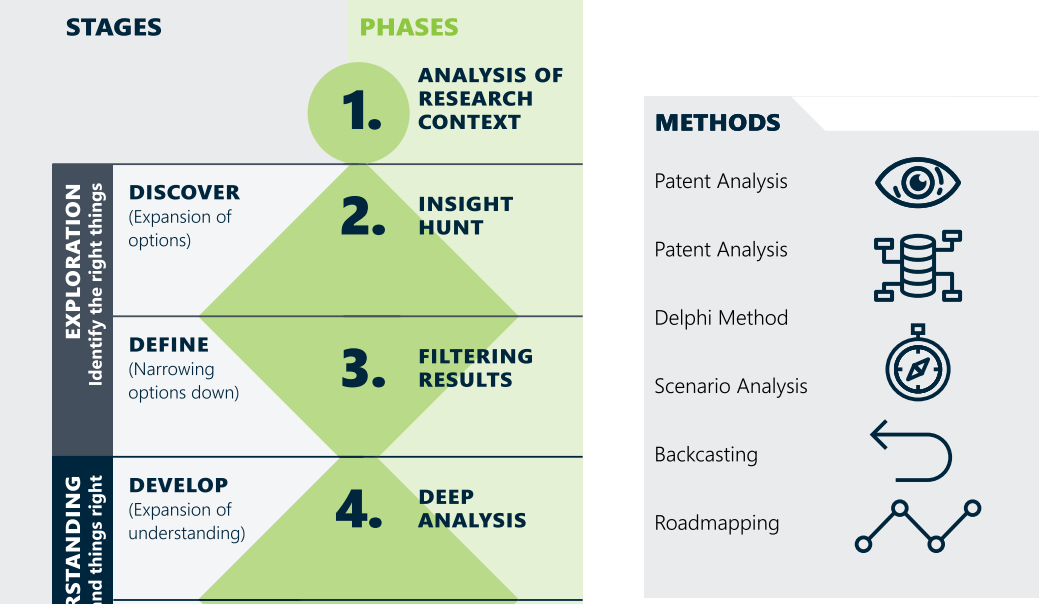
Following an open tender in 2020 (Frontex/OP/515/2020/AH),[11] Frontex contracted Steinbeis 2I GMBH to conduct this research study between January and September 2021. This activity was implemented with Frontex human and financial resources as a quick win project within the EU Innovation Hub for Internal Security.

Three expert consultation events (two Technology Foresight Workshops and a Delphi survey) took place during the project. A broad group of stakeholders was involved in these events to exploit collective intelligence and promote consensus-oriented discussions: more than 40 experts from entities representing the EBCG community, EU Institutions (DG Home, DG JRC, eu-LISA, EUROPOL and the Fundamental Rights Agency), international organisations (INTERPOL and ICAO - NTWG), the US Department of Homeland Security, three EU-funded R&I projects (including industrial producers of systems and components, academic institutions and RTOs), trade associations and consultants.

A custom technology foresight methodology was developed for the purposes of the study, opening the door to the exploration of a vast field of biometric technologies, which were analysed from various perspectives in the context of border checks.

Each phase of this complex research study produced its own set of insights, intended to support the EBCG community in decision-making

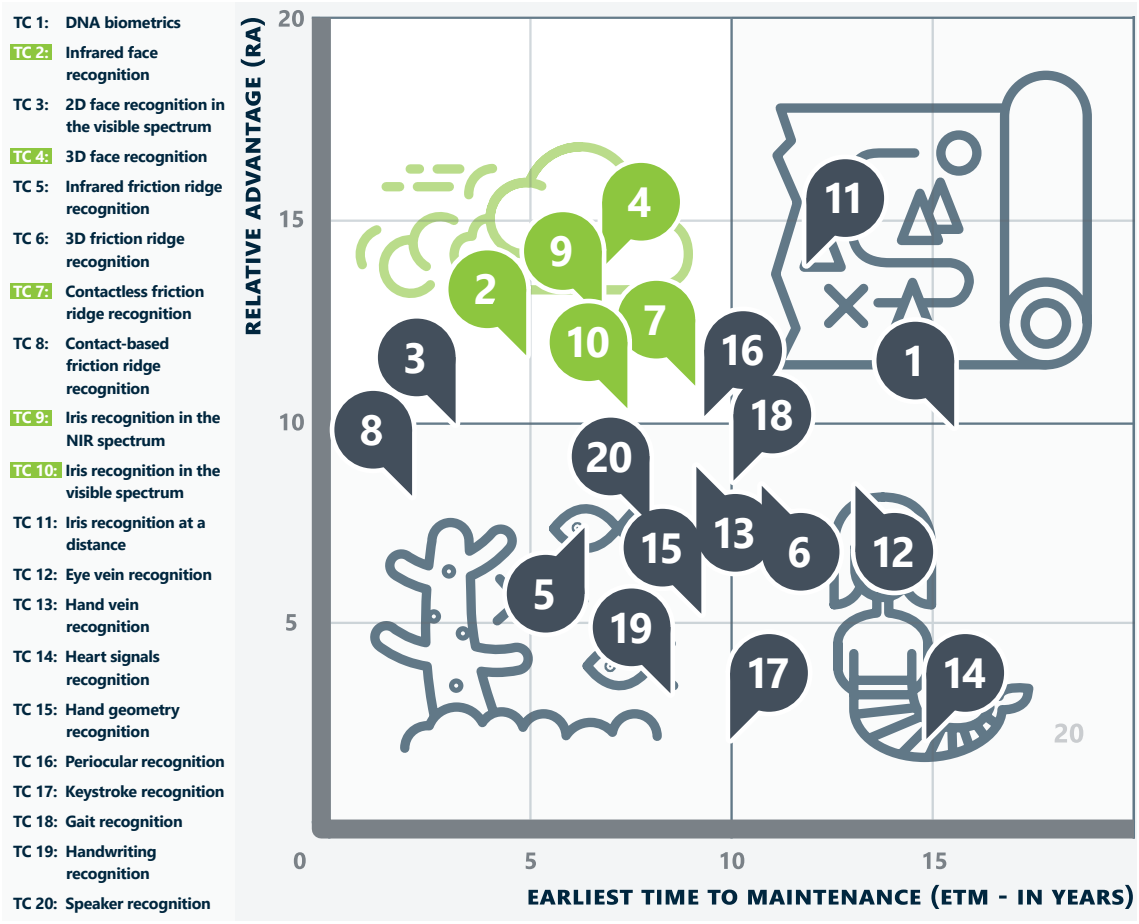
11 eTendering - Data (europa.eu)



