

Results of **Research & Innovation** activities

2021
2022
2023

FRONT**X**

 **EUROPEAN BORDER AND
COAST GUARD AGENCY**

Results of
**Research &
Innovation**
activities

2022



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© European Border and Coast Guard Agency
(Frontex), 2023

Luxembourg: Publications Office of the Euro-
pean Union, 2023

Print:
TT-AW-23-001-EN-C
ISBN 978-92-9467-636-8
ISSN 2600-4755
doi 10.2819/10929

PDF:
TT-AW-23-001-EN-N
ISBN 978-92-9467-637-5
ISSN 2600-4755
doi 10.2819/056542

FPI 23.0187

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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

Dear Reader,

I am happy to present to you the third edition of the report on the results of Frontex research and innovation in 2022. The document contains valuable insights on the activities completed during the year and on the new initiatives launched whose results will be included in future editions.

In the ever-evolving landscape of border management and law enforcement, we must embrace the transformative power of research and technology to elevate our capabilities and adapt to new challenges. By integrating novel technologies into our work, we can revolutionise the border crossing experience of travellers, or the way we detect, analyse, and respond to potential threats, while also providing our officers with the support they need to carry out their vital missions. Each year Frontex research and innovation takes our capabilities to a higher level.

In 2022, our innovation activities continued with an increasing intensity and extension of scope in comparison to previous years due to the launch of new and ambitious innovation frameworks, like the *Call for Proposals for Research Grants* and the *Prize Contest on the Detection of Low Flying Objects*. These new endeavours required the preparation of specific concepts and policies which included extensive internal and external consultations. The new activities escalate current cooperation with academia, think tanks and non-profit research organisations for the Call for Proposals, and step-up engagement with European companies for the Prize Contest.

The Agency launched several research initiatives jointly with other EU JHA agencies under the aegis of the EU Innovation Hub for Internal Security. The Research Study on High Altitude Pseudo-Satellites and the study on Key Enabling Technologies are currently advancing

with core deliverables. Those research exercises were defined together with all EU contributors. At Frontex we believe that co-creation and joint research activities can maximise and bring truly competitive research results. Among the JHA Agencies partnering with Frontex is the Fundamental Rights Agency, as both studies include relevant fundamental rights impact assessments of the technologies analysed.

Frontex engagement as the Senior User in the EU Framework Programme on Research and Innovation is presented in this annual report as one of the main highlights. Following the 2020 agreement signed with the European Commission formalising the role of Frontex in the EU Framework Programme on Research and Innovation, the first Horizon projects to which Frontex officially contributed from selection to completion were successfully concluded in 2022. Our engagement materialised in concrete project results such as with EFFECTOR, an outcome which now brings tested concepts and tools to Frontex operations.

It is my belief that introducing innovation into operational processes is successful only if the upgraded processes correspond to a stated need. This is at the core of the Frontex Entry and Exit System support package, designed and launched at the beginning of 2022 to support Member States' technical capacities. The package targets developing Member States capacities for the implementation of Entry Exit System at Border Crossing Points. In 2022, the results included notably the provision of advice on BCP functioning, and the re-design of operational processes with the use of simulations of passenger models and BCP workflow processes. Also, support was provided through the organisation of a conference in Rotterdam dedicated to processes and

solutions for EES in the maritime domain. Many activities are still ongoing in 2023, like the development of a knowledge platform with information on the new border checks procedures, now available to all border guards and all BCP across the EU. The pilot project at the seaport of Saint-Malo, France, testing the use of a web-app questionnaire on the Conditions of Entry into the EU continues in 2023 and will support the development of EU solutions for border checks including EES requirements.

I would like to express my sincere gratitude to all those who in one way or another contributed to the research and innovation activities listed in this report. The European Border and Coast Guard Agency hopes to continue working with you and for you. We will continue to shape the future of our borders with the development and

testing of innovative technologies and more efficient processes, including interoperability, while we address the needs of our community, seeking secure, fundamental rights' respectful and highly effective European integrated border management.

I am wishing you a fruitful reading and look forward to your feedback and further engagement.



Hans Leijtens
Frontex Executive Director

2. List of acronyms

BCP	Border Crossing Point
BVLOS	Beyond Visual Line of Sight
CGF	Coast Guard Functions
CGFO	Coast Guard Functions Operations
CONOPS	Concept of Operations
CMS	Common Minimum Standards (for Border Surveillance)
DG Home	EU Commission's Directorate-General for Migration and Home Affairs
DIS	Document Inspection Systems
DG JRC	European Commission's Directorate-General Joint Research Centre
DIS	Document Inspection Systems
EBCG	European Border and Coast Guard
ECGFO	European Coast Guard Functions Operations
EES	Entry Exit System
EIBM	European Integrated Border Management
ELOS	Extended Line of Sight
eu-LISA	EU Agency for the Operational Management of Large-Scale IT Systems
EURODAC	European Asylum Dactyloscopy Database
EUROPOL	European Union Agency for Law Enforcement Cooperation
EU SATCEN	European Union Satellite Centre
EUSPA	European Union Agency for the Space Programme
FRA	European Union Agency for Fundamental Rights
HAPS	High-Altitude Pseudo-Satellites
I-Cells	Innovation Cells
I-Days	Industry Days
IoT	Internet of Things
JHA	Justice and Home Affairs
KET	Key Enabling Technologies
LE	Law Enforcement
MSs / SACs	Member States / Schengen Associated Countries
MTS	Methodology for Development of Technical Standards
NUI	Natural User Interface
PAM4DIS	Performance Assessment Methodology for Document Inspection Systems
RPAS	Remotely Piloted Aircraft Systems
SAR	Search and Rescue
SSS	Self-Service Systems

TRL

Technology Readiness Levels¹

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)

VLOS VTOL WG

Visual Line of Sight

Vertical Take Off and Landing

Working Group

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 past reports² 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 2022.

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 Technology 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 2022 include:

- the continued input of Frontex as Senior User to the EU's framework programme on research and innovation;
- the research study on the Green Deal and the European Border and Coast Guard;
- the facilitation of dialogues with industry
- the Methodology for the development of technical standards for equipment to be deployed in Frontex activities;
- the activities under the EES Support Package to Member States;

- the study on Advance Information on land and sea borders;
- the development of a Capability Tool for Operational Testing and Evaluation of Document Inspection Systems (PAM4DIS).

The activities which were ongoing and whose final results were not yet available at the beginning of 2023 will be presented in the next iteration of the report. The section dedicated to ongoing research and innovation activities is extensive and features important developments planned for continued implementation in 2023 such as the first Call for proposals under Frontex Research Grants Programme and the launch of the first ever Frontex Prize Contest on the detection of low-flying objects. The duration of these activities confirms the multiannual perspective that needs to be taken into account for research and innovation. Regular updates on ongoing research and innovation activities will be shared via the Frontex website.

In addition, in 2022 Frontex continued to pro-actively support the EU Innovation Hub for Internal Security, by contributing to the meetings and events of the Hub, by keeping other Hub members updated on Frontex research projects and coordinating its research activities in order to ensure their optimal value and applicability across the JHA domain.

The total amount of Frontex budget for contracts for the implementation finalised research and innovation projects whose results are presented in this report reaches almost EUR 825,000 while the budget assigned to activities launched and ongoing in 2022 reached almost EUR 3 Million.³

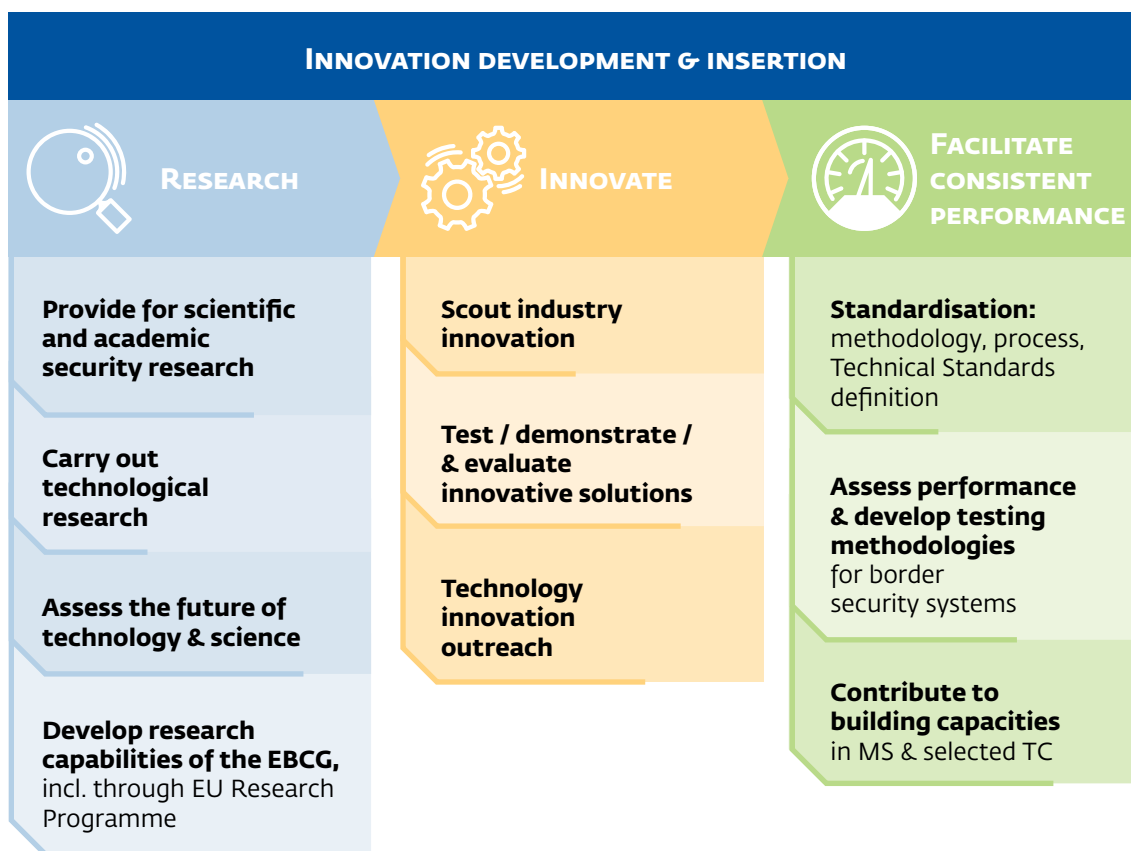
² [Results of Research & Innovation activities 2020 \(europa.eu\)](#); [Results of Frontex Research and Innovation Activities 2021 \(europa.eu\)](#)

