D4.5 - Initial commercialisation and impact generation report

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Table of Contents

Executive Summary 7

1 Introduction 8

2 FLEXI-cross exploitation framework 9
2.1 FLEXI-cross solution 9
2.2 Transversal innovative aspects 9
2.3 Expected benefits 10
2.3.1 Mobile, cost-effective and efficient solutions 10
2.3.2 Security, reliability and privacy during cross-border checks for both passengers and cargo 11
2.3.3 Superior performance in terms of traffic handling capacity, waiting times, security and privacy 11
2.3.4 Dynamic, flexible and mobile technological solutions 11

3 FLEXI-cross Intellectual Property Rights (IPRs) 13
3.1 Management of foreground 13
3.2 Background IPR 14
3.3 Ownership rights 19
3.4 Access rights 19
3.4.1 Exercise of access rights, waiving of access rights 19
3.4.2 Access rights for implementing the action 19
3.4.3 Access rights for exploiting the results 19
3.4.4 Access rights for entities under the same control 19
3.4.5 Access rights for the granting authority, EU institutions, bodies, offices, or agencies, and national authorities for policy purposes (Horizon Europe actions) 20
3.4.6 Access rights for the granting authority, Euratom institutions, funding bodies, or the Joint Undertaking Fusion for Energy (Euratom actions) 20
3.5 FLEXI-cross IPR registry 20

4 FLEXI-cross Policy Innovation 23
4.1 Social and policy regulation 23
4.2 Regulation gaps 23
4.3 Improvement 24

5 FLEXI-cross Key Exploitable Results 26

6 FLEXI-cross Initial Market Analysis 29
6.1 Target Markets & Trend Analysis 31
6.2 Market Segmentation 34
6.3 Target Users and Customers 36
6.4 Competition 37
6.5 SWOT Analysis 39

7 FLEXI-cross Exploitation Plans 41
7.1 Individual Exploitation Plans 41
7.1.1 ENG 41
7.1.2 BEIA 42
7.1.3 EBOS 43
7.1.4 WINGS 44
7.1.5 HOLO 44
7.1.6 ICCS 45
7.1.7 KEMEA 46
7.1.8 GIBP 47

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7.1.9 IGPF 47
7.1.10 TCCFR 48
7.1.11 ATG 48
7.1.12 HPOL 48
7.2 Exploitation plan analysis 49
7.3 Preliminary Joint Exploitation Paths 51
7.3.1 Role definition 51
7.3.2 Delivery and deployment model 51
7.3.3 Pricing Licensing policy 52
8 FLEXI-cross Initial Business model 53
9 Significance of FLEXI-cross to the Wider Impacts 58
9.1 Societal aspects 58
9.2 Economic aspects 59
9.3 Scientific aspects 60
10 Conclusions 61
11 References 62

List of Figures

Figure 1 FLEXI-cross initial architecture 9
Figure 2 FLEXI-cross IPR management approach 13
Figure 3 Illegal border-crossings January 2023 (source: Frontex) 29
Figure 4 Comparison of illegal border crossings January 2022 vs January 2023 per route 30
Figure 5 Border Security Market - Growth Rate by Region (2023 - 2028) Source: Mordor Intelligence 32
Figure 6 Security Systems Service activities market growth in Europe in the period 2011 – 2020 (Million €) 33
Figure 7 Evolution of the number of enterprises in the Security Systems sector by FLEXI-cross involved countries 34
Figure 8 Border Security System Market Segments 35
Figure 9 FLEXI-cross Main Target Customers Segments 37
Figure 10 Analysis of the FLEXI-cross consortium composition 49
Figure 11 Analysis of the activities linked to the FLEXI-cross project 50
Figure 12 Analysis of the competitive advantages of the partner in the FLEXI-cross consortium 50
Figure 13 Analysis of the partners' expectations in participating FLEXI-cross project 50
Figure 14 Analysis of the barriers to the FLEXI-cross feasibility 51
Figure 15 Initial FLEXI-cross business model at proposal stage 53
Figure 16 Lean Canvas blocks 53
Figure 17 Business Model template VS FLEXI-cross information to be used 54
Figure 18 FLEXI-cross pathway towards impact 58

List of Tables

Table 1 FLEXI-cross transversal innovative aspects 10
Table 2 FLEXI-cross Background IPR 15
Table 3 FLEXI-cross Foreground IPR 21
Table 4 FLEXI-cross Key Exploitable Results 26
Table 5 Security Systems Service Activities sector size in 2020 (Source: EUROSTAT) 33

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Table 6 Security Systems Service market growth in 2011-2020 in countries involved in the FLEXI-cross project (Million €) 34
Table 7 FLEXI-cross main competitors 38
Table 8 Exploitation elements collect from each FLEXI-cross partner 41

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Glossary of terms and abbreviations used

Terminology/Acronym	Description
5G	5th Generation
AI	Artificial Intelligence
CAGR	Compound Annual Growth Rate
DoA	Description of Action
EBCG	European Border and Coast Guard
EC	European Commission
EGNOS	European Geostationary Navigation Overlay System
EO	Electro-Optical
EPRS	European Parliament's Research Service
EU	European
EUROSUR	European Border Surveillance System
GA	Grant Agreement
GDP	Gross Domestic Product
IBM	Integrated Border Management
IA	Innovation Area
ICT	Information and Communication Technologies
IoT	Internet of Things
IPR	Intellectual Property Rights
IR	InfraRed
KERs	Key Exploitable Results
ML	Machine Learning
NDA	Non-Disclosure Agreement
P&L	Profit and Loss
SW	Software
THB	Trafficking in Human Beings
TIA	Transversal Innovative Aspect

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Executive Summary

This deliverable is the initial report on the commercialization and impact generation of the FLEXI-cross solutions including a deployment/ adoption planning covering business aspect and it has been elaborated by *Task 4.3 Market analysis, Exploitation, Commercialisation and Sustainability*, *Task 4.2 Capacity building with national & EU border authorities and training activities* and *Task 4.4 Impact generation and business, social and policy innovations*.