Overview of the project set-up and the main methods used

processes. These were compiled in the Research Study report and its three Annexes, which contain:

- A thorough explanation of the overarching Technology Foresight Methodology and Tools adopted, customised to the needs of this study but with future implementations in mind, described in detail in an annexed Technology Foresight Manual. The devised methodology can be used to conduct a similar study on a different topic, to analyse newly identified technologies in a comparable manner or to conduct an in-depth analysis of the biometric technological clusters identified as non-key within the study.
- A Taxonomy of Biometric Technologies and Biometric-Enabled Technological Systems, also thoroughly described in a dedicated Annex, which can be of great benefit to future R&I activities on these subjects.
- The results of the in-depth analyses conducted on patents, scientific literature, and EU-funded projects, which provide an overview of the global technological landscape and show the evolution of the EU's interest in biometrics over time. The insights, collated and detailed into the third Annex, will improve future research initiatives.
- A customised set of scenarios for the EU in 2040, which can be used to future-proof any potential new technology as well as systems or products intended for use in the areas of travel and border checks (not limited to biometric technologies).
- A Prioritisation Matrix of biometric technological clusters, which can serve as the groundwork for future research, planning, and decision-making, allowing for the systematic comparison of emerging future technologies. It can also be used to track the impact of technological advances and other factors on the placement of technologies on the Matrix.
- A set of roadmaps developed for the identified key technological clusters (KTCs: contactless friction ridge recognition, 3D face recognition, infrared face recognition, iris recognition in the near-infrared spectrum, iris recognition in the visible spectrum), which can be used as a starting point for further analysis of their development paths, monitoring associated opportunities and challenges,



Prioritisation Matrix (4CF Matrix) presenting the outcomes of the Delphi survey. Assessment of the 20 biometric technological clusters identified in the study in terms of their Relative Advantage and Earliest Time to Mainstream. The short-listed KTCs are marked in green.

and questioning the assumptions of underlying strategic plans.

- A set of capability readiness heatmaps showing an overview of the extent to which KTCs' cluster-specific needs are met at present or will be fulfilled in the future. They can be used by the EBCG community to identify the actions necessary for strategic capability development.

Due to the substantial amount of information provided and the adopted participatory foresight approach, the research study will directly contribute to an enhanced understanding of the relevance and applicability of novel biometrics and technology. The findings can also be used by public organisations, research and technology organisations, academia and industrial entities in Europe to identify areas of strategic interest and to make informed decisions about paths of future development in biometrics, acting towards strengthening the European strategic autonomy in this sector.

The initial dissemination of results of the research included presentations in multiple fora (EU Innovation Hub for Internal Security, eu-LISA's Biometric Working Group, EU-ANSA Futures Cluster, Frontex Research for Innovation Network and eu-LISA Industry Roundtable), as well as the publication of a project fiche and six newsletters on the Frontex website (see Annex I). The final research study will be made available on the Frontex website in 2022.

Research for Innovation Network

In 2021, as a continuation of the efforts inaugurated with the scoping meeting in 2019, the work towards the establishment of a permanent Research for Innovation Network (R4IN) was restarted. The network's main goals are to further enhance the collaboration within the EBCG community and to improve the quantity and quality of the EU Border Security Research and Innovation.

The first meeting of the network was organised in an online format and brought together 26 representatives responsible for enabling, monitoring, and coordinating technology research and innovation in the border security domain from 13 MSs / SACs. As a follow-up to the first meeting, Frontex Research and Innovation designed and disseminated to MSs / SACs a survey to collect information on their future research needs. The results of the survey will be presented in the next plenary meeting, planned for Q2 2022.

7. Technical industry dialogues

Frontex Industry Days

Frontex Industry Days are organised to carry out the Agency's mandate as per Article 66(1) of the European Border and Coast Guard Regulation, which states that the Agency 'shall proactively monitor and contribute to research and innovation activities relevant for European integrated border management'.

To this end, Frontex organises regular technical dialogues with companies known as 'I-Days'. These events bring together industry players active in the European Integrated Border Management (EIBM) sector with Member State representatives, EU agencies and institutions, international organisations and Frontex entities and staff. Information on these events as well as the process applied is available on the Frontex website.[12]

The aim of I-Days is to facilitate industry dialogue in an operational area of crucial interest to the EBCG community, to map out the market for innovations and to update our knowledge base on developing trends and technological advancements. We are looking for state-of-the-art technologies and services available on the market, as well as newly developed products able to cover multiple and complex operational scenarios. Emphasis is placed on cost-effectiveness and operational efficiency.

Frontex aims to apply a harmonised approach across the Agency, ensuring equal treatment, transparency, and traceability of dialogue with industry. At the same time, efforts are made to increase the effectiveness of dialogue on technology, research, innovative and commercial solutions. Frontex I-Days, while offering a level playing field for the industry, also provide valuable opportunities for the entire EBCG community to keep abreast of the dynamic and highly competitive market of products relevant to EIBM.

During industry days in 2021, around 137 solutions relevant to border management were presented by more than 115 companies to the EBCG community, including representatives of Member States, Schengen Associated Countries, EU agencies and institutions (Frontex included) and selected third country partners.

Meetings with industry on innovation organised by Frontex:

- Industry Days on Airborne Maritime Surveillance Solutions, 26-27 January 2021 (virtual), dedicated to the latest developments in airborne platforms, maritime surveillance sensors, command and control software, data fusion and analytics, beyond line-of-sight encrypted wideband communications.
- Industry Days on Return and Reintegration Assistance, 2-3 February 2021 (virtual), oriented to explore solutions for delivering return and reintegration assistance to non-EU nationals returning to their countries of origin.
- Biometric equipment exhibition, integral part of the Intern ational Conference on Biometrics for Borders, 30 November 2021 (virtual), focused on biometric

12 Invitations to the planned I-days are published in the Announcements section: Announcements (europa.eu)
e.g. Frontex Thematic Industry Days: Airborne Maritime Surveillance Solutions (europa.eu)
Thematic Industry Days: Return and Reintegration Assistance (europa.eu)
International Conference on Biometrics for Borders (ICBB 2021) - invitation to industry (europa.eu)
Invitation to Frontex online Industry Days 6-10 December 2021 (europa.eu)
General contact information for companies and a summary of the process is available on the Frontex website:
Industry contact point (europa.eu)

interoperability of solutions in the context of the European Union's external border management.