³ The budget assigned corresponds to the totality of budget committed in the financial system or foreseen for commitment in order to continue the activity as planned. The final amount spent may vary.

4. Introduction – note on report 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 2022. Thus, activities performed totally or partly during previous years that have led to a result in 2022 are also in scope. This approach reflects the complexity of research and innovation processes, whose preparation and implementation typically runs over several years. While information on specific and general activities contained herein has been shared with the public via news releases



Main research and innovation areas at Frontex

and publications available on websites⁴, 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 Security⁵. In 2022 the Agency was actively contributing to the EU Innovation Hub for Internal Security, consulting with the Hub members the two projects launched in 2022 with the Hub: keeping other Hub members updated on Frontex research projects and coordinating its research activities to ensure their optimal value and applicability across the JHA domain.

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>. 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

5.1. EU Research and 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 Reference⁶ 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.

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 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).

5.2. Border-security related EU-funded projects finalised in 2022

Six projects were finalised in 2022: EFFECTOR, D4FLY, ARESIBO, ILEAnet, PERCEPTIONS and MIRROR. Frontex participated in several of their activities. From the perspective of Frontex especially the results of EFFECTOR and D4FLY are relevant.

⁶ [Frontex to provide border security expertise to European Commission's research projects \(europa.eu\)](https://europa.eu)



EFFECTOR project

The EFFECTOR project focused on improving maritime situational awareness by making better use of maritime surveillance systems and data sharing, to enable faster detection of new events and better-informed decision making. The project drew from previous research studies and its final solution was tested, validated and demonstrated in real operational scenarios, together with maritime authorities, end users and practitioners.



The main outcomes of the project included the implementation of interoperability framework and associated data fusion and analytics services for maritime surveillance, implementation of multi-layered data lake platform, and enhancement of operational efficiency and reduction of operational costs in multi-state operations.

On 8-9 June 2022, Frontex attended the EFFECTOR Greek Maritime Trial in the Regional Integrated Border Management and Migration Centre (RIBMMC) of the Hellenic Police in Alexandroupolis. The trial was focused on testing specific components of the EFFECTOR platform based on the integration of surveillance systems and sensors deployed in the field (e.g. maritime means, unmanned aerial vehicles, radio frequency detectors, thermal vision cameras, radars, telecommunications, meteorological stations, etc.). The project team successfully ran two operational scenarios which could be followed from the Regional Integrated Border Management and Migration Centre of the Hellenic Police.

The project objectives and outcomes translated to Frontex systems. Collaboration was established between the Effector project and the relevant Frontex entity responsible for operational data management resulting in the development of a software adaptor between the Frontex Joint Operations Reporting Application and the CISE⁷ network. With the use of this adaptor during one of the EFFECTOR's trial campaigns Frontex successfully performed information exchange with partners from outside EBCG community. The software adaptor was handed over to Frontex for future use. Preparations are ongoing to integrate the developed adaptor in Frontex systems.

D4FLY project

At the end of June 2022, Frontex participated in the final demonstration of D4FLY project. The demonstration aimed to give an overview of the tools developed by the project for the improvement of border crossing and the verification processes. D4FLY explored, developed, and validated new technologies to augment the current capabilities and capacities of border authorities in countering emerging threats in document and identity verification (e.g. forged documents, impostor fraud, morphed faces) at manual and highly automated land, sea and air border crossing points.



The solutions were tested during two scenarios: one in an automated border control post and the other, in a coach where border guards were verifying identities in a crowded confined space. The demonstration participants pre-enrolled using a specifically designed kiosk and then passed through a biometric corridor. During the enrolment, the passport was scanned by the kiosk and different cameras captured biometric features (2D, 3D and thermal face, iris and somatotype features). Encrypted reference data was stored in a database. A smartphone was used as a "carrier of identity" while passing through the corridor. The sensors installed in the corridor area captured participant's biometrics, compared them with those stored in the database and either confirmed or rejected the border crossing to a border guard carrying a tablet as border check equipment. Two types of masks and contact lenses with fake iris prints, and passport with a morphed photograph were successfully detected as fraud, during the demonstration.

The project development and final results benefited from the feedback of Frontex experts on combatting and detection of document fraud.

7 Common Information Sharing Environment



5.3. Border-security Horizon projects launched and ongoing in 2022

In addition to the projects listed on the dedicated section of the Frontex website⁸ and described in the previous reports (BorderSense,

MEDEA, ITFLOWS, METICOS, ISOLA, ENTRANCE, BorderUAS, iMARS, CRITERIA, AI-ARC, SilentBorder, MULTISCAN 3D, PROMENADE and NESTOR), seven new projects relevant to border security were launched under Horizon in 2022 and will be monitored and supported by Frontex:



Project EURMARS will improve sensing capabilities for a wide range of security risks and threats in wide border areas, by clustering high altitude platforms technology, satellite imagery, unmanned vehicles and ground-based sensors into a novel joint surveillance capability.



Project I-SEAMORE aims at delivering a platform to be used in managing the operation of multiple assets and systems with advanced maritime surveillance capabilities that can be easily deployed and operated at European maritime operation centres.



Project ODYSSEUS will leverage the power of digital technology offering to citizens the appropriate tools to cross land and sea borders in a secure and seamless manner without stopping, while equipping the border authorities with novel tools for secure identity verification and unobtrusive vehicle/luggage/cargo checks, eliminating long delays at border.



Project FLEXI-cross aims to increase security and reliability of EU border checks for people and goods through the development, deployment and validation of a toolkit of innovative border-checking solutions. The resulting flexibility and dynamicity of border check planning will offer novel capabilities such as dynamic deployment of check-points and support via mobile applications for border personnel.



Project MELCHIOR aims to improve a novel technology for fast detection of drugs, explosives, weapons and illicit goods concealed on individuals and in critical cavities of the human body based on infrasound mechanical impedance interrogation, optionally complemented with other harmless and non-contact technologies.



Project iFLOWS will design, develop, integrate, test and validate a novel multi-tier synergistic toolkit for enhancing intelligence extraction, screening and detection of illicit material and hazardous substances within courier and postal flows moving across and within EU borders.



Project PARSEC addresses the detection of threats and illicit goods in postal and express courier flow. It will develop and test next-generation non-intrusive technologies and combine them into an architecture designed for detection accuracy, speed, and reliability.

8 [Horizon projects \(europa.eu\)](https://europa.eu)



6. Providing research capabilities for EBCG



6.1. Research Study on the Green Deal and the EBCG

In March 2022 Frontex Research and Innovation finalized the project entitled the Green Deal and the European Border and Coast Guard (EBCG). The project's overall objective was to answer a research question: How to reduce the environmental footprints of the EBCG's facilities, operations, and services in order to achieve, and then maintain, a high level of environmental sustainability? The final report demonstrates how Frontex and its community can act and perform on sustainability within four focus areas: Green Office, Green Operations, Green Community, and Enabling Change. The report delivers high-level general principles that could have a direct and positive impact on the EBCG overall environmental performance and actionable recommendations in the area of sustainability in the short, medium and long term.

The main report was published on Frontex website⁹ and was widely distributed to the Agency's staff as well as the border management and law enforcement community with a view to apply its findings to relevant activities. The same audience was invited to two online webinars during which

Frontex highlighted concrete solutions that are available to help achieve sustainability goals. All knowledge was publicly shared on Frontex website in the form of the visual booklet with the key takeaways, knowledge insights and video clips.

Additionally, the research study was promoted in internal and external fora such as the Frontex Research for Innovation Network, the Justice and Home Affairs (JHA) Agencies' Network, the Greening Network, and the EU Innovation Hub.