Overall, the scope of the Initial commercialisation and impact generation report is to define how project outputs can be transformed into products or services for commercialization. The plan assesses the opportunities associated to FLEXI-cross exploitable Results through market analysis and viable business models. In addition, it defines partners' individual exploitation plans. The results of this deliverable have been achieved through an active and collaborative participation of all project's partners, where all key exploitable assets have been addressed and analysed thoroughly.

In particular, this first version of FLEXI-cross Exploitation Plan manages the initial approach to exploitation, including coverage of IPR and policy regulations, uptake channels and enlargement of data feeds to new sources including open-source information.

The deliverable is organised into the following sections:

- Section 1 – Introduction: Includes the purpose of this document.
- Section 2 – FLEXI-cross exploitation framework: Describes the project solution.
- Section 3 – FLEXI-cross Intellectual Property Rights (IPRs): Outlines the management of ownership rights.
- Section 4 – FLEXI-cross Policy Innovation: Summarizes the policy regulations to refer to.
- Section 5 – FLEXI-cross Key Exploitable Results: Presents the results that the consortium could be exploited.
- Section 6 – FLEXI-cross Initial Market Analysis: Explains the analysis of the project domain, the segmentations, and the main competitors with target users.
- Section 7 – FLEXI-cross Exploitation Plans: Presents the partner exploitation plan including an aggregated analysis of the collected information.
- Section 8 – FLEXI-cross Initial Business Model: Schematizes the methodology that will be followed in the second period of the project to prepare the business model.
- Section 9 – Significance of FLEXI-cross to the Wider Impacts: Explains how the project will approach the societal, economic, and scientific aspects.
- Section 10 – Conclusions
- Section 11 - References

The Glossary of terms and abbreviations used are also provided.

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1 Introduction

This deliverable is a result of the activities carried out into the *Task 4.2 Capacity building with national & EU border authorities and training activities* (leads by BEIA), *Task 4.3 Market analysis, Exploitation, Commercialisation and Sustainability* (leads by ENG), and *Task 4.4 Impact generation and business, social and policy innovations* (leads by EBOS).

The Work Package 4 aims to maximise the impact of the FLEXI-cross results and interact with existing initiatives and relevant bodies, in order to support the improved border checks vision, as well as support the development of improved experiences for both passengers and border authorities' staff. The main objectives of this WP linked to the commercialisation aspects are the following:

- Map the market landscape, identifying opportunities and obstacles.
- Create synergies with relevant associations, projects and initiatives, and provide the methodological framework to serve as a continuous point of reference for the establishment of collaborations.
- Develop an efficient Intellectual Property Right (IPR) and data management plan towards maximisation of the exploitation potential.

This deliverable *D4.5 Initial commercialisation and impact generation report* will illustrate the initial report on the commercialization and impact generation of the FLEXI-cross solutions including a deployment/adoption planning covering business aspect.

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2 FLEXI-cross exploitation framework

2.1 FLEXI-cross solution

As stated in the deliverable *D1.3 Initial FLEXI-cross solution architecture & testing methodologies*, the FLEXI-cross project aims to increased security and reliability of European border checks for people and goods, while enhancing and improving the border management capabilities, through the development, deployment and validation of a toolkit of innovative border-checking solutions, in real operational environments, addressing road, rail and port borders. The resulting flexibility and dynamicity of border check planning will offer novel capabilities such as dynamic deployment of checkpoints and support via mobile applications for border personnel, while guaranteeing high level of security, privacy of personal data and protection of people's fundamental rights.

Figure 1 shows a high-level view of the initial FLEXI-cross architecture.

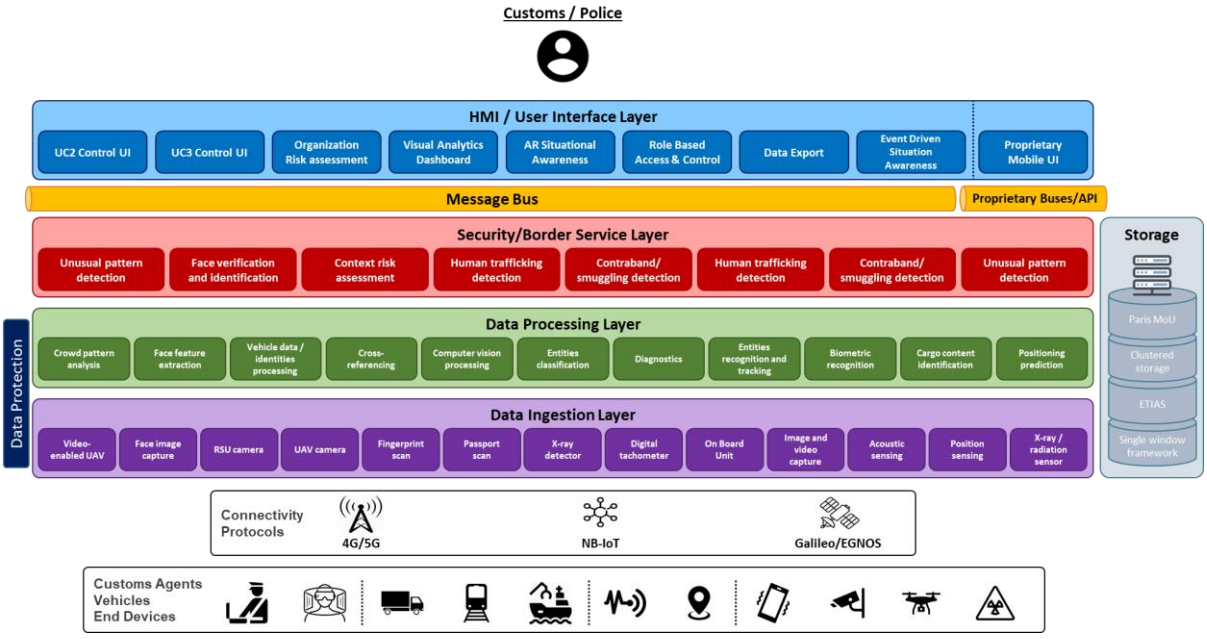

Figure 1 FLEXI-cross initial architecture

2.2 Transversal innovative aspects

The architecture has been based on the insights derived from Task 1.2, where detailed use cases and corresponding Key Performance Indicators (KPIs) are co-designed to validate the proposed FLEXI-cross solutions in real-life border crossing environments. The architecture design will ensure a user-centric approach, emphasizing ease of use, efficiency, availability, and accuracy, while addressing interoperability aspects to integrate with existing systems and devices utilized by border authorities.
In the Grant Agreement, the consortium described how the FLEXI-cross project will contribute to the enhancement of 6 Innovation Areas (IAs):