- Industry Days, 6-10 December 2021 (virtual), centred on border management solutions for surveillance: VTOL RPAS and Command and Control (C2) software, satellite-based solutions, document checks, and biometric and other solutions related to law enforcement with the potential to be used in border crossing points (e.g. data analytics). Discussions were focused on technical standards, performance, reliability, and integration possibilities. The meeting reports as well as presentations delivered during the i-days are available on Frontex website[13].

13 https://frontex.europa.eu/future-of-border-control/research-and-innovation/announcements/frontex-industry-days-6-10-december-2021-follow-up-FPOUfo

8. **Testing new services** relevant for border management and border security

Establishing framework for consultation on technology innovation: Innovation Cells

Frontex set up a dedicated network of Member States' experts for technical research discussions to develop technology testing and demonstrations: the Innovation Cells.

This structured engagement will improve the understanding of Member States' operational needs and gaps as regards technology, allowing for (i) the identification of products/services, at the level of operational prototype or above, to be piloted based on the thematic and technical knowledge of participants, (ii) technical discussions on technology testing, (iii) the identification of possible technologies of relevance addressing needs identified in the capability development plans and capability roadmap.

The network will also be a forum for discussions on the results of research activities and the outcomes of pilot projects. These insights will lead to a harmonised joint definition and development of follow-on projects while the resulting technical expertise may be used to enhance capability planning processes at national level.

Frontex pilot projects offer an excellent opportunity for Member States to engage and test solutions according to their needs. A real time piloting environment constitutes a unique chance to test the latest technology and innovative approaches to carry out border surveillance and border checks.

In 2021, two meetings of the Innovation Cell Border Checks and two meetings of the Innovation Cell Surveillance took place, allowing for a constitution of the expert groups, presentation of the concept and discussion on ongoing pilot projects, future technology innovation needs as well as outcomes of the EU research framework programme projects and their relevance/readiness for further development in line with EBCG needs.

EES Land Border pilot projects: Bulgaria and Spain

The European Union is moving forward with the implementation of its 'Smart Borders'[14] package, which will make it easier for genuine travellers to cross Europe's borders while protecting the security of millions of Europeans.

Within the Smart Borders package, the Entry/Exit System (EES) will register the entry and departure data of travellers, including biometrics of non-EU nationals crossing the external borders of Member States. The system's implementation will significantly impact the work of border guards and national authorities, and introduce new technology, equipment, and flows for both border officers and travellers. Preparation of Member States for the vital changes at BCPs is a crucial and pressing challenge.

For this reason, Frontex made a concerted effort to pilot the EES processes, applying new technologies at BCPs which are likely to be significantly impacted by the new system – busy land border crossings. Under the EES Land Borders Pilot Project, Frontex executed two operational EES technological pilots in three selected BCPs. The pilot project was implemented in close cooperation with host Member States Spain and Bulgaria, the EU Agency for the Operational Management of Large-Scale IT Systems (eu-LISA), the Joint Research Centre (JRC) and the Fundamental

14 https://ec.europa.eu/home-affairs/pages/page/smart-borders-background_en

Self-service kiosks and biometric corridor used in the EES Land Border pilot project at La Línea, Spain

Rights Agency (FRA), with the support of technological contractors.

Following an open tender procedure,15 Frontex awarded contracts (Frontex/OP/433/2020/AH) to two EU companies, Vision Box and Everis,[16] to develop, install, and provide operational support for the testing operations of an EES Pilot Core-System at selected BCPs in Bulgaria and Spain. The test solutions were deployed from May to October 2021 at BCP La Línea in Spain, and at BCP Kapitan Andreevo (on entry) and Kalotina (on exit) in Bulgaria, where border control officials simulated the EES system, its biometric registration and verification workflows.[17]

Thus, the Frontex Entry/Exit System Land Border Pilot Project brought a comprehensive, operational simulation of the EES processes applying novel technological solutions to facilitate a seamless border crossing.

The pilot set-up

The tested solution included four self-service system (SSS) kiosks and two biometric corridors at each crossing. As an innovative process, SSS kiosks allowed the registration/verification of up to four travellers simultaneously, supervised by one border guard. In a second step, the Biometric Corridor facilitated a seamless border crossing by applying biometrics on the move recognition.

Although the main focus of the trial was on pedestrian travellers, the mobile workstation was occasionally used for EES processing of travellers driving vehicles without the need for the drivers to step out of their cars or trucks and carry out the entry/exit process and validations at the SSS.

15 eTendering - Data (europa.eu)
16 In April 2021 Everis became part of NTT Data.
17 This activity was implemented with Frontex human and financial resources, as a quick win project within the EU Innovation Hub for Internal Security.

In addition, the system in Bulgaria was installed in hired office containers equipped to serve as a flexible, scalable and easily deployable BCP. The portability and small size of the system's constituent elements makes it ideal to be administered by a border authority and to be allocated and relocated on demand to a BCP that needs intensive automation at a given point in time.

Travellers were invited to participate in the pilot as volunteers, using SSS and mobile systems to register biometric data, which was reconciled in a mock-up EES database integrated with the host Member State's national border checks system. In the course of the pilot project, more than 15 000 travellers used the pilot premisses to perform all the EES-required actions for the border crossing as if the EES was operational.

The piloted approach was based on a constant improvement of the technical means and border control processes that will facilitate the final implementation of the system in all Member States.

Cooperation with eu-LISA fostered the exchange of technical and operational information on the performance of the EES biometric functionalities.

Main findings

Lessons learnt during the pilot allowed for the development of a proof of concept, focusing on shortening processing times and reducing border guards' workload, which can be used to facilitate EES operations, while respecting the space constraints reported at most BCPs.

The pilot project also delivered a number of lessons learnt in terms of technology and its placement, environmental factors and functionalities, facial image and fingerprints acquisition, biometric corridor seamless operation, the use of mobile devices and border guard workload and processes.

Specifically, the pilot showed that, in order to maintain a smooth flow and productivity, the support of assistants for the management of SSS registration and queues was relevant, while the border guards' supervision focused on the border check activity at the SSS and the Biometric Corridor. Despite consuming resources, such a set-up was superior to the alternative of processing each traveller in manual booths. In addition, with system adaptations, as well as better information for travellers and their familiarisation with the system, the proportion of border guards' resources to travellers may be reduced.