6.2. Technology Foresight on Biometrics for the Future of Travel

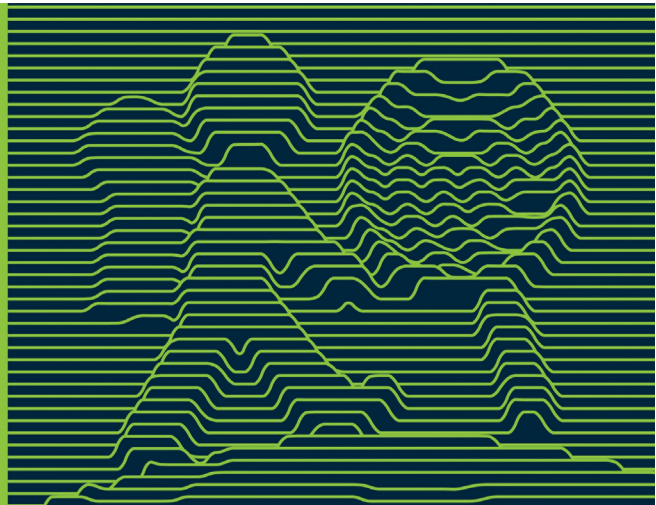
Following the completion of this Research Study in 2021, a thorough editorial and layouting review was conducted in 2022 in order to produce the final publishable versions of the Study, its Executive Summary and the three Annexes (the *Technology Foresight Manual*, the *Taxonomy of Biometric Technologies and Biometrics-Enabled Technological Systems*, and the *Patentometric and Bibliometric Analyses of Biometric Technologies*). The five volumes were eventually published by the Publications Office of the European Union and on Frontex website in October 2022¹⁰.

⁹ [The Green Deal and the European Border and Coast Guard \(europa.eu\)](https://europa.eu)

¹⁰ [Frontex publishes technology foresight on biometrics for the future of travel \(europa.eu\)](https://europa.eu)



Technology Foresight on Biometrics for the Future of Travel



The dissemination of the results of this research continued throughout 2022 by means of presentations in multiple fora and events, including the *JRC Foresight Network Meeting* (January 2022), the *Research, Development, and Industry Day for Management of Migration Flows* (MEDEA EU-funded project, May 2022), the *CEPOL Research & Science Conference* (June 2022), and the *Expert Workshop on the Strategic foresight in the area of fundamental rights* (organised by the European Union Agency for Fundamental Rights, October 2022).

An article on the research study was also published on the *European Law Enforcement Research Bulletin*, Special Conference Edition, Volume Nr.6 (December 2022).

6.3. Research for Innovation Network

Research for Innovation Network (R4IN) is a panel of experts from Member States and Schengen Associated Countries that has as main goals to further enhance the collaboration within the EBCG community and to improve the quantity and quality of the EU Border Security Research and Innovation. Year 2022 brought together the network participants in June. The meeting was organized in a hybrid format, back-to-back with the Horizon Border

Security Projects Workshop, with a total of 18 participants from seven Member States, DG Home and Frontex.

An important product of the network is the survey on the future research needs of Member States/Schengen Associated Countries, that gathered contributions from nine Member States/ Schengen Associated Countries. The survey was organized in four main sections and the respondents have been asked to assess the relevance for border management in the medium to long term (5 years and beyond), on scale from 1 to 10, of the following topics/themes: surveillance (semi-autonomous surveillance towers, Remotely Piloted Aircraft Systems (RPAS) management and counter RPAS system, Internet-of-Things and advanced connectivity capabilities), border-checks (Beyond the state of art biometrics solutions, Blockchain for border control) and operations (Low environmental footprint solutions for aerial and maritime assets). The results have been straightforward, underlining the EBCG interest in RPAS systems.

More information about the R4IN meeting and meeting documents can be found on Frontex EU Research Webpage¹¹.

11 [Horizon Border Security Projects Workshop and Research for Innovation Network \(R4IN\) meeting \(europa.eu\)](https://europa.eu)



6.4. Cooperation with JRC on analysis of emerging technologies in the field of border security

Frontex and the Joint Research Centre¹² have a fruitful collaboration on numerous scientific and technical domains.

One of the most advanced areas of work is the technology watch in the field of border security.

Frontex Research and Innovation expressed interest in using the JRC's TIM (Technology and Innovation Monitoring) analytics capacity for identifying and monitoring existing and emerging technological solutions relevant for European Integrated Border Management. The main objective was to assess challenges and opportunities in emerging technology and science that may address operational needs of the EU Border and Coast Guard community.

Eleven technologies were selected and prioritized for analysis due to their potential impact, as follows:

First priority

- High Altitude Pseudo Satellites
- Blockchain for border control
- IoT and border control
- Intelligent video surveillance
- GNSS radar for maritime surveillance
- Track while scan
- Underwater sensor network

Second priority

- Video synopsis
- Parafoil UAV
- Algorithmic surveillance (only for non-personal data)
- Micro drone surveillance

The scientific landscape was analysed for each of them in a report elaborated by the JRC titled *Weak Signals in Border Management and Surveillance Technologies*¹³.

The JRC's TIM analytics tools were used to identify emerging technologies or emerging new applications of known technologies (so-called "weak signals") in the field of Border Management. The list of emerging technologies presented in this report is the result of a detection process ran by the JRC during the second semester of 2021 using "TIM Trends"¹⁴. This software combines text mining techniques, computational capability and data visualisation and has been specifically designed by JRC to detect weak signals of emerging technologies or new scientific topics.

Two datasets were used to run the detection process: the Scopus collection of scientific publications (from 1996 to summer 2021) and worldwide patent applications from Patstat (from 1996 to summer 2021), following a methodology combining text mining, scientometrics and domain knowledge. Frontex Research and Innovation provided the domain knowledge to select the weak signals.

The findings of the report will be useful to formulate future research topics, including research to be financed under the Horizon programme, or to further investigate emerging technologies relevant for border management. The report identifies the industrial and academic institutions involved in research on specific theme and as such will facilitate contact to relevant entities dealing with these technologies.

¹² European Commission's Joint Research Centre

¹³ [JRC Publications Repository - Weak Signals in Border Management and Surveillance Technologies \(europa.eu\)](https://publications.europa.eu/en/publication-detail/-/publication/11111111-1111-1111-1111-111111111111)

¹⁴ TIM Trends is a tool of the TIM analytics suite developed by JRC. Link to TIM analytics website: https://knowledge4policy.ec.europa.eu/text-mining/topic/tim_analytics_en



- solutions to improve the border crossing experience while maintaining security and compliance: innovative solutions for queue management, passenger registration, biometric data acquisition, pre-registration, and reducing waiting time for travellers.

I-Days organised in 2022

Frontex online Industry Days, 29-30 March 2022

The industry presentations showcased various types of technology solutions for surveillance, biometrics, and RPAS (Remotely Piloted Aircraft System) applications.

Some of the surveillance solutions presented included handheld observational binoculars, long-range cameras, and 5G-based surveillance systems that relied on cloud technology and real-time AI analytics. RPAS technology was also presented, including solar-powered drones and maritime surveillance systems. Some biometrics solutions included kiosks and gates for secure border control, a combination of a smartphone and a compact fingerprint scanner, and a contactless fingerprint technology that enabled smartphone cameras as scanners. There were also solutions included a collaborative photographic acquisition system for biometric registration and verification purposes, a mobile surveillance management system for mobile devices, and autonomous surveillance tower platforms. Furthermore, a subcutaneous vein pattern-based biometric identification system with a Common Criteria EAL2¹⁶ certificate was presented.

The presented solutions were relevant to improve security and efficiency in various applications such as border control, surveillance, and field operations. Information on the I-Days is available on Frontex website, including the summary report¹⁷.

Frontex online Industry Days – Law Enforcement, 17-18 May 2022

The I-days focused on capabilities for law enforcement and immigration authorities such as the safe detection and identification of concealed persons, harmful substances, illegal goods in vehicles, vessels, clandestine compartments, or containers. Additionally, technologies enabling the detection of multiple jamming methods for location equipment, automatic recognition of vehicle number plates, and automatic recognition of language and dialect from live or pre-recorded audio sources, with translation support.

Information on the I-Days is available on Frontex website, including summary report¹⁸

Frontex online Industry Day – Vehicle Rental, 6 July 2022

The objective of the event was to identify providers of a wide transportation fleet that could be made available in a compact, flexible, and sustainable format during Frontex operations. The vehicles used in Frontex operations need to perform under a range of climate conditions, geographical regions, users and operators, road conditions, and need to be capable of supporting additional equipment and customization. For Frontex operation, a constant fleet readiness is necessary, backed by a plan in case of accidents, maintenance works, or other circumstances causing unavailability of the vehicle.

Information on the I-Days is available on Frontex website¹⁹.

Frontex online Industry Day - Warehousing and Transportation Services, 12 September 2022

Frontex invited commercial operators that offer storage and dispatch services for firearms,

16 EAL2 is one of the criteria of Evaluation Assurance Levels which are standards for IT Security as per ISO/IEC 15408-5:202

17 [Invitation to Frontex online Industry Days 29-30 March 2022 \(europa.eu\)](#); [Frontex Industry Days 29-30 March 2022 – follow up \(europa.eu\)](#)

18 [Invitation to Frontex online Industry Days – Law Enforcement 17-18 May 2022 \(europa.eu\)](#), [Frontex Law Enforcement Industry Days 17-18 May 2022 – follow up \(europa.eu\)](#)

19 [Invitation to Frontex online Vehicle Rental Industry Day – 6 July 2022 \(europa.eu\)](#)



ammunition, non-lethal weapons, and other law enforcement equipment.