1. Augmented Reality (AR) Situation Awareness
2. Predictive Vehicle Risk Assessment & Targeted Vehicle Inspection
3. 5G/IoT enabled Mobile Solution for Portable Border Check Capability
4. Multimodal Biometrics
5. Blockchain Interoperability
6. Tethered Unmanned Aerial Vehicle (UAV) for abnormal behaviour detection

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Based on these six innovation areas and the initial architecture of the FLEXI-cross toolkit, it has been identified four Transversal Innovative Aspects (TIAs) that represent a high-level overview of the work done including the planned one. Each of these four TIAs cover all the six Innovative Areas by focusing different points of view:

- the instantiation in real trial
- the gap analysis
- the data interoperability
- the communication robustness

The Transversal Innovative Aspects (TIAs) represent the concrete way through the consortium will demonstrate the realization of the ambition described for each innovation area.
The FLEXI-cross Transversal Innovative Aspects are summarized in the table below.

Table 1 FLEXI-cross transversal innovative aspects

FLEXI-cross Innovations	Description of Transversal Innovative Aspects
Instantiation in Different Pilots	The architecture is designed to be instantiated in different pilot scenarios, enabling seamless deployment in diverse operational environments. This flexibility allows the FLEXI-cross toolkit to adapt to varying border-crossing scenarios, ensuring efficiency and effectiveness across different contexts.
Addressing Process Gaps	The designing components can fill the gaps of the current Border Check Point processes. By identifying and addressing these gaps, the FLEXI-cross architecture enhances the operational capacity of EU border checkpoints, streamlining procedures for travellers, operators, and border authorities.
Interoperability through Data Export Tool	The architecture is designed with a focus on interoperability, enabling bidirectional data exchange between the FLEXI-cross toolkit and the legacy systems used by end-users. This seamless connection ensures smooth integration with existing systems and devices, facilitating efficient data sharing and processing.
Addressing Communication, Network, and Environmental Constraints	The FLEXI-cross architecture aims to address communication, network integration, and environmental constraints. By considering these factors, the FLEXI-cross system ensures robust communication between various modules and components, optimizes network utilization, and accommodates diverse environmental conditions in real operational border-crossing environments.

2.3 Expected benefits

2.3.1 Mobile, cost-effective and efficient solutions

FLEXI-cross will significantly upgrade the operational capacity of EU BCPs and will introduce flexible planning and check-point deployment procedures leading to a seamless border crossing experience for travellers (reduction of waiting times), operators (deployment of mobile-check points, increased traffic handling capacity) and staff of border authorities ("Bird's eye view" of all available data, reduction of biometric check time), tailored to the real-life requirements of the EU border authorities through its capabilities of:

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- Ground-breaking analysis regarding legacy systems used in border-checking operations and identification of weak points and potential improvements from a technical standpoint.
- Market, socio-economic and environmental impact analysis of the envisioned solutions, to design appealing solutions that will be seamlessly adopted by the EU border authorities.
- Architectural design of the innovative software (SW) solutions to be deployed in the three trial facilities, based on the requirements (technical, business, environmental, etc.) of the respective EU border authorities.

2.3.2 *Security, reliability and privacy during cross-border checks for both passengers and cargo*

The FLEXI-cross solution will provide advanced anti-trafficking and anti-smuggling mechanisms while securing and protecting people's fundamental rights and personal data, through a comprehensive data governance framework. Through this objective FLEXI-cross will deliver as output:

- Specifications of appropriate Data Management procedures for border-checking and control processes to guarantee protection against malicious interventions and to deal with data ownership and confidentiality issues.
- A detailed data governance scheme to address the secure and private exchange of critical personal data at border conditions, among end-devices and public authority servers as well as the exchange of sensitive information among neighbouring countries/authorities.
- A comprehensive toolkit of solutions targeting the pre-emptive detection of outliers and the threat classification of incoming vehicles and passengers, and the detection, warning and documentation of illegal trafficking and smuggling attempts.

2.3.3 *Superior performance in terms of traffic handling capacity, waiting times, security and privacy*

Through these expected benefits, FLEXI-cross will deliver as output:

- Advanced devices, legacy systems and equipment and innovative SW functions, integrated into almost market ready solutions, allowing the testing of multiple border-crossing scenarios in heterogeneous environments, covering most of the modes of access into the EU.
- Multiple trial sessions of the selected border-crossing/checking scenarios in real operational border environments using realistic end-user data from the involved authorities.
- Means, tools (KPI analysis, validation/benchmarking, etc.) and methodology for the technical and business validation of the selected use cases.

2.3.4 *Dynamic, flexible and mobile technological solutions*

Capitalising competencies of the consortium and its rich network, FLEXI-cross will accelerate the adoption and take up of the project's results in Europe and beyond through wide Dissemination, Communication and Exploitation (D&C&E) means, as well as demonstrate flexibility, user acceptance and facilitate the technology transfer via synergies with the European Border and Coast Guard and of its Agency (Frontex), Horizon Europe Cluster 3-5 projects, European Union Agency for the Operational Management of Large-Scale IT Systems in the Area of Freedom, Security and Justice (eu-LISA), European Association for Biometrics (EAB), policy-makers, the Digital Europe Programme and other research and social innovation projects, as well as other relevant by other Framework Programmes projects and beyond.