The pilot has shown that in all cases the average time spent on processing was significantly longer in comparison to pre-EES processes, which is understandable considering the additional data collection requirements. The SSS data entry kiosks helped to reduce queue pressure and provided a more dynamic traveller experience compared to the alternative of queuing to the manual booth.

Challenges

The pilot project also shed light on a number of challenges related to processing times, space constraints, interconnectivity and communications, travellers' cooperation and other factors:

- The travellers' lack of familiarity with the technology, the restricted space conditions and the poor lighting of the set-up in Bulgaria meant that the SSS was overall less capable of enrolling travellers, with a success rate for Visa Exempt TCNs of 23.4%. On the other hand, the well-accustomed travellers and the custom-built area for hosting the system in Spain contributed to a better success rate of approximately 60%. Similarly, the verification rate for travellers in Bulgaria was 48.3% and in Spain 97%. This shows that optimisation of space and equipment placement plays a strong role in the level of efficiency gains as regards EES processes.
- Regarding biometric data quality, in the course of the pilot project, both contractors integrated the eu-LISA User Software Kit developed to calculate the quality of raw biometric images and to assess the biometric data capture quality compared to a predefined minimum standard. It turned out that achieving the required quality in a reasonable time proved challenging.
- The environmental conditions of light and space had a considerable impact on the system's performance, forcing adjustments and improvements to be made to mitigate the negative outcomes.

- The pilot has shown that clear communication and interaction with travellers through different means (signage, panels, assistant personnel and website) is key to the success of the new procedures, which at first might cause considerable confusion.

These are useful indications for border control authorities pointing to the need of adapting the border control area, equipment, process, and flows, in order to optimise the processing of the different categories of travellers and avoid long waiting lines.

The EES Land Border Pilot Project evaluation report, which will be distributed in 2022, will be a valuable source of information for the Member States, border authorities and EU Agencies as Europe prepares for the implementation of the EES and continues to make the necessary adjustments.

Maritime Surveillance Aerostat II Pilot Project

The main purpose of pilot project Aerostat II was to assess and validate the concept of employing multi-platform aerostat-based technology to perform persistent satellite-enabled networked surveillance missions, utilising advanced sensors in an integrated package to cover wide maritime coastal areas. This pilot project followed on the recommendations, experience and lessons learnt obtained from a previous pilot project (Aerostat I) hosted in Greece (Samos), in 2019.

With redesigned technical and operational requirements (which included a new platform, more powerful sensors and a robust communications architecture), the main proof of concept foresaw the use of two aerostat platforms under simultaneous operation in a contiguous maritime environment, broadcasting 24/7 sensors data received by the ground control stations to a remote web-based secure platform.

Following an open tender procedure,[18] the contract (Frontex/OP/612/2020/JL) was awarded in December 2020 to a consortium consisting of two EU companies, in-Innovative navigation GmbH (IN), consortium leader, and CNIM Air Space (CNIM). Over the course of 2021 this consortium was responsible for preparing, implementing, and operating the technology solutions in Greece, delivering an integrated maritime surveillance service in trial mode.

The trial covered a deployment period of 120 days (4 months), between 9 July and 6 November 2021, and was supported by the Hellenic Coast Guard (HCG). The pilot project took place in two deployment sites in the Thracian Sea, Alexandroupolis and Limnos.

The system presented consistently high rates of availability and reliability. However, the service level rate was affected by the worsening weather conditions at the end of the summer. An extreme weather event caused an incident in Limnos, that needed to be promptly mitigated to continue with the trial. The overall system performance was very satisfactory, including the assessment of the aerostat platform, sensors, command, control, and communications architecture. The supporting operational organisation provided high levels of safety, risk management and effectiveness.

The assessment of the tested solution can be summarised as follows:

Performance: The performance was very satisfactory. The system was able to provide a reliable and secure maritime situational picture to remote operational users as planned. The payload capabilities were effectively managed into an integrated surveillance model that proved adequate for persistent 24/7 maritime surveillance missions. The operational organisation was an enabler of the systems capabilities, providing a sustainable model to plan, coordinate and execute surveillance missions in an effective and safe manner.

Reliability: The overall Aerostat II solution was demonstrated to be highly reliable. For Maritime Surveillance Aerostat Systems the weather limitations should be considered, as this type of platform is not able to perform well all-year round. A lesson learnt from Aerostat I, and confirmed

18 eTendering - Data (europa.eu)

The aerostat used in the pilot project Maritime Surveillance Aerostat II

by the incident in Limnos, suggests that future CONOPS for Aerostat-based technological solutions should be used in conjunction with fixed or mobile surveillance systems to maximise service level rates and ensure a continuous surveillance of the Area of Interest. The incident in Limnos proved the synergistic approach of utilising the same payloads of the Aerostat system in a fixed surveillance system. This optimises the use of these sensors that, in general, account for a large cost of the deployed capability.

Cost-efficiency: The approximate cost of a flying hour of an Aerostat is EUR 500-1 000, a small fraction of the cost of similar airborne surveillance systems. The cost is dependent on many factors, namely the technical and operational capabilities involved. Economies of scale can be found for longer deployments. A significant share of the cost is related with the logistical cost of transport to the Area of Operations.

Conclusions

Overall, the pilot project Aerostat II validated the proof of concept of utilising this technological solution for maritime border surveillance applications and confirmed that an aerostat-based technology can be used as a multi-platform networked maritime persistent surveillance capability.

The easy integration between all systems, the supporting reliable communications architecture and the reduced logistical footprint allows this concept to be agile and scalable to provide wide area integrated maritime surveillance.

Aerostat-based technology is a high performance, reliable and cost-efficient maritime persistent surveillance capability

Aerostat technological solutions have significant potential to augment and enhance border surveillance capabilities within the context of European Integrated Border Management. The system demonstrated overall high performance, reliability and cost-efficiency. This solution demonstrated high availability in terms of readiness/ability to operate.

Aerostat-based technology is affected by adverse weather

One of the main challenges of integrating Aerostat-based technology in maritime surveillance is the limitations on operating in adverse weather conditions (high winds and thunderstorms). This directly affects the service level rate, as the system might need to be grounded for safety reasons for winds of 70+ km/h or thunderstorms. Nonetheless, the possibility of developing an integrated model consisting of aerostats and mobile surveillance systems can mitigate these technical limitations.