The purpose of the meeting was to allow industry representatives to showcase their latest portfolio of services to Frontex business units, particularly in the areas of secure and reliable storage and dispatch of law enforcement equipment across different geographical regions. Frontex operations and activities are performed mainly in the Member States at the European Union external border and neighboring countries.

Information on the I-Days is available on Frontex website²⁰

Frontex online Industry Day: Counter-drone adversarial testing and evaluation services, 6 October 2022

The meeting discussed the pressing security concerns regarding the illegal use of low-flying objects (including drones) for criminal and terrorist activities such as smuggling, reconnaissance, and facilitating irregular migration. Member States and industry experts highlighted the need for effective and cost-efficient technical systems to detect, track, and identify these objects. The Industry Day provided an opportunity for industry representatives to share their latest products and services with the Agency and Member States. The Agency was seeking comprehensive information from service providers on their capabilities, including provision of testing and evaluation services in real-world conditions, a diverse portfolio of threat-emulating aerial platforms, experienced

professionals on operating Unmanned Aerial Systems (UAS) and Low Flying Objects (LFOs), simulation of threat scenarios, and risk assessment frameworks.

Information on the I-Days is available on Frontex website²¹.

Frontex online Industry Days, 8-9 December 2022

During the I-Days, discussions highlighted challenges in the development of border management solutions for situational awareness and search and rescue (SAR), using High-Altitude Pseudo-Satellites (HAPS). Technical challenges include the need for advanced lightweight technologies for energy storage, communication, and control systems to operate at high altitudes for extended periods. Regulatory challenges include the lack of established regulations for HAPS operation, requiring close collaboration with government agencies for compliance and permits. Cost-benefit analysis and integration with other communication and monitoring systems pose cost and integration challenges, respectively. Lastly, HAPS must be able to operate in diverse weather conditions and environments, necessitating robust systems and redundancy measures for continuous operation. The findings of the I-Days will feed into research activities related to HAPS.

Documentation related to the I-Days is available on Frontex website, including summary report²².

20 [Invitation to Frontex Online Warehousing and Transportation Services Industry Days 12 September 2022 \(europa.eu\)](#)

21 [Invitation to Online Industry Day: Counter-drone adversarial testing and evaluation services \(europa.eu\)](#)

22 [Invitation to Frontex online Industry Days 8-9 December 2022 \(europa.eu\)](#)



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

8.1. Technology Innovation in 2023

At the end of 2022 two major technology tests were concluded: Pilot Project Maritime Surveillance Aerostat II in Greece and Pilot Project EES at Land Borders in Bulgaria and Spain. The first months of the year were devoted to the elaboration of evaluation reports which were released later in the year. The technology testing activities launched in 2022 are in various stages of implementation and their results will be available in 2023 or 2024. Short descriptions are included in the section on Ongoing Research and Innovation Activities.

8.2. Innovation Cells: consulting technology innovation with Member States

Frontex has created a specialized network of technical experts from Member States called the Innovation Cells (I-Cells) to facilitate discussions on technology innovation. This initiative aims to enhance Member States' understanding of operational needs, technological gaps, and Frontex technology testing activities through structured engagement. The Innovation Cells will allow for the identification of products and services at an operational prototype level to be piloted, based on participants' technical and thematic knowledge. Technical discussions on technology testing, as well as the identification of relevant technologies that address capability development plans and roadmap needs, will also take place.

Additionally, the network will serve as a platform for discussions on research activities' outcomes and pilot projects' results. These insights will lead to the development of follow-on projects in a harmonized and joint manner. The resulting technical expertise will benefit national-level capability planning processes.

Frontex's pilot projects offer Member States an exceptional opportunity to test solutions tailored to their needs in a real-time piloting environment. This unique chance allows for the testing of the latest technology and innovative approaches to carry out border surveillance and checks.

In 2022, the Innovation Cell Border Checks and the Innovation Cell Surveillance meetings were held, which facilitated the formation of expert groups. In addition the Innovation Cell Law Enforcement was launched. The meetings of the I-Cells also included presentations of concepts and discussions on ongoing pilot projects, future technology innovation needs, and outcomes of the EU research framework programme projects. For example, the achievements of Meticos and Medea funded by the EU research and innovation programmes, were presented to the I-Cell Border Checks in December 2022. These outcomes were analysed for their relevance and readiness for further development in line with EBCG needs.





9. Improving Operational Performance of EBCG capabilities

9.1. Technical Standards for Equipment: Methodology and Maintenance

As provided for by Article 64 of the EBCG Regulation, the Technical Equipment Pool shall comprise equipment that conforms to the technical standards defined by the Agency, in consultation with the Member States and the European Commission, as a condition for it to be deployed in the Agency's operational activities. The technical standards are adopted by decision of the Management Board, and subject to the proposal of the Executive Director.

On 28 June 2022, the Management Board of Frontex adopted the Methodology for Development of Technical Standards for the equipment to be deployed in Frontex activities (MTS). This Management Board Decision²³ is a new important milestone to ensure consistency in the development of the technical standards that ensure interoperability and compatibility of the equipment in the Technical Equipment Pool managed by the Agency.

In addition, the maintenance process of the Technical Standards was conducted in the second semester and concluded in December 2022. The scope of the maintenance was limited to: (a) report factual mistakes, (b) inform about possible obsolete equipment that should be considered for removal from the Technical Standards, (c) propose changes to the status of an existing requirement from mandatory to recommended or otherwise, (d) update references to relevant international standards or documents. Feedback going beyond the purpose of the maintenance was considered as well and thoroughly discussed with the approaching Member States.

There was a total of eight Member States reacting on the different technical standards. The feedback was compiled, and bilateral discussions with the Member States took place.

9.2. Supporting Member States on preparations for the EES entry into operation

The preparation of the national systems to collect the information required by the Entry Exit System (EES) and to implement the connection of the national system to the Natural User Interface (NUI) is the responsibility of each individual Member State and Schengen Associated Country. All Member States are expected to adapt their border management processes and human resources capabilities (e.g. by contracting and training additional persons) in order to accommodate the changes needed in view of the entry into operation of the EES.

Throughout its activities carried out with border control authorities in the past two years, Frontex has observed that Member States are still facing difficulties in the implementation of the end-to-end system connections, in the adaptation of border check procedure, and in the preparations at BCP level. Addressing difficulties at BCP level is particularly difficult since solutions need to be tailored to the particularities of each BCP in terms of volume and characteristics of the flow of passengers, infrastructure constrains, as well as staff availability and capacities.

At the end of 2021 the DG Home has requested Frontex to further extend its support to Member States to address these difficulties and help mitigate the risk of further delays in the entry into operation of the EES. This extended support takes the shape of an EES Support Package

²³ Management Board Decision 36/2022 adopting the Methodology for Development of Technical Standards for the equipment to be deployed in Frontex activities



focusing on actions supporting the operational implementation of the EES at BCP level.

Within Frontex, the Research and Innovation Unit has the task to setup and coordinate the EES support package, and to collaborate with the other divisions and units in defining, describing and finally implementing these activities, following a needed reprioritisation at all levels of the Agency. The actions of the EES support package completed in 2022 are listed below.

Conference on EES in the maritime domain

On 18-19 October 2022 in Rotterdam, with the support of the Royal Netherlands Marechaussee Frontex organised the Conference on EES in the maritime domain.

The main topics discussed were related to the EES procedures for maritime Border Crossing Points (BCPs) involving passengers on cruise ships, pleasure boats, ferries, and presentations of technical solutions from industry. The speakers discussed the difficulties that border guards, carriers, and operators will encounter at maritime BCPs with the EES as well as practical solutions that are being adopted. A site-visit to the Europoort Rotterdam took place on the second day of the event.

The key messages emphasised during the conference include:

- One of the primary challenges of the EES implementation is to attain a consistent service level at all ports. This requires cooperation between the port, the carriers, and the host administration, as well as harmonized practices across Member States.
- The increase in waiting time is one of the key concerns with the EES entry into operation, particularly on ports facing spatial or financial constraints. The problem is most acute in locations where passengers are expected to stay only briefly in the EU. Self-service system kiosks and mobile/handheld devices are possible solutions.
- Targeted information campaigns will raise awareness among passengers of the new border checks requirements and fluidify of the flows at BCPs level.
- The establishment of BCPs operating temporarily in response to the increased traffic during peak periods is a possible compromise solution to avoid overload while reducing the need for permanent staffing.

- At ferry terminals, mobile containers designed for passenger pre-enrolment in SSS kiosks and mobile applications are being considered to optimise the border check process.
- For the safety of travellers, it is important to separate pedestrians from car traffic.
- Developing a certification program for EES equipment will speed up the procurement process.
- A potential solution to optimise the passenger service is to introduce the possibility of capturing data before the trip.