FLEXI-cross will also exploit the most promising outcomes tailored to the needs of travellers and border authority workers through:

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- a cooperative exploitation path with roles aimed at ensuring the sustainability and wider uptake of the FLEXI-cross solutions, leveraging interested and committed stakeholders (by a group of partners);
- a path entailing the development of detailed exploitation plans by each individual partner, in-line with each partner's business and research strategy (by each partner);
- exploitation and commercialisation of the Key Exploitable Results (KERs) produced by the project (by the involved partners).

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3 FLEXI-cross Intellectual Property Rights (IPRs)

FLEXI-cross project will produce significant research results, business and technological innovations, which will enrich both the academic and professional areas, to maintain all project outcomes a strategy is needed for handling all the IP Rights matters that will be developed under WP4 “Impact Maximisation and Outreach”, Task 4.4 “Impact generation and business, social and policy innovations”, creating an encouraging environment for further exploitation of the generated discoveries and knowledge. Accordingly, within FLEXI-cross project we will follow a three-level approach for IPR management as presented in Figure 2.

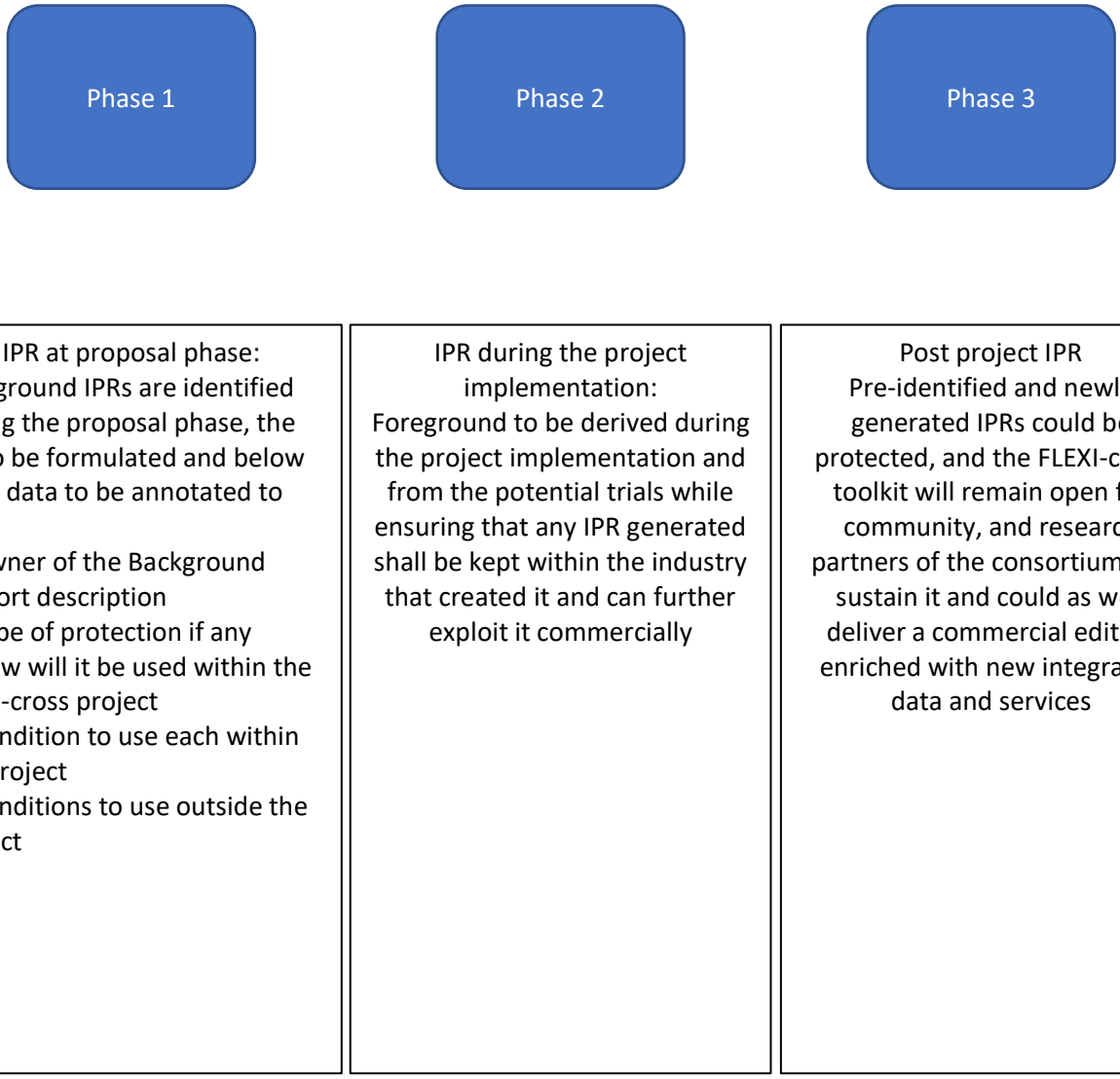

Figure 2 FLEXI-cross IPR management approach

3.1 Management of foreground

The effective management of foreground intellectual property rights (IPR) is crucial to ensure the successful implementation and commercialization of FLEXI-cross project's outcomes. This section outlines the methodology for managing foreground IPR within the context of the project scope. By

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following this approach, we aim to protect and maximize the value of the intellectual property generated throughout the project's duration.

1. Understand the Project's IPR Policy: Get familiarized with the project's IPR policy, which should outline the principles and rules regarding foreground IPR. This policy is defined in the article 16 of the Grant agreement.
2. Identify Foreground IPR: Identify the potential foreground IPR that may arise during the project implementation. This includes any inventions, discoveries, know-how, or other intellectual property that emerges as a result of the project's activities.
3. Regularly communicate with project partners to stay informed and active about their contributions and potential IPR.
4. Document Ownership and Contributions: Establish a clear record of ownership and contributions related to foreground IPR (see section 3.5). Maintain documentation that specifies the origin of each piece of foreground IPR, and the contributions made by project partners.
5. Relate Foreground with any available Background: For improvement and new discoveries within an available background, or if any improvement in TRL within a specific product.
6. Define the protection: for the new result, discovery, invention, to specify the protection method that will be adopted, such as patent, copyright, TM, Utility model.
7. Define the conditions to use the results within the FLEXI-cross project context: The condition will dictate how other partners within the consortium can use the results during the project, such as free to use, licence fee, restrictions, non-disclosure agreement (NDA).
8. Define the conditions to use the results after the end of the project: The condition will dictate how other partners within the consortium can use the results after the project closure, such as free to use, licence fee, restrictions, NDA.