Main benefits of Aerostat-based technology for maritime surveillance missions

Aerostat-based technology contributes to effective integrated wide-area surveillance through powerful sensors (camera, Radar, AIS), supported by secure and reliable data sharing capabilities to operational users. A multi-layered surveillance model (for detection, recognition and identification) together with persistent 24/7 surveillance operations (day/night) allowed a continuous maritime situational picture. The solution demonstrates full scalability (the overall C2 system is able to integrate any number of systems), with high reliability and availability. The reduced approximate cost per flying hour when compared to other airborne surveillance assets, together with its ability to stay airborne for long periods of time (3 to 7 days), makes this system very adequate for longer deployments. The system has a reduced logistical footprint which renders flexibility to a redeployment according to operational needs.

Main challenges

In terms of the main challenges to consider, the findings from the implementation of pilot project Aerostat II confirm the findings and recommendations from pilot project Aerostat I concerning the critical importance of the identification and selection of adequate deployment sites. Also, the aerostat systems have limitations that need to be taken into consideration, namely, it's not an all-year round capability: the system has adverse weather susceptibility (high winds and thunderstorms). Furthermore, to fully maximise the operational capabilities, the operation of the system requires experienced maritime surveillance operators.

9. Improving operational performance of EBCG capabilities

Standards for Technical Equipment

A core objective of the research and innovation activities of the Agency is to drive the process of harmonisation and standardisation, under which the European Border and Coast Guard Agency has a mandate to define and support the development of technical and operational standards.

Frontex developed, in cooperation with the Member States and the Commission, Technical Standards to ensure compatibility and interoperability of technical equipment. In September 2021, a first iteration of four Technical Standards was released focusing on maritime equipment, aerial equipment, land border equipment, as well as document inspection equipment. They were released under Management Board Decision 51/2021,[19] thereby ensuring that Member States' equipment part of the Technical Equipment Pool managed by Frontex complies with the requirements.

The purpose of the Technical Standards is to promote interoperability and compatibility of equipment participating in Joint Operations. The Technical Standards provide a set of requirements for equipment to be included in the Technical Equipment Pool and deployed for the operational activities of the Agency.

In addition, the Agency developed, in close cooperation with EBCG stakeholders, a Technical Guide for border checks on EES related equipment, supporting Member States in their preparations for the entry into operation of the Entry/Exit System (EES). This document was released in June 2021 and since then has been used by Member States in their preparations.

Facilitating knowledge transfer on biometrics relevant for border security (ICBB)

The thematic focus of the International Conference on Biometrics for Borders 2021 was biometric interoperability in the context of the European Union's external border management, including topics related to border security and specific border control technologies. The conference event was organised online on 30 November 2021.[20] The conference addressed interoperability from an operational and user experience perspective, also considering a future vision of biometrics and artificial intelligence due to large-scale interoperability and data sharing across international borders.

Interoperability topics discussed in the conference were related to the adoption of shared operational standards to support biometric data acquisition, processing, and information exchange in the context of the frameworks for interoperability between EU information systems defined in the Smart Borders Package. Interoperability requirements need to be addressed from a user and conceptual level when information is exchanged and accessed across borders. Information systems and common repositories and services for border management and security currently under development, such as the Common Identity Repository (CIR), the Shared Biometric Matching Service (sBMS), the Multiple-Identity Detector (MID) and the European search portal (ESP), are examples where interoperability is a key success factor.

To meet national border management authorities' needs for innovative interoperable technologies, part of the conference was dedicated to an

19 https://frontex.europa.eu/assets/Key_Documents/MB_Decision/2021/MB_Decision_51_2021_adopting_Technical_Standards_for_the_equipment_to_be_deployed_in_Frontex_activities_opt.pdf

20 International Conference on Biometrics for Borders (ICBB 2021) (europa.eu)

The banner of ICBB 2021.

Online Industry Exhibition demonstrating needs and solutions adopted to achieve interoperability.

Supporting Member States' capabilities in using advance information

The Study on Advance Information on Land and Sea Borders was conducted between January 2020 and June 2021 and aimed at researching what information is collected on travellers crossing the external borders of the European Union (EU) ahead of their arrival and at assessing how such information is collected, transmitted and processed in order to optimise the traveller analysis capability for border control in the EU. In addition, the study identifies best practices related to the processing of AI on land and sea borders.

The study was mandated with a view to address EU Member States' capability needs to bridge information gaps on travellers crossing the external land and sea borders, but also to take into consideration the need expressed by Member States to expand the scope of AI to other modes of transport beyond aviation. The study also takes into account the planned implementation of the Entry/Exit System (EES) and the European Travel Information and Authorisation System (ETIAS) which oblige carriers to verify prior to boarding the status of all travellers entering into the Schengen area.

To develop the study, a consulting company was contracted.[21] Desk research, surveys and interviews were conducted to gather information. Various stakeholders were consulted for that purpose, including EU Member States, Agencies (EMSA, EUFRA, EUROPOL, eu-LISA, Frontex) and institutions (DG HOME, DG MARE, DG MOVE, DG TAXUD), international organisations (IMO, INTERPOL, IOM, OSCE, UNOCT, WCO), sea and land carriers, and carrier associations and organisations working in the area of travel.

The intended audience of the study is decision-makers and practitioners involved in the collection, transmission and processing of AI to facilitate border checks at EU land BCPs.

The study consists of three parts:

1. Assessment of AI on land borders,
2. Assessment of AI on sea borders,
3. Assessment of best practices on AI on land and sea borders.

The first two parts cover a number of topics, including the overview of the legal framework, types of data collected, collection and transmission requirements and methods, operational

21 The contract was signed with Unisys Belgium SA as result of a negotiated procurement procedure (NP/1109/2019/AH).

The Advance Information Data Flow for Ferries

impact, processing of AI, data quality aspects as well as privacy and data protection (DP). The analysis focuses on EU MSs and Schengen Associated Countries with external land and sea borders.

The third part of the study identifies, describes and evaluates best practices of Member States as regards the collection and processing of AI on travellers crossing the EU's external land and sea borders. It is based on use cases in the selected Member States and includes the research conducted on processing practices in some third countries.