These findings are used in Frontex activities relevant for supporting EES entry into operation, at maritime borders.

EES Study Visit

A Study Visit on the Entry/Exit System was organised on 20-21 April 2022 in the Netherlands. The aim was to give an opportunity to EU Member States to see technical solutions related to EES being tested by the Netherlands, with a view to support MSs in optimising and redesigning their BCPs.

The study visit included:

- A meeting during which the Dutch authorities presented their national plans for the EES implementation and for the future of border management;
- A tour of the training centre to show the EES-related equipment used for training purposes and being piloted at seaports (i.e. self-service system, mobile solutions for seaports);
- A tour of the test centre to have demonstrations of EES-related equipment and software (i.e self-service system, national system interface).

The study visit was attended by 30 participants from 22 Member States/Schengen Associated Countries, eu-LISA and Frontex. Participants were highly satisfied and interested in attending other study visits but also to further discuss the EES implementation during workshops on EES use cases.

Technical Advice to BCPs and support to the end-to-end testing activity

Frontex offered technical advice on the EES process designed for specific BCPs based on national assessments to Member States: Austria, Finland, Greece, Italy, Slovakia and Slovenia.



The Agency also organized field visits to visualise physical space where EES dedicated equipment will be installed and provide advice, in Italy and Slovakia. The aim of these field visits was, in collaboration with Member States, to select specific BCPs where EES equipment is already in place, or becomes available in the short term, to show characteristics that can be of interest to other Member States (e.g. integration of technical solutions, workflows, traveller' guidance systems), with the provision of advice on updated border checks process integrating EES requirements and new equipment, proposing fine-tuning, increase knowledge on existing procedures at BCPs and integration of EES equipment for border checks.

Given Member States' requests for support the EES end-to-end testing activity, this activity will continue in 2023.

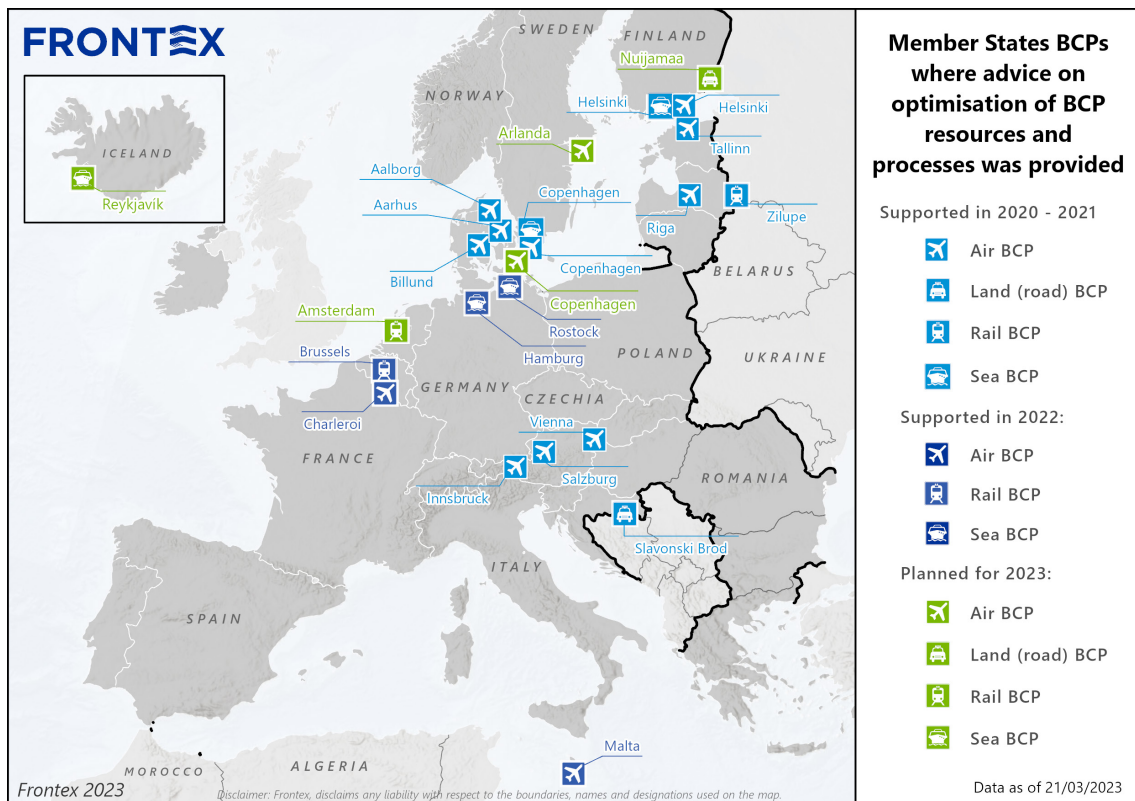
Supporting Member States' capabilities in simulations of BCP processes

In 2022, operational research support to the Entry/Exit System implementation continued to be provided to Member States:

- Five BCPs in three Member States were supported with assessments on BCP process

flows: Charleroi Airport and Brussels South Train Station in Belgium, Hamburg Harbour and Rostock Harbour in Germany, Malta Airport in Malta. Simulations of different scenarios for these specific BCPs were run and solutions were recommended for the optimised implementation of EES.

- Generic EES models per BCP type and per EES scenario were developed based on the individual BCPs assessments carried out from 2020 until mid-2022.
- A Handbook (consisting of two parts) on operational research models to support the EES implementation was developed to describe and explain how to use the generic EES models so that Member States can run simulations by themselves.
- A Report on Simulations Findings for the EES based on BCPs analyses carried out in 2020-2022 was developed to share key observations resulting from simulations.
- A Report on Typical Use Cases for the EES based on BCPs' analyses carried out 2020-2022 was developed to identify common conclusions to shape typical use cases to further support Member States with the EES implementation.



Member States BCPs where advice on optimisation of BCP resources and processes was provided



Given Member States's requests for operational research support, this activity will continue in 2023, and the development an Operational Research Capability for Member States' own use of generic EES models may be started.

9.3. Common Minimum Standards for Land Border Surveillance

Cooperation, unified rules and standards are essential to effectively manage the EU's external borders, addressing migratory challenges and contributing to Europe's security. Furthermore, Regulation 1896/2019 on the European Border and Coast Guard (Art 10.1.z) requires Frontex to support the development of technical standards for equipment in the area of border control and return, including for the interconnection of systems and networks, and the development of common minimum standards (CMS) for external border surveillance, in line with the respective competences of the Member States and of the European Commission.

In November 2022, the Working Group (WG) of five pre-selected Member States including Estonia, Finland, Latvia, Lithuania and Poland presented the draft document developed in 2021-2022 to other Member States with external land borders. This presentation was the opportunity for all Member States to provide their comments. All comments were taken into account in the final document CMS for land border surveillance.

CMS for land border surveillance are a guidance document to develop national border surveillance strategy, operational model, cooperation, and border surveillance capabilities. It is structured around the following topics:

- National land border surveillance strategy
- National operational model
- Intra-service, inter-agency and international cooperation
- Border surveillance capabilities
 - Factors for the selection of the surveillance equipment
 - Technical equipment and integrated solutions
 - Staffing and patrolling
 - Training
 - Data management

- Information exchange
- Security
- Asset management

9.4. Capability Tool for Operational Testing and Evaluation of Document Inspection Systems (PAM4DIS)

The performance of Document Inspection System (DIS) is critical when performing travel document checks. However, DIS continue to represent a 'black box' to many of its end-users who do not have the necessary influence in controlling the key processes related to identification and verification.

To help improve this situation, Frontex initiated an activity in 2018 called 'Performance Assessment Methodology for Document Inspection Systems (PAM4DIS)'. The first iteration of 'PAM4DIS' was aimed primarily at testing the validity and reliability of the developed methodology itself in real-life situations.

To overcome the limitation of the first methodology in terms of completeness and applicability, Frontex initiated a consecutive activity in 2022 called 'PAM4DIS 2.0' to develop a practical capability tool for operational testing and evaluation of DIS. This tool shall support the operational performance assessment of DIS, through testing and evaluation of DIS under realistic conditions.

The result of the activity is the Capability Tool Guidance Document for Operational Testing and Evaluation of DIS²⁴ which introduces:

- A practical approach for applying the PAM4DIS, described in process steps,
- The creation and compilation of test document sets,
- The preparation of protocols and questionnaires,
- The process of conducting the test,
- The guidelines for interpretation of test results.

The Guidance Document also includes detailed formulas, examples for test document sets, test charts and additional tools implementing the formulas and processes as well as command line tools to analyse image quality results.

24 The Capability Tool Guidance Document for Operational Testing and Evaluation of Document Inspection Systems is in publication process and will be available in 2023.



10. Other research and innovation activities

In addition, during 2022 Frontex has made available its research and technology innovation expertise as follows:

Support to training activities

Frontex research officers continued to support the Entry/Exit System training by delivering on-line 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.

Action Plan on synergies between civil, defence and space industries²⁵ adopted by the Commission in 2021

As part of the Action Plan on synergies between civil, defence and space industries, Frontex contributed to the finalisation of the impact assessment for secure connectivity programme. In November, Frontex took part in the discussion on the Space Strategy for Security and Defence.