The methodology described above provides a foundation for handling foreground IPR in FLEXI-cross project in an efficient manner.

In addition to assuring compliance with the project's IPR policy and any other legal requirements, it offers a structured method to addressing ownership, protection, and exploitation rights. With the use of this methodology, we will maximize the significance and worth of the project's results.

3.2 Background IPR

Background intellectual property rights (IPR) are a crucial factor to take into account while analysing the project and its expected outcomes. Before getting into the details, this part gives a broad summary of the historical IPRs that are available before the start of the project implementation.

By examining the background IPR, we can assess any potential constraints or opportunities that may impact the development, implementation, and commercialization of FLEXI-cross project. Furthermore, understanding the background IPR landscape will enable us to define the boundaries within which our project's foreground IPR can be effectively managed and protected.

This section will provide a comprehensive analysis of the existing patents, trademarks, copyrights, and other intellectual property that have been identified prior the project start.

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Table 2 FLEXI-cross Background IPR

BG ID	Background	Contributing Partner (Partner Name)	Short Description of BG	Type of Protection (patent, coyright, TM, Utility model …)	How will it be utilised within FLEXI-cross project?
1	EDSA Event Driven Situation awareness	ENG	Visual Analytics Dashboard including data modelling, data extraction and storage	To define in the D4.6	The situation awareness can be used in the control room to monitor the flow of people embarking and disembarkingor crossing a border according to the data coming from the Biometric authentication modules.
2	Visual Analytics Dashboard	eBOS	Web application capable of providing (near) real-time data updates, interactive visualizations, and a responsive layout, ensuring users have up-to-date information and can explore data across different devices. Users can customize widgets, drill down into details, apply filters, and navigate through data hierarchies. The dashboard also offers intuitive filtering controls and integrates with external systems, enabling users to focus on relevant data subsets and consolidate information from multiple sources.	To define in the D4.6	The cockpit can be used to show statistics on detections, flows of passengers, geo political risk maps.
3	Innovative Risk Assessment	eBOS	The Risk Assessment dashboard is a user-friendly tool	To define in the D4.6	The module will be Used as a risk register, that shows statistical graphs for the reported

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BG ID	Background	Contributing Partner (Partner Name)	Short Description of BG	Type of Protection (patent, coyright, TM, Utility model …)	How will it be utilised within FLEXI-cross project?
	module (specifically designed for Customs Authorities)		designed to visualize risk assessments. It takes as input the identified risks and presents them in an intuitive and informative manner. The dashboard offers a comprehensive overview of the risks. The visualizations in the dashboard provide a clear representation of the risks, enabling users to quickly identify critical areas and allocate appropriate resources for risk mitigation. The dashboard may include charts, graphs, heatmaps, and other visual elements to present risk data effectively.		risks within the toolkit, escalated from other modules.
4	WINGS ARTEMIS Platform	WINGS	Artificial Intelligence and IoT Powered Platform for the Proactive Management of Utilities. including autonomous vehicle data ingestion and processing.	To define in the D4.6	Within FLEXI-cross, the AI powered functionalities for Logistics applications focusing on the digestion and fusion of heterogeneous data from distributed sources functionalities will be extended to offer border authority process and resource utilisation optimisation, remote monitoring and control of border-checks, and smartphone access

BG ID	Background	Contributing Partner (Partner Name)	Short Description of BG	Type of Protection (patent, coyright, TM, Utility model …)	How will it be utilised within FLEXI-cross project?
					to backend server information for agents.
5	The WINGS Chariot Platform	WINGS	Addressing Industry 4.0 and Intelligent Logistics operations.	To define in the D4.6	The WINGS Chariot platform (which uses Artificial Intelligence/Machine learning (AI/ML) functionalities and advanced connectivity protocols such as 5G, Internet of Things, etc.) will be extended to provide tracking of incoming vehicles, and to enable passenger pre-registration and process overview control.
6	5G testbed	BEIA	For data-enabled assisted navigation using IoT sensing and video camera.	To define in the D4.6	We are focusing on the implementation of a data-enabled assisted navigation application using an IoT sensing system and video cameras installed in Galati port and on ships and barges.
7	Network application for data stream organisation.	BEIA	For data-enabled assisted navigation.	To define in the D4.6	The asset will be used for collecting and transmitting the sensors and audio/video data.
8	Network application for distributed sensor data ingestion, fusion & postprocessing.	BEIA	For data-enabled assisted navigation.	To define in the D4.6	The asset will be extended for more accurate electronic border checks.
9	Data analytics using Deep Learning on a proposed set of Technologies	BEIA	For data-enabled assisted navigation.	To define in the D4.6	The asset will enable reduced to make models on deep learning technology and make a database for face/voice biometry.
10	AR3S product	HOLO	Enables engineers to visualize and work with 3D	To define in the D4.6	The communication /collaboration capabilities among operators could be

BG ID	Background	Contributing Partner (Partner Name)	Short Description of BG	Type of Protection (patent, coyright, TM, Utility model …)	How will it be utilised within FLEXI-cross project?
			CAD data in an AR and Mixed Reality environment		enhanced through the XR use cases and devices (e.g., Smart glasses).
11	ISAR SDK Product	HOLO	Interactive Streaming for Augmented Reality.	To define in the D4.6	ISAR SDK is the cross-platform remote rendering solution to enable high performance XR experiences. It is easy to integrate and significantly shortens development processes. In FLEXI-Cross this technology could stream high polygon content and create more immersive and effective experience for operators using Smart glasses.
12	Face recognition & identification mobile application for real time victim identification	ICCS	A mobile face recognition application for real time victim identification	Copyright	In FLEXI-cross, the mobile face recognition application will be extended and adapted so as to support related checks in Border Control Points (BCPs).
13	The Intelligent UxV surveillance platform (INUS)	ICCS	Consists of a free flight UAV system with payload (RGB camera, control options, etc) that provides in near/ real time and in the edge: i) processed UAV video and ii) ML/AI object detection and tracking, iii) User Interface (UI) deployed to the intelligence officer's workstation	Copyright	In FLEXI-cross, the mobile face recognition application will be extended and adapted so as to support related checks in Border Control Points (BCPs).