The transport modes considered throughout the entire study are passenger train, car, coach/bus and truck within the land transport mode, and ferry, cruise ship, fishing vessel, pleasure boat and cargo ship (or freighter) within the sea transport mode.

The Assessment of AI on land borders provides a number of recommendations, such as:

- introducing a specific legal framework and adopting standards for all types of land carriers, defining the purpose for which AI on land borders is collected and used (while equally considering public health purposes), determining a data retention period and other data protection requirements;
- introducing a closed and mandatory list of passenger and driver/crew data (where applicable) based on Machine Readable Zone (MRZ) data fields which, together with the standardised time and method of data collection/transmission, would enhance harmonisation and implementation across EU MSs;
- with regard to data processing, defining the role and responsibility of the AI data processing entity, determining the databases for automated targeting against the AI and specifying the use of risk profiles for traveller targeting purposes;
- specifying the scope of AI data collection in terms of carriers (e.g. international high-speed trains and international coach services only) and routes (e.g. extra-Schengen inbound and outbound only) was suggested with the adoption of a risk-based approach for specific high-speed trains and cross-border buses, to minimise the impact on their business model.

The assessment of AI on sea borders provides a number of recommendations, which, to a large extent, are identical to the ones provided for the land domain, namely:

- on the specific legal framework and standards, purpose and data retention regime, closed and mandatory list of passenger and crew data (where applicable) which, together with the standardised time and method of data collection/transmission, would enhance harmonisation and implementation across EU Member States;
- with regard to data processing, next to suggested actions applicable to both land and sea transport modes, a specific recommendation was made encouraging Member States to build a strong processing capability for collecting and processing large volumes of data in a short amount of time to address the challenge related to short ferry trips

The third part of the study identifies, describes, and evaluates best practices of Member States as regards the collection and processing of AI on travellers crossing the EU's external land and sea borders. It is based on use cases in the selected Member States and includes the research conducted on processing practices in some third countries.

The study will be published in 2022 and will be disseminated to EU Member States / Schengen Associated Countries, EU agencies and institutions to feed into their preparations for a proposal for a new Advance Passenger Information (API) legislation.

10. Other research and innovation activities

In addition, during 2021 Frontex has made available its research and technology innovation expertise as follows:

- Frontex continued to provide its internal research expertise in the implementation of the Instrument for Pre-accession Assistance (IPA) II 'Regional Support to Protection-Sensitive Migration Management in the Western Balkans and Turkey' Project. The research expertise provided was in relation to the identification and registration of mixed migration flows aiming at developing IT systems and communication infrastructures in that area in line with EU standards and best practices. As a result, a Masterplan for both Western Balkan Beneficiaries Montenegro and North Macedonia was developed. These Masterplans will help the Beneficiaries to develop their national capacities on identification and registration of mixed migration flows in line with EU requirements and, in particular, in compatibility with the EURODAC. The Masterplans have been developed by a contractor, and in cooperation with eu-LISA. They will be finalised in Q1-2022.
- Frontex Research and Innovation provided continuous research services and support to other entities within Frontex, following requests and management instructions. Among others, Research and Innovation conducted a short research activity to identify possible inter-operability issues between fingerprint scanners deployed by the Agency during Joint Operations and national components of the EU systems, in particular EURODAC.
- Frontex research officers continued to support the Entry/Exit System training by delivering online presentations on experiences from Frontex EES simulations, Frontex Guidelines for equipment used in the field of the EES, and experiences from Frontex EES pilots, for six training sessions. The most recent results of Frontex research and innovation activities relevant for EES were made available to the training participants.
- Frontex contributed to the majority of the actions under the "Action Plan on synergies between civil, defence and space industries"[22] adopted by the Commission in 2021, while research and innovation expertise has been provided to the following actions:
  - Action 2 on promoting synergies by further improving coordination of EU programmes and instruments,
  - Action 4 on technology roadmaps,
  - Action 5 on Hybrid Standards,
  - Action 6 on innovation incubator and dual-use innovation,
  - Action 9 on EU drone technologies (in support of Frontex point of contact),
  - Action 10 on EU space-based global secure communications system.
- Frontex contributed to the ISGS, which involves all Commission services and agencies where space services and data play a role, or where there is an interest to help building an EU space policy, to discuss about emerging policies linked to space technologies. Frontex interest in the use of space technologies for border management activities includes the fields of navigation (Galileo), earth observation (Copernicus), and secure space connectivity.
- Frontex provided input to the elaboration of the EES Handbook.

22 COM(2021) 70, https://ec.europa.eu/info/files/action-plan-synergies-between-civil-defence-and-space-industries_en

Framework Contract for the Provision of Research and Innovation Assistance and Advisory Services

Following the launch of an open tender (Frontex/OP/451/2020/ZB) in 2020,[23] this four-year Multiple Framework Contract in cascade became fully operational in January 2021, consisting of three lots:

- Lot 1: Research and innovation expertise and technical advice support services;
- Lot 2: Research and innovation studies, analyses and evaluations;
- Lot 3: Research and innovation support to field activities.

The services provided under this framework contract aim to support or improve activities related to the responsibilities and mission of Frontex in the area of research and innovation, streamlining various research services, as well as facilitating and harmonising the deliverables concerning research studies, technology pilots and work on standards and capacity assessments.