Support to Montenegro

In order to provide findings and recommendations to the Montenegrin authorities in the assessment of the current border checks, 10 different border crossing points (BPCs), land, sea, air and railway were visited in 2022 by a Frontex delegation.

Information about the infrastructures, the equipment provided, the standard operating procedures used, the specific training of first and second line border guards and the information sharing systems between the BCPs was collected during the field visit and feedback was provided in several domains such as legal institutional framework and strategies, staffing and training, infrastructure.

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

The framework contract facilitates access to services to support or improve activities related to the responsibilities and mission of Frontex on 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.

In 2022, twelve research and innovation projects were launched under the framework contract, based on the initiative of multiple Frontex business entities.

To further improve the usability of the framework contract, amendments to the ordering procedure and the contract itself were prepared in 2022, with a view to be implemented in 2023.

²⁵ COM(2021) 70, https://ec.europa.eu/info/files/action-plan-synergies-between-civil-defence-and-space-industries_en

11. Ongoing research and innovation activities

Entry/Exit System (EES) support package: Advice on optimisation of BCP resources and processes

In 2023, the support to the optimisation of BCPs will continue under the framework contract for research assistance and advisory services (Frontex/OP/451/2020/ZB), with simulations to be run for up to six BCPs.

Preparations to develop an Operational Research Capability started in 2022, in cooperation with other relevant Frontex departments. The aim is to make the generic EES models, together with the simulation software, available to Member States to run their own simulations. For 2023 it is planned to develop and test such capability as a proof of concept, and, following positive assessment, organise workshops for experts from Member States on its use.

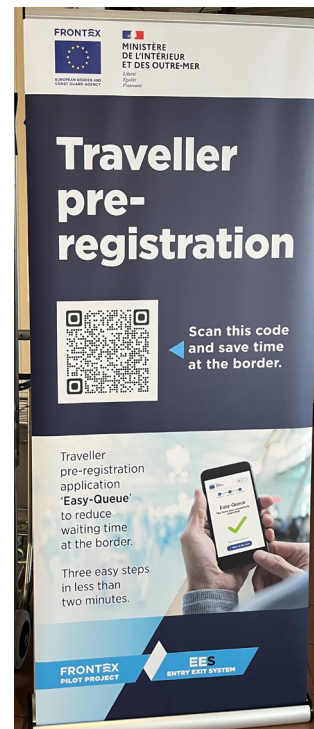
EES Support package: Pilot project Conditions of entry questionnaire in support of EES

The results of the 2021 EES Land Border pilot projects indicated that technology can successfully assist with the mandatory EES processes at BCPs, and has also shown that regardless of the technology applied, the additional steps required by the EES increase the duration of the border crossing process. A significant portion of this processing time is taken up by the mandatory step of the Schengen Borders Code traveller's questionnaire on conditions of entry ('questionnaire'). The questionnaire may be adjusted to the requirements of each Member State and usually collects self-declared information about the length and destination of travel and means of subsistence. The questionnaire process, which takes on average 30 seconds is further lengthened when the traveller does not understand the questions asked or needs to retrieve information (i.e., verify

destination details, trip plans, money held etc.) to be able to answer them correctly.

In this context Frontex examined how the questionnaire could be completed with less time engagement of the border guard at the BCP, which led to the idea of offloading it from the Border Control Post's (BCP) direct area by creating a webpage, which the traveller may access using a PC, tablet or mobile phone in his/her own time, before arrival at the border entry point i.e. during transit. This type of facilitation is a concept that a number of Member States have been considering and which Frontex set out to develop with Member State France in the pilot project *Conditions of entry questionnaire in support of EES*.²⁶

The project developed a website allowing travellers to fill in the questionnaire before entering the EU host country in the port of Saint Malo, France. An information campaign directs the traveller via a QR code to the website allowing to use their personal device to access the questionnaire and provide relevant information before arrival, and submit it via the Internet to the French border check central system. This aims to reduce the average



Information banner encouraging travellers to access the website and fill the Conditions of Entry questionnaire

26 [Frontex and France run pilot project to ease travel across borders \(europa.eu\)](https://europa.eu)

BCP processing time by an estimated 30 seconds and should improve the user experience of travellers and border guards, facilitating border crossing point management.

Following the information on postponement of the EES entry into operation, as well as the first unsuccessful tender for the technical solution, the project implementation started in Q3 2022 and will be finalised in the first quarter of 2023. In December 2022, at the beginning of the operational tests, a showcase and live demonstration of the website, integrated with the French system, was organised for Member States, eu-LISA, and DG Home experts.

EES Support package: EES Toolkit for BCPs and SharePoint Knowledge Platform

In 2022, as part of the EES support package, Frontex launched the development of a Toolkit on best practices on EES for BCPs. The Toolkit consists of guidelines and practical reference material for border guards in leaflet style (digital and print formats) and aims to facilitate consultation and understanding of basic EES processes guidelines and best practices. Its English version is planned to be released in early 2023 and translations to other EU languages will be provided, depending on Member State's requests.

In order to respond to Member States' needs and support exchanges on preparation to the EES, a series of workshops and a plenary meeting for Member States were organised on exchange of operational solutions around use cases.

The Toolkit as well as information collected during the workshops was made available on a dedicated online searchable platform whose purpose is to consolidate knowledge and related information on EES to support Member States in their preparations for EES implementation.

Common Minimum Standards for Maritime Border Surveillance

In 2022, following the finalisation of the Common Minimum Standards for land border surveillance, Frontex launched the drafting the CMS for maritime border surveillance. Frontex established a new WG composed of eleven pre-selected Member States with external sea borders, including Bulgaria, Croatia, Cyprus, Finland, Germany, Italy, Lithuania, Latvia, Malta, Poland and Portugal. The WG drafted the CMS for Maritime Border Surveillance covering aspects such as national border surveillance strategy, operational model, cooperation, and border surveillance capabilities. The WG decided to include SAR in the CMS because SAR has become a crucial part of maritime surveillance operations. Furthermore, national authorities conducting maritime surveillance are also either responsible for SAR and/or cooperate with other national authorities. The CMS for maritime surveillance will be finalised in 2023.

The main objective of the CMS is to support the harmonisation of border surveillance concepts and practices between the Member States. This document outlines a set of practices and identified commonalities concerning maritime border surveillance based on the input of the contributing Member States.

Research Study: High Altitude Pseudo Satellites

In 2022 Frontex launched a research study on High-Altitude Pseudo-Satellites (HAPS), carried out under the auspices of the EU Innovation Hub for Internal Security²⁷. The HAPS study project team gathers experts not only from Frontex but also from the EU Innovation Hub members such as DG JRC, Europol, FRA, together with EUSPA and EU SatCen.

High-Altitude Pseudo-Satellites (HAPS) are technological solutions that have attracted significant

27 The EU Innovation Hub for Internal Security is a collaborative network of innovation labs that works to provide the latest innovation updates and effective solutions to support the work of internal security actors in the EU and its Member States. It is composed of representatives from EU JHA Agencies, European Commission (DG Home and DG JRC), the Council General Secretariat and the EU Counter Terrorism Coordinator, as well as EU Member States. For more information please see [EU Innovation Hub for Internal Security | Europol \(europa.eu\)](https://europa.eu/innovation-hub-for-internal-security)

HIGH ALTITUDE PSEUDO SATELLITES

RESEARCH STUDY | FIRST INSIGHT

This month, Frontex has started a new research study: "Research study on High Altitude Pseudo Satellites (HAPS)". Through this study, Frontex aims at contributing to developments in research and innovation relevant to its area of operations, to bridge the gap between technological and research advancements and the needs of the European Border and Coast Guard (EBCG).

The outcomes from the research would serve as a baseline to review and evaluate whether and how Frontex and the project stakeholders can utilise HAPS and maximise the solutions they provide. The research study is carried out in coordination with an external contractor. Throughout its duration, Frontex will regularly publish insights on the study.

WHAT? - CONTEXT AND OBJECTIVES

The EU is aiming at strengthening its innovation capability and ensuring its global competitiveness. High Altitude Pseudo-Satellites (HAPS) are flying devices, closely mirroring the capacity and operability of satellites. While this technology is still in the early stages of development, it presents significant potential uses in the context of surveillance, internal security and border control. For this purpose, Frontex supported by the external contractor will carry out a research study on the HAPS market and an assessment of their use as capability enablers/multipliers.

HOW? - APPROACH AND METHODOLOGY

In order to deliver these objectives, the research team will carry out four work packages:

- 1 Overview of the HAPS market
- 2 Specific assessment on HAPS and potential use cases
- 3 Fundamental rights impact assessment
- 4 Data sharing and dissemination

The research team will use a wide range of data collection and analysis tools across the work packages, including: desk research and literature review, benchmarking via SWOT analysis, market research, stakeholders consultations (interviews, workshops), fundamental rights checklist and data triangulation. The study insights will be published on Frontex website throughout its duration and presented in a webinar at its end.

WHO? - STUDY STAKEHOLDERS



WHEN? - PLANNING

The project was kicked-off officially on the

24TH NOVEMBER 2022

and will be closed the latest by the

END OF SEPTEMBER 2023

QUESTIONS?