3.3 Ownership rights

Ownership rights is dictated within the Grant agreement and is detailed below.

Results are the property of the beneficiaries who generate them. However, if results are jointly generated and it is not possible to determine the individual contributions of each beneficiary or separate them for the purpose of protection, joint ownership arises among two or more beneficiaries. To ensure compliance with the obligations under the project Agreement, the joint owners must reach a written agreement, known as a "joint ownership agreement," which specifies the allocation and terms of their joint ownership. Unless stated otherwise in the joint ownership agreement or consortium agreement, each joint owner has the right to grant non-exclusive licenses to third parties to exploit the jointly owned results. However, the other joint owners must be provided with a minimum of 45 days advance notice and fair and reasonable compensation.
The joint owners have the option to agree, in writing, on an alternative regime other than joint ownership. If third parties, including employees and personnel, may assert rights to the results, the relevant beneficiary must ensure that those rights can be exercised in a manner consistent with their obligations under the Agreement.
In the final periodic report, the beneficiaries are required to indicate the owner(s) of the results by providing a results ownership list.

3.4 Access rights

3.4.1 Exercise of access rights, waiving of access rights

Request to exercise access rights and the waiver of access rights must be communicated in writing.
Unless specifically agreed in writing with the beneficiary granting access, access rights do not include the right to sub-license.
If a beneficiary is no longer involved in the action, it remains obligated to grant access.
In the event of a beneficiary's default on its obligations, the beneficiaries may agree in writing to revoke access rights for that beneficiary.

3.4.2 Access rights for implementing the action

Beneficiaries must grant each other royalty-free access to the background necessary to carry out their own tasks under the action. However, the beneficiary holding the background may impose restrictions on access or agree with other beneficiaries that access will not be royalty-free.
Beneficiaries must also grant each other royalty-free access to the results needed for implementing their own tasks under the action.

3.4.3 Access rights for exploiting the results

Beneficiaries must grant each other access to the results needed for exploiting their own results, under fair and reasonable conditions.
Access to the background needed for exploiting the results must be granted by the beneficiary holding the background, unless prior notification of access restrictions has been provided before joining the Agreement.
Requests for access should be made within one year after the end of the action, unless otherwise agreed in writing.

3.4.4 Access rights for entities under the same control

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Access to results and background must be granted, under fair and reasonable conditions, to entities established in an EU Member State or Horizon Europe associated country that are under the direct or indirect control of another beneficiary or have the same direct or indirect control as that beneficiary. Access is granted when these entities need it to exploit the results of the beneficiary. Such requests should be made directly to the beneficiary concerned, unless otherwise agreed in writing.
Requests for access should be made within one year after the end of the action, unless otherwise agreed in writing.

3.4.5 Access rights for the granting authority, EU institutions, bodies, offices, or agencies, and national authorities for policy purposes (Horizon Europe actions)

Beneficiaries receiving funding under the grant must grant royalty-free access to their results to the granting authority, EU institutions, bodies, offices, or agencies for the development, implementation, and monitoring of EU policies or programs. However, access to beneficiaries' background is not granted. These access rights are limited to non-commercial and non-competitive use.
For actions under the cluster 'Civil Security for Society', access rights also extend to national authorities of EU Member States for the development, implementation, and monitoring of their policies or programs in this area. Access is subject to a bilateral agreement to ensure appropriate use and confidentiality obligations. The requesting national authority or EU institution, body, office, or agency must inform all other national authorities of the request.

3.4.6 Access rights for the granting authority, Euratom institutions, funding bodies, or the Joint Undertaking Fusion for Energy (Euratom actions)

Beneficiaries receiving funding under the grant must grant royalty-free access to their results to the granting authority, Euratom institutions, funding bodies, or the Joint Undertaking Fusion for Energy for the development, implementation, and monitoring of Euratom policies and programs or for compliance with international cooperation obligations. These access rights include the right to authorize third parties to use the results in public procurement and the right to sub-license. Access is limited to non-commercial and non-competitive use.

3.5 FLEXI-cross IPR registry

Foreground IPR includes discoveries, ideas, inventions, concepts, know-how, trade secrets, works of authorship, software, writings, drawings, designs, processes, techniques, formulas, data, specifications, technology, and other creations, developments and materials, whether or not patentable or copyrightable, that are conceived, created, developed, or reduced to practice by or on behalf of a party under or in connection with this Agreement. These assets hold potential for commercialization and require proper management to secure exclusivity, incentivize innovation, and facilitate knowledge transfer.
In this section we will analyse the novelty, inventiveness, and commercial viability of specific foreground IPR assets. We will discuss ownership, contributions, and any collaborations or agreements governing their management.
The list presented in this section will be progressively elaborated during the whole project life cycle, since Foreground is based on new findings, and results, which may be generated later within the project.

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Table 3 FLEXI-cross Foreground IPR

FG ID	Project Result /Achievement	Main Contributing Partner (Partner Name)	Supporting Contributing Partner(s)	Related Background Number	Short Description of FG	Type of Protection (patent, copyright, TM, Utility model …)	Conditions to Use within FLEXI-cross project (free to use, licence fee, restrictions, NDA..)	Conditions to Use after the end of the Project (free to use, licence fee, restrictions, NDA..)
1	EDSA	ENG	HOLO, ICCS	1	Situation awareness for passengers embarking and disembarking in ports	Confidentiality agreements	Access rights are only granted for the purpose of the FLEXI-cross project activities.	Usage and exploitation are conditioned to commercial license agreement
2	Face verification/identification (FACE-VI) mobile application	ICCS	-	12	Extended and adapted mobile face application for real time verification/ identification to support related checks in Border Control Points (BCPs).	Copyright	The component is not open available. ICCS is sole owner (100%) of the component, mainly to be exploited in R&D projects. ICCS is a public, non-profit research institute and has no direct commercial activities.	Concerning the component, ICCS is interested to collaborate with other research institutions, non-profit organizations, practitioners, end-users/stakeholders and industrial partners to extend its palette of project portfolio in the security, border management, crisis management/emergency response and civil protection domain.