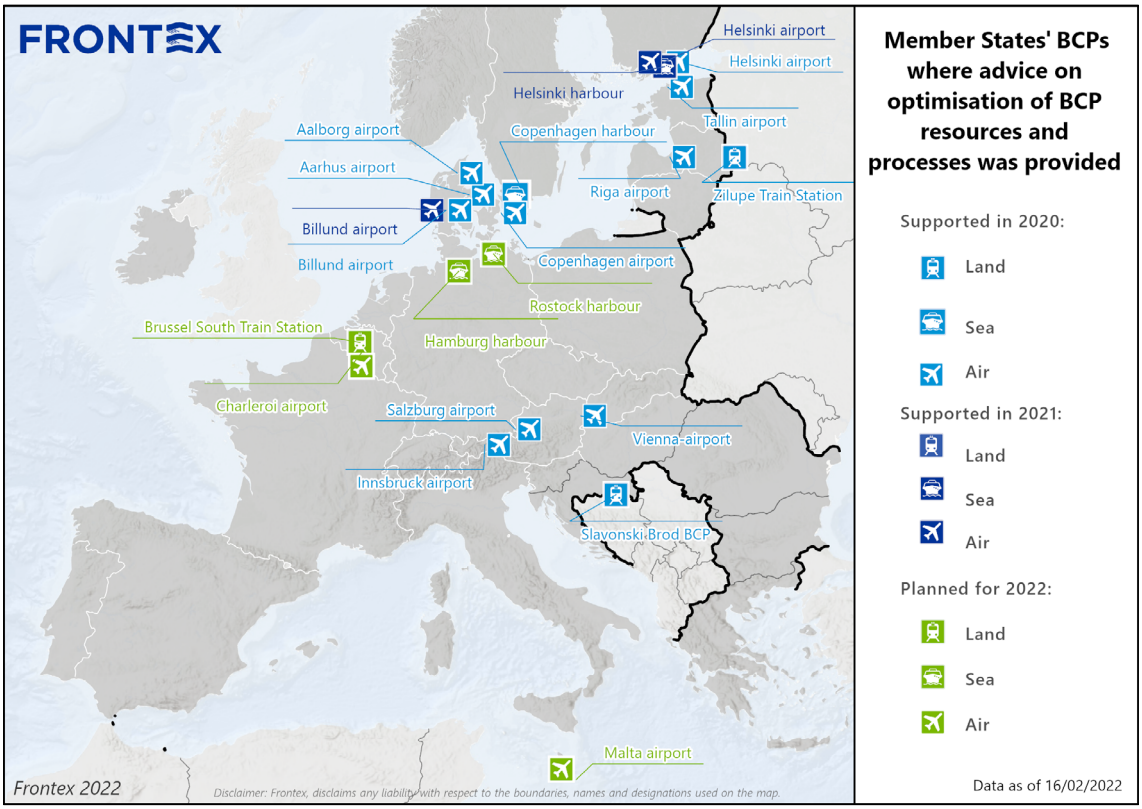
This initiative originated from the need to have an agile and fast instrument that allows all Frontex entities to commission high-quality scientific and technical support and advice, within a number of strategic areas relevant to Frontex research, technology development and innovation such as:

- Technologies for Border Checks
- Technologies for Border Surveillance
- Information and Communication Systems
- Emerging and Key Enabling Technologies
- Futures Research
- EU-funded Research and Innovation programmes

In 2021 the Framework Contract was successfully instrumental to swiftly commission several research studies and assessments, serving the needs of several Frontex entities. It is planned that the framework contract will be used in 2022.

23 https://etendering.ted.europa.eu/cft/cft-display.html?cftId=6900

11. Ongoing research and innovation activities



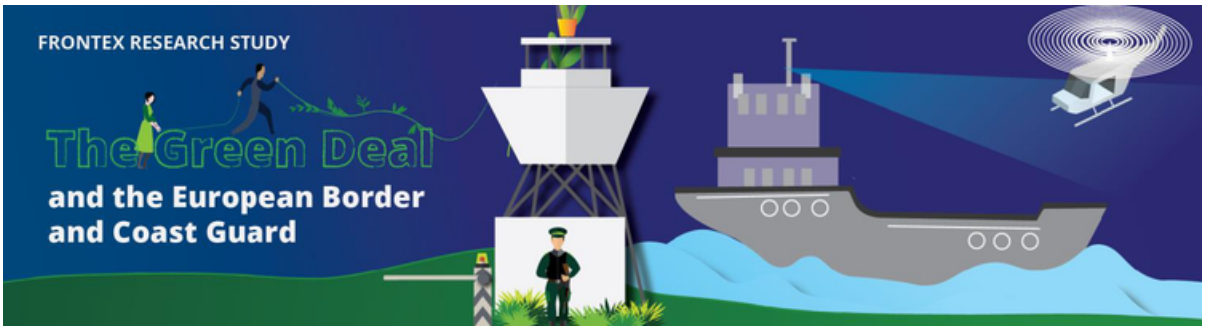
Advice on optimisation of BCP processes, as provided in 2020-2021, and planned for 2022. Some BCPs were supported twice, in 2020 and 2021 (Helsinki airport, Billund airport).

Advice on optimisation of BCP resources and processes

Upon request, Frontex provides support to Member States in respect of process optimisation and infrastructural re-design at specific BCPs to implement the Entry/Exit System (EES).

Since 2019, Frontex has been using operational research and simulation solutions to support MSs in this regard (e.g. when implementing new technologies/systems, solving issues such as long waiting times or assessing vulnerabilities). Concretely, with the use of such simulation solutions, MSs can be helped in their decision-making about, for instance, the type and number of pieces of equipment/technology (e.g. manual booths, e-gates, self-service kiosks, mobile solutions) to install, the number of border guards to deploy or the physical installation of the equipment in the area of the BCPs.

Following requests by some MSs, in 2019-2020 Frontex contracted an external expert to undertake simulations and on-site support on the BCP processes optimisation. In total, in 2020, the service was provided to 13 BCPs in six requesting Member States. The outcomes of the assessments were shared with MSs, allowing them to use the results of simulations for the preparation of procurement procedures for EES-related equipment.



One of the illustrations of the Research Study on the Green Deal and the EBCG, focusing on fossil-free fleet

The support on the optimisation of BCPs provided in 2021 has been implemented under the framework contract for research assistance and advisory services (Frontex/OP/451/2020/ZB) and will continue in 2022. Simulations were run for four additional BCPs in three Member States in 2021, while other BCPs are to be supported in 2022. A final report on this activity is also planned for 2022, as well as a handbook on the use of the EES models, together with generic models, for Member States' own use

Common Minimum Standards for Land Border Surveillance

Frontex's mandate foresees that for the effective implementation of Regulation 1896/2019 (Article 10 (1), point z), Common Minimum Standards (CMS) for external border surveillance should be developed. To support the Member States in the development of the CMS, and upon the proposal of Lithuania, Frontex has established a Working Group composed of five pre-selected Member States that share similar land border characteristics. The common minimum standards are being developed considering the type of borders, the impact levels attributed by the Agency to each external border section and other factors such as geographical particularities. When developing these common minimum standards, possible limitations deriving from national law have been taken into account. Several workshops, interviews and meetings were organised with the Working Group, resulting in the draft version of the CMS for land border surveillance, to be finalised in 2022.