If you have any questions regarding this research study, you can contact Frontex at:

✉ RESEARCH@FRONTEX.EUROPA.EU



The first insight of the research study on HAPS published on Frontex website.

interest from the EBCG community and other stakeholders, due to their potential to address operational gaps and further enhance existing surveillance and communications capabilities. This was underlined in the recent [Report on Weak Signals in Border Management and Surveillance Technologies](#), jointly delivered by

DG JRC and Frontex, where HAPS were listed as one of the eleven emerging technologies of relevance for the EBCG community. The current research study aims at exploring if HAPS can indeed be a capability enabler/multiplier and how the JHA community can maximise the opportunities provided by such solutions.

The preliminary and interim results will be published on Frontex website²⁸ with the final report planned to be available on the Frontex website by the end of 2023.

Research Study: Key Emerging Technologies and Privacy Enhancement

In line with its mandate, Frontex shall monitor and contribute to developments in research and innovation relevant to its area of operations, to bridge the gap between technological and research advancements and the needs of the European Border and Coast Guard.

Identifying research and innovation initiatives in the area of technology as well as increasing synergies and pooling of resources are also among the objectives of the EU Innovation Hub for Internal Security²⁹.

One of the common challenges faced by the Justice and Home Affairs (JHA) actors while supporting the EU Member States' internal security authorities is the access to data while minimising or avoiding risks to privacy and data protection.

On these lines, and to address the common challenge to the EU Innovation Hub participants, the research study on Key Emerging Technologies and Privacy Enhancement was launched in 2022, under the leadership of Frontex, with the goal to support and with the participation of the EU Innovation Hub. The study will focus on the specificities of the JHA domain and its most relevant use cases, by providing:

- An overview of current and future Privacy Enhancement Technologies designed to support privacy and data protection with relevance to processes, information systems and practices of law enforcement, migration management, asylum and justice.
- Technology assessments for specific privacy enhancement technologies.
- Applicable knowledge on privacy enhancement related to autonomous platforms and edge computing.

The research study was launched in 2022 and is outsourced under the framework contract for research assistance and advisory services. It is planned that its results will be available in 2023.

Trial of Vertical Take-Off and Landing (VTOL) Remotely Piloted Aircraft Systems (RPAS) for multi-purpose aerial surveillance (up to 25 kg MTOW) for law enforcement and coast guard functions

This pilot project is a Frontex trial that aims to evaluate the use of Remotely Piloted Aerial Systems (RPAS) with Vertical Take-off and Landing (VTOL) capabilities onboard maritime assets deployed in future Frontex operations. The trial seeks to develop a proof of concept for using VTOL RPAS onboard maritime assets such as coastal patrol vessels and offshore patrol vessels in support of Coast Guard Functions (CGF).

The use of VTOL RPAS for maritime surveillance missions in support of CGF is a potential operational capability gap that has been identified in Frontex RPAS Study and expert-level meetings. The project aims to identify and develop a capacity-building model for this future capability by mapping legal and regulatory frameworks, technical and operational processes and procedures required.

The project faces several challenges, including identifying and addressing legal and normative topics related to the operation of VTOL RPAS from ships, harmonizing the legal and regulatory frameworks, and developing a safe and effective operation of VTOL RPAS. The project also aims to contribute to mitigating an existing operational capability gap by deploying innovative VTOL RPAS capabilities to enhance multipurpose surveillance at sea. The project will need to achieve comprehensive technical and operational testing and evaluation of VTOL RPAS capabilities, as well as develop an integration model for Frontex Standing Corps for the ECGFO and assess the overall operational effectiveness and cost-efficiency of the tested solution.

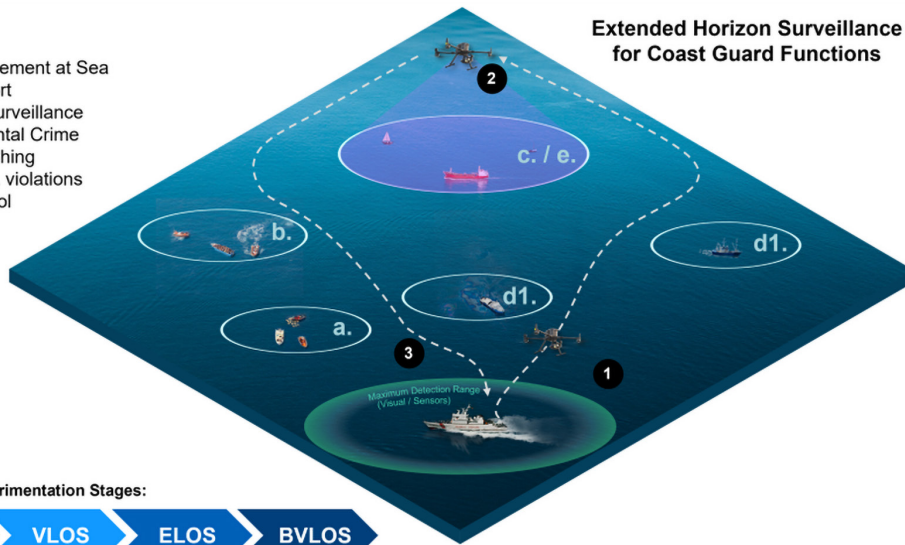
²⁸ [News and events \(europa.eu\)](https://www.europa.eu)

²⁹ More information on the EU Innovation Hub for Internal Security is available here: <https://www.europol.europa.eu/operations-services-innovation/innovation-lab/eu-innovation-hub-for-internal-security>

CONOPS:

- a. Law Enforcement at Sea
- b. SAR support
- c. Maritime Surveillance
- d. Environmental Crime
 - d1. Illegal Fishing
 - d2. MARPOL violations
- e. Border Control

Extended Horizon Surveillance for Coast Guard Functions



Operational Experimentation Stages:



Typical multipurpose mission carried out by Coast Guard authorities in support of Coast Guard Functions (CGF) using an aerial surveillance platform (VTOL RPAS) that takes off and lands from a maritime asset (coastal patrol vessel or offshore patrol vessel) patrolling a maritime area of interest.



Objectives of the pilot project.

The Trial's eight objectives are illustrated above and include:

1. Identifying the relevant legal and regulatory frameworks for Law Enforcement that apply to the use of VTOL RPAS from maritime assets in support of Coast Guard Functions operations.
2. Mapping out the technical and operational processes and procedures required to ensure a safe and effective operation of VTOL RPAS.
3. Developing an experimental capacity building model for VTOL RPAS, which can be used as a reference for both the Agency and Member States.
4. Supporting MSs at the EU's maritime borders by deploying innovative VTOL RPAS capabilities to enhance multipurpose surveillance at sea in the context of Coast Guard Functions using VTOL RPAS (up to 25 KG Maximum Take Off Weight) from maritime assets, and

- helping to mitigate an existing operational capability gap.
5. Conducting comprehensive technical and operational testing and evaluation of VTOL RPAS capabilities for maritime surveillance missions in support of CGF.
 6. Developing an integration model for Frontex Standing Corps for the ECGFO, providing training, and identifying capacity building requirements for future in-house capability development with VTOL RPAS.
 7. Validating the proof of concept of employing VTOL RPAS from maritime assets across a wide range of missions within CGF support operations.
 8. Assessing the overall operational effectiveness and cost-efficiency of the tested solution

Preparation for the second iteration of Technical Standards

The Methodology for Development of Technical Standards for the equipment to be deployed in Frontex activities³⁰ states that “the capability development planning process and the process of developing Technical Standards should adhere to a common high-level taxonomy that ensures uniformity and a common shared understanding across both processes”.

The current Technical Standards for the equipment to be deployed in Frontex activities³¹ were developed during several years (2018-2021), in an iterative way. Developed before the Methodology was in place, the current Technical Standards do not follow a common uniform structure, lack a common uniform approach and lack the taxonomy of the border management equipment to ensure systematic addressing of all equipment. Last but not least, some equipment and domains were identified as missing in the first iteration.

Anticipating the acknowledgement of the above as valid justification for the update of Technical

Standards and advancing the work for the drafting of these updates, in 2022 Frontex started the preparations for the second iteration of Technical Standards, outsourcing the development of proposal of taxonomy of equipment and identification/analysis of standards and standardisation activities at national, EU and international level that need to be taken into consideration for the identification and definition of technical standards of the equipment in the Technical Equipment Pool. The results of these activities will support the further work of experts, once the update process is formally started.

Border Checks and Migration Management Equipment: solutions for Interoperability

Following on the requirement of interoperability of Frontex equipment included in the Technical Equipment Pool, that should enable a plug and play use in operational and crisis scenarios, as well as following Member States’ reports on technical compatibility issues regarding Frontex fingerprint scanners, in late summer 2021 Frontex launched activities to assess and mitigate the issue. The assessment of existing fingerprint scanners and facial image capture systems in Member States³² revealed that 19 Member States deployed ten fingerprint scanners from more than 13 different manufacturers and implemented national software solutions for interacting with EURODAC for asylum seekers. The next steps towards resolving this issue are planned for 2023, and include dialogue with industry on available middleware solutions, bilateral meetings and survey to Member States on national contexts, in order to obtain an updated picture since 2018. Depending on outcomes of these, next steps are planned for developing recommendations/solutions to address interoperability and tests with volunteer Member States.