Funded by the European Union

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Research Executive Agency. Neither the European Union nor the granting authority can be held responsible for them.

FG ID	Project Result /Achievement	Main Contributing Partner (Partner Name)	Supporting Contributing Partner(s)	Related Background Number	Short Description of FG	Type of Protection (patent, copyright, TM, Utility model …)	Conditions to Use within FLEXI-cross project (free to use, licence fee, restrictions, NDA..)	Conditions to Use after the end of the Project (free to use, licence fee, restrictions, NDA..)
3	INtelligent UxV surveillance - Unusual Pattern Extraction (INUS-UPE) platform	ICCS	-	13	Extended and adapted platform to support to Border Control Points (BCPs). Consists of a tethered UAV system with RGB camera, control options, etc that provides in near/ real time and in the edge: i) video streaming (raw UAV video footage and processed video) and ii) a pattern analysis module for enhanced ML/AI object detection, multiple tracking by detection , and unusual pattern extraction, iii) extended User Interface (UI) deployed to the intelligence officer's workstation	Copyright	The component is not open available. ICCS is sole owner (100%) of the component, mainly to be exploited in R&D projects. ICCS is a public, non-profit research institute and has no direct commercial activities.	Concerning the component, ICCS is interested to collaborate with other research institutions, non-profit organizations, practitioners, end-users/stakeholders and industrial partners to extend its palette of project portfolio in the security, border management, crisis management/emergency response and civil protection domain.

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4 FLEXI-cross Policy Innovation

4.1 Social and policy regulation

The FLEXI-cross project is a relevant and innovative initiative that aims to improve the security and efficiency of EU border checks for people and goods, while respecting the privacy and rights of the individuals involved. To achieve this, the project needs to comply with the European social and policy regulations that apply to border management and data protection. Some of these regulations are:

- The Schengen Borders Code [1]

  This is the main legal framework for external border management in the EU. It sets out the rules and procedures for border checks, border surveillance, and cooperation among Member States and with the European Border and Coast Guard Agency (Frontex). It also establishes the conditions for the temporary reintroduction of internal border controls in exceptional circumstances.

- The General Data Protection Regulation (GDPR) [2]

  This is the comprehensive data protection law that governs how personal data of individuals in the EU may be processed and transferred. It applies to any entity that collects, uses, or shares personal data of EU residents, regardless of where they are located. It grants individuals certain rights over their data, such as the right to access, rectify, erase, or restrict the processing of their data. It also imposes obligations on data controllers and processors, such as the duty to obtain consent, ensure data security, report data breaches, and conduct data protection impact assessments.

- The EU Charter of Fundamental Rights [3]

  This is the document that enshrines the fundamental rights and freedoms of individuals in the EU. It covers a wide range of topics, such as dignity, equality, justice, solidarity, citizenship, and democracy. It also includes specific provisions on the right to respect for private and family life, the right to the protection of personal data, the right to asylum, and the prohibition of discrimination.

- The EU Strategy and Action Plan for Customs Risk Management [4]

  This is the policy document that outlines the strategic objectives and actions for enhancing customs risk management in the EU. It aims to improve the identification and targeting of security and safety risks, while facilitating legitimate trade and ensuring the protection of the financial and economic interests of the EU and its Member States. It also promotes the cooperation and coordination among customs authorities and with other relevant stakeholders, such as border guards, police, and trade operators. These social and policy regulations provide the legal and ethical basis for developing and deploying the innovative border-checking solutions that the project envisages.

4.2 Regulation gaps

Some possible **gaps** in the European social and policy regulation for border security and privacy are listed below. Additionally, engaging with legal experts, regulatory bodies, and stakeholders involved in border management can provide valuable insights into potential gaps and challenges that need to be addressed during the development and implementation of the FLEXI-cross solutions:

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- The lack of a common framework for data protection and privacy across the EU and its partner countries, especially in the context of cross-border data flows and access for national security and law enforcement purposes.

  The OECD identified this as a critical gap that affects the trust and cooperation among countries and the protection of human rights and freedoms

- The lack of harmonised standards and procedures for biometric data collection, processing, and sharing at the EU external borders, especially in relation to the interoperability of EU-wide information systems for borders and security. The European Data Protection Supervisor (EDPS) raised concerns about the potential risks of discrimination, error, and abuse of biometric data, and called for more safeguards and oversight mechanisms.
- The lack of a clear and consistent legal framework for the use of new technologies and solutions for border management, such as drones, artificial intelligence, blockchain, or augmented reality. The European Parliament's Research Service (EPRS) highlighted the challenges and opportunities of these technologies and stressed the need for a human rights-based approach, ethical guidelines, and impact assessments.
- The lack of a comprehensive and coherent strategy for addressing the root causes of migration and asylum flows, and for ensuring solidarity and responsibility-sharing among the EU Member States and with third countries. The European Commission's New Pact on Migration and Asylum, proposed in 2020, aims to address these issues, but it faces political and legal obstacles and has not been adopted yet.