Research Study: The Green Deal and the European Border and Coast Guard

In June 2021 Frontex launched a research study on sustainability titled "The Green Deal and the European Border and Coast Guard (EBCG)". Its overall goal was to support Frontex and the EBCG community in reducing the environmental footprints of their facilities, operations, and services in order to achieve and then maintain a high level of environmental sustainability. The preliminary results were presented during the network meeting of the Heads of the Justice and Home Affairs (JHA) agencies, in November 2021, while the final report and the visual booklet with findings are planned to be publicly available on the Frontex website in 2022.

One of the key goals of this research study is to contribute to knowledge sharing in the area of sustainability. Its findings were regularly published on the Frontex's website in the form of knowledge insights and videos.[24] They were also presented to Frontex staff and the EBCG community during two online webinars, "Sustainability in the EBCG".

The research study benefited from contributions of many Frontex staff, Member States (in particular the French Ministry of Interior, the Swedish Coast Guard and the Portuguese Navy), EU Agencies (the European Defence Agency, the European Environment Agency and the European Central Bank) and international partners (the US Department of Homeland Security) who shared their knowledge, ideas and inspirations.

24 News and events (europa.eu)

Border Management Innovation Centre (BoMIC)

The further reinforcement of the Frontex mandate in the field of research and innovation has created the need for a physical space where the entire EBCG community can explore, assess, test, simulate and showcase emerging and enabling technologies: a Border Management Innovation Centre (BoMIC). It is proposed that the future Frontex permanent premises include such an innovation centre, consisting of areas for experimentation, demonstration and testing of technologies, along with the associated collaborative space and focus areas.

The objective of a BoMIC is to contribute to the effective implementation of relevant parts of the framework programme for research and innovation (Horizon), to facilitate cooperation with other Justice and Home Affairs (JHA) counterparts in the framework of the EU Innovation Hub for Internal Security, to deliver the technological research and innovation capability to further enhance the collaboration with the Joint Research Centre's (JRC) specialised labs and units, and to provide a simulation environment for the assessment of processes and procedures with a focus on human-technical solutions interaction and specific technologies (e.g. biometrics).

To analyse the feasibility of including a BoMIC in the Frontex permanent premises, in 2021 Frontex commissioned a business case study to address its components, space, functions, possible alternatives of setting up the BoMIC, cost estimates in a 15-year horizon and recommendations for an optimal solution. The results of the study will be available in 2022 to facilitate decisions and next steps regarding the establishment of a BoMIC.

Methodology for the Development of Technical Standards

In 2021 the development of the methodology for Technical Standards was launched, based on a common methodological approach and organisational process which was gradually developed and applied to maintain objectivity and procedural validity during the first iteration of Technical Standards. The overall objective of the Methodology for Development of Technical Standards (MTS) is to ensure that the process leading to the interoperability and compatibility of the equipment included in the Technical Equipment Pool is solid, consistent, coherent, shared and acknowledged. It is planned that the Methodology will be submitted for endorsement in 2022.

Support to Montenegro

Following a written request from the Head of the Montenegro Border Police (in July 2021), Frontex provided research and innovation and other expertise to develop and implement technical assistance aiming at supporting the Montenegrin authorities in the assessment of the current border checks and border surveillance systems. Such assessment is needed in view of the alignment of these systems to EU requirements, in particular the Schengen Borders Code.

Performance Assessment for Document Inspection Systems

In 2021 Frontex launched the development of a practical capability tool to facilitate independent testing and evaluation of the performance of document inspection systems. The tools will be designed to facilitate regular testing under realistic operational conditions, by Frontex or Member States/Schengen Associated Countries.

Annex I – Key research and innovation products

1. Frontex Research Glossary v 2.0[25]
2. Technical Guide for Border Checks on Entry/Exit System (EES) related equipment[26]
3. Management Board Decision 51/2021 of 21 September 2021 adopting Technical Standards for the equipment to be deployed in Frontex activities[27]
4. Dissemination products for the *Technology Foresight on Biometrics for the Future of Travel* – Project Fiche and Newsletters:
   - Defining the Methodology and Setting the Context
   - Scenario Analysis
   - Scenario Customisation
   - Taxonomy of Biometric Technologies
   - Technological Clusters in the Ring – The Delphi Survey
   - The Research Study

25 https://frontex.europa.eu/documents-and-publications/frontex-research-glossary-8TbMTP
26 https://frontex.europa.eu/publications/technical-guide-for-border-checks-on-entry-exit-system-ees-related-equipment-ci9yAd
27 MB_Decision_51_2021_adopting_Technical_Standards_for_the_equipment_to_be_deployed_in_Frontex_activities_opt.pdf (europa.eu)

Annex II – Budget and cooperation partners of research and innovation activities

The data presented in this Annex comprises the following types of information:

- **Total budget EUR** refers to the total budget paid for the contracts relevant for the implementation of specific research and innovation projects/activities, as signed with the contractors listed. In addition, for the EES pilot projects, the total amount includes also grants to Member States for the operation of the trials.[28] This amount does not include the cost of workshops organised in relation to a specific activity, the cost of publications, or the cost of Frontex staff missions. The cost included for the International Conference on Biometrics for Borders pertains to the cost of conference logistics in relation to the ICBB 2021.
- **Cooperation partners: contractors** refers to the contract signatories.
- **Cooperation partners: contributors** refers to entities which hosted or participated in the testing of technology solutions.

Frontex technology innovation activities

Title	Total budget EUR	Cooperation partners: contractors	Cooperation partners: contributors
EES Land Border Pilot project, Spain	825.607,82	Everis	Spanish National Police
EES Land Border Pilot project, Bulgaria	526.215,78	Vision-Box	Chief Directorate Border Police Bulgaria
Maritime Surveillance Aerostat II	2.980.500,00	Consortium: in-Innovative navigation GmbH (consortium leader) CNIM Air Space	Hellenic Coast Guard Hellenic Civil Aviation Authority

Frontex capacity development activities, concerning new technologies

Title	Total budget EUR	Cooperation partners: contractors
Study on Advance Information on Land and Sea borders	78.057,38	UNISYS BELGIUM SA
International Conference on Biometrics for Borders	38.751,09	Defacto Event Factory

Frontex research activities

Title	Total budget EUR	Cooperation partners: contractors
Technology Foresight on Biometrics for the Future of Travel	491.500,00	STEINBEIS 2I GMBH

28 Information on the grants awarded during 2020 and 2021 are available in the Frontex website under Key Documents (europa.eu)

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