³⁰ Adopted through MB Decision 36/2022

³¹ Adopted through MB Decision 51/2021

³² Through an ad-hoc query done in 2018 by European Migration Network



FRONTEX RESEARCH GRANTS PROGRAMME

NOVEL TECHNOLOGIES FOR BORDER
MANAGEMENT (OPEN THEME)

Launch of the Call for Proposals under the Research Grants Programme

Throughout 2022, Frontex Research and Innovation set up the Research Grants Programme, a new collaborative funding programme to increase the impact of technological research in border management by supporting small-scale research projects of non-profit research organisations and academic institutions operating in EU Member States and Schengen Associated Countries.

The initiative was officially launched in December 2022 along with the publication of the first Call for Proposals for granting funds under the Programme, for which a total budget of up to EUR 250,000 has been earmarked. The Call has been dedicated to *Novel Technologies for Border Management* aiming to foster and support EU's technological research and innovation on a broad range of technologies of high relevance for the European Border and Coast Guard, including:

- technologies for border checks;
- technologies for border surveillance and situational awareness;

- technologies for information and communication management and data analytics;
- simulation tools;
- technologies for standing corps and logistic support;
- advanced technologies for environmentally sustainable systems and operations;
- disruptive, emerging and key enabling technologies.

Research organisations and academic institutions were invited to submit proposals for research projects lasting between six and twelve months and requesting Frontex a co-funding not exceeding 60,000 EUR to reimburse up to 90% of their eligible project's direct costs. Applications were allowed from both single entities and consortia of up to four co-applicants, with a submission deadline in March 2023.

The call for proposals and all its annexes (including the application forms) were made available for downloading on the Frontex webpage³³.

33 <https://frontex.europa.eu/about-frontex/grants/>



Launch of the Prize Contest on the Detection of Low -flying Objects

In 2022 Frontex developed a new prize contest format focused on preliminary research on emerging technologies and operational capability gaps, through the award of inducement prizes to the most innovative and promising solutions.

Published in December 2022, the Prize Contest on the Detection of Low Flying Objects is the first prize contest in Frontex history³⁴.

The term "low-flying objects" encompasses all types of platforms that could be used for illicit activities and cross-border crime, including piloted aircraft, aerial platforms, drones, biomimetic platforms, custom-built drones, commercial drones, and bigger drones capable of transporting payloads. The challenge of detecting these several types of platforms is significant, as different detectability envelopes characteristics in terms of acoustic, radar cross-section, radio frequencies, and speed. The time to react and act is small, putting pressure on the detection process.

The challenges faced by organizations and the counter-drone industry when it comes to detecting low-flying objects, such as drones include:

- Detecting several types of platforms: The distinct types of low-flying platforms have

different detectability envelopes, which pose a significant challenge for detection.

- Time to react: The time to react and act is small, putting pressure on the detection process.
- Several types of threats: Border security systems need to consider several types of threats, including illegal border crossing, cyber-attacks, contraband, and hostile reconnaissance.
- Paradox in detecting drones: Custom-built drones are easier to hear but not as common as off-the-shelf drones, which are more difficult to detect.
- Integration challenges: The new systems need to work with existing surveillance systems, which can pose integration challenges.
- Lack of standards: There is a lack of standards for how the systems should perform, making it difficult to set a benchmark for performance.
- Emergent nature of threats: The speed of technological change and the speed at which organizations adapt are not the same, which can pose challenges for the counter-drone industry to meet the needs of organizations. This requires closer collaboration between end-user organizations and the industry to develop user-centric innovative technologies to create better solutions.

The Prize Contest will be implemented in 2023.

34 [Prize Contest \(europa.eu\)](https://europa.eu)

Annex I: Key research and innovation products

1. Management Board Decision 36/2022 adopting the Methodology for Development of Technical Standards for the equipment to be deployed in Frontex activities (available on website in the Public Documents Register [Public Register of Documents \(europa.eu\)](https://europea.eu))
2. Summary and Key Messages: Conference on EES in the maritime domain.
3. Handbook on operational research models to support the Entry/Exit System implementation. Part 1: Air/Sea Border Crossing Points
4. Handbook on operational research models to support the Entry/Exit System implementation. Part 2: Rail/Land Border Crossing Points
5. Generic Operational Research Models for BCPs:
 - Generic Operational Research Models for Air Border BCPs: type A, B, C, D
 - Generic Operational Research Models for Sea Border BCPs: type A,B, C
 - Generic Operational Research Model for Land BCPs
 - Generic Operational Research Models for Rail BCPs: type A,B
6. Report on Simulations Findings for the Entry/Exit System. BCPs analyses 2020-2022 (Sensitive).
7. Report on Typical Use Cases for the Entry/Exit System. BCPs analyses 2020-2022; (Sensitive).
8. Study on Advance Information, comprising the following main reports:
 - Final Consolidated Report Study on Advance Information on Land and Sea Borders (Sensitive and public versions)
 - Final Report on Advance Information on Land Borders (Sensitive)
 - Final Report on Advance Information on Sea Borders (Sensitive)
 - Study Report on Best Practices on Advance Information on Land and Sea Borders (Sensitive)
9. Maritime Surveillance Aerostat 2 Pilot Project. Evaluation report, Volume I and II. (Sensitive)
10. Frontex EES Land Border Pilot Project Bulgaria and Spain. Evaluation Report (Sensitive), including Annexes I-III (Sensitive)
11. *Research Study on the Green Deal*, and related dissemination package News release and video: [Frontex Publishes the Green Deal Report \(europa.eu\)](https://europea.eu) Research Study, Annexes to the Research Study, Booklet summarising the results of the study: [The Green Deal and the European Border and Coast Guard \(europa.eu\)](https://europea.eu)
12. Guide on Common Minimum Standards for Land Border Surveillance (Sensitive).
13. Full and complete version of Technology Foresight on Biometrics for the Future of Travel ([Frontex publishes technology foresight on biometrics for the future of travel \(europa.eu\)](https://europea.eu)) including:
 - Research Study
 - Executive Summary
 - Annex I: Technology Foresight Manual
 - Annex II: Taxonomy of Biometric Technologies and Biometrics-Enabled Technological Systems
 - Annex III: Patentometric and Bibliometric Analyses of Biometric Technologies

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

Budget and cooperation partners of activities completed

- **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. 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 Conference on EES in the maritime domain and the EES study visit pertain to the cost of event logistics.
- **Cooperation partners: contractors** refer to the contract signatories.
- **Cooperation partners: contributors** refer to entities which hosted or participated in the implementation of specific activities.

Frontex capacity development activities, concerning new technologies

Title	Total budget EUR	Cooperation partners: contractors	Cooperation partners: contributors
Conference on EES in the maritime domain	€ 74,875	Pomilio Blumm Srl	Royal Netherlands Marechausse
Operational research support for simulation of BCP processes	€ 134,934	PricewaterhouseCoopers EU Services	
Support to the development of Common Minimum Standards for Land Border Surveillance	€ 99,941	PricewaterhouseCoopers EU Services	Estonia, Finland, Latvia, Lithuania, Poland
Capability Tool for Operational Testing and Evaluation of Document Inspection Systems (PAM4DIS)	€ 109,700	Austrian Institute of Technology	Portugal
EES study visit	€ 4,663	Pomilio Blumm Srl	Royal Netherlands Marechausse

Frontex research activities

Title	Total budget EUR	Cooperation partners: contractors	Cooperation partners: contributors
Research Study the Green Deal and the EBCG	€ 399,900	Deloitte Consulting & Advisory BV	

Budget assigned to activities ongoing in 2022

- **Budget assigned EUR** refers to totality of budget committed in the financial system

or foreseen for commitment in order to continue the activity as planned. The final amount spent may vary.

Activities ongoing in 2022	Budget assigned EUR
Standardisation activities:	€ 200,429
i. Support to the second iteration of Technical Standards	
ii. Support to the development of CMS for Maritime Border Surveillance	
EES Support Package actions	€ 465,288
i. Pilot Project on Conditions of entry questionnaire in support of EES,	
ii. Development of EES Toolkit	
iii. Supporting Member States' capabilities in simulations of BCP processes, including development of simulation capabilities	
iv. Study on technologies for mobile or remote equipment for BCP	
Research Studies;	€ 499,850
i. On High Altitude Pseudo Satellites	
ii. On Key Enabling Technologies and Privacy Enhancement for the JHA domain	
Testing the use of multiplatform VTOL RPAS for border surveillance, including the cost of logistics	€ 265,926
Research Grants	€ 240,000
Prize Contest on the Detection of Low Flying Objects, including the cost of logistics	€ 1,242,562

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Agency (Frontex), 2023



Publications Office
of the European Union

Print:
TT-AW-23-001-EN-C
ISBN 978-92-9467-636-8
ISSN 2600-4755
doi 10.2819/10929

PDF:
TT-AW-23-001-EN-N
ISBN 978-92-9467-637-5
ISSN 2600-4755
doi 10.2819/056542

FPI 23.0187

2021
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