4.3 Improvement

The FLEXI-cross project can tackle the improvement for the gaps in the European social and policy regulation for border security and privacy by:

- Developing a secure, private and traceable sensitive / personal data exchange based on blockchain technology, that ensures the respect of human rights and freedoms, and provides clear and consistent rules for cross-border data flows and access for national security and law enforcement purposes. This could enhance the trust and cooperation among countries and the protection of individuals' data.
- Harmonising the standards and procedures for biometric data collection, processing, and sharing at the EU external borders, and ensuring the interoperability of EU-wide information systems for borders and security, through the use of portable biometric based checks and real-time multi-source cross-referencing. This could improve the efficiency and accuracy of border checks, while reducing the risks of discrimination, error, and abuse of biometric data. It could also require more safeguards and oversight mechanisms, such as independent audits, data protection officers, and complaint mechanisms.
- Establishing a clear and consistent legal framework for the use of new technologies and solutions for border management, such as drones, artificial intelligence, blockchain, or augmented reality, through the co-design and validation of the FLEXI-cross solutions with key European border authorities and end-users, and the involvement of relevant stakeholders, such as civil society, academia, and industry. This could foster innovation and competitiveness in the border security sector, while ensuring a human rights-based approach, ethical guidelines, and impact assessments.
- Adopting a comprehensive and coherent strategy for addressing the root causes of migration and asylum flows, and for ensuring solidarity and responsibility-sharing among the EU Member States and with third countries, through the use of anti-trafficking and anti-

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smuggling protection via predictive risk assessment of vehicle and people, and the increased safety and improved experience for border-personnel based on advanced Human Machine Interfaces and enhanced situational awareness via Augmented Reality. This could reduce the pressure and challenges on the EU external borders and enhance the protection and integration of migrants and asylum seekers. It could also require the implementation and evaluation of the European Commission's New Pact on Migration and Asylum, proposed in 2020.

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5 FLEXI-cross Key Exploitable Results

As far as the analysis of FLEXI-cross exploitation framework (Section 2) and according to the Grant Agreement (GA) and initial development activities carried out during the first year of the project, the FLEXI-cross consortium has identified a preliminary list of 14 key exploitable individual results which are presented in the following Table 4:

Table 4 FLEXI-cross Key Exploitable Results

Key Exploitable Results	Partner	Description	Initial TRL	Final TRL
EDSA Event Driven Situation awareness	ENG	The situation awareness can be used in the control room to monitor the flow of people embarking and disembarking or crossing a border according to the data coming from the Biometric authentication modules.	6	8
Visual Analytics Dashboard	EBOS	The cockpit can be used to show statistics on detections, flows of passengers, geo political risk maps.	6	8
Innovative Risk Assessment module (specifically designed for Customs Authorities)	EBOS	The module will be extended to cover the Customs' clearance processes in ports, so as to speed up the processes and reduce unnecessary controls on legitimate trades.	5	7
WINGS ARTEMIS Platform – Artificial Intelligence and IoT Powered Platform for the Proactive Management of Utilities.	WINGS	The AI powered functionalities for Logistics applications focusing on the digestion and fusion of heterogeneous data from distributed sources functionalities will be extended to offer border authority process and resource utilisation optimisation, remote monitoring and control of border-checks, and smartphone access to backend server information for agents.	6	7
WINGS OBU including autonomous vehicle data ingestion and processing.	WINGS	The AI powered functionalities for Logistics applications focusing on the digestion and fusion of heterogeneous data from distributed sources functionalities will be extended to offer border authority process and resource utilisation optimisation, remote monitoring and control of border-checks, and smartphone access to backend server information for agents.	6	7
The WINGS Chariot Platform	BEIA	The WINGS Chariot platform (which uses AI/ML functionalities and advanced connectivity protocols such as 5G, IoT, etc.) will be extended	4	6

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Key Exploitable Results	Partner	Description	Initial TRL	Final TRL
addressing Industry 4.0 and Intelligent Logistics operations.		to provide tracking of incoming vehicles, and to enable passenger pre-registration and process overview control.		
5G testbed for data-enabled assisted navigation using IoT sensing and video cameras.	BEIA	We are focusing on the implementation of a data-enabled assisted navigation application using an IoT sensing system and video cameras installed in Galati port and on ships and barges.	5	7
Network application for data stream organisation.	BEIA	The asset will be used for collecting and transmitting the sensors and audio/video data.	5	7
Network application for distributed sensor data ingestion, fusion & postprocessing.	BEIA	The asset will be extended for more accurate electronic border checks.	5	7
Data analytics using Deep Learning on a proposed set of technologies	BEIA	The asset will enable reduced to make models on deep learning technology and make a database for face/voice biometry.	4	7
AR3S enables engineers to visualize and work with 3D CAD data in an AR and Mixed Reality environment	HOLO	The communication /collaboration capabilities among operators could be enhanced through the XR use cases and devices (e.g., Smart glasses).	7	8
ISAR SDK Interactive Streaming for Augmented Reality.	HOLO	ISAR SDK is the cross-platform remote rendering solution to enable high performance XR experiences. It is easy to integrate and significantly shortens development processes. In FLEXI-Cross this technology could stream high polygon content and create more immersive and effective experience for operators using Smart glasses.	7	8
Face recognition &	ICCS	In FLEXI-cross the face recognition & identification mobile application will be	5	7

Key Exploitable Results	Partner	Description	Initial TRL	Final TRL
identification mobile application for real time victim identification		extended and adapted so as to support the biometric identification tools in BCPs.		
The Intelligent UxV surveillance platform (INUS)	ICCS	In FLEXI-cross, the features of the INUS platform will be extended and adapted to support Border Control Point (BCPs)	6	8

Once the exploitable results have been identified, the next step will be to characterize them during the second period of the project.

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6 FLEXI-cross Initial Market Analysis

In 2022, around 330 000 irregular border crossings were detected at EU's external border. This is the highest number since 2016 and an increase of 64% from the previous year [1]. After the pandemic-induced low number in 2020, this was the second year in a row with a steep rise in the number of irregular entries. The Western Balkan route accounted for nearly half of the total. Syrians, Afghans and Tunisians together accounted for 47% of the detections in 2022. The number of Syrians roughly doubled to 94 000. Women accounted for fewer than one in ten of the detections, while the share of reported minors fell slightly to around 9 percent of all detections. Separately, almost 13 million Ukrainian refugees were counted on entry at the EU's external land borders from Ukraine and Moldova between 24 February 2022 until the end of the year, which are not included in these figures. In the same period, 10 million Ukrainian nationals were reported on exit at the same border sections.

In January 2023 [2], more than 13 200 irregular border crossings were detected at EU's external borders, down 12% from a year ago in large part due to poor weather conditions on some sea routes, preliminary Figure 3 compiled by Frontex showed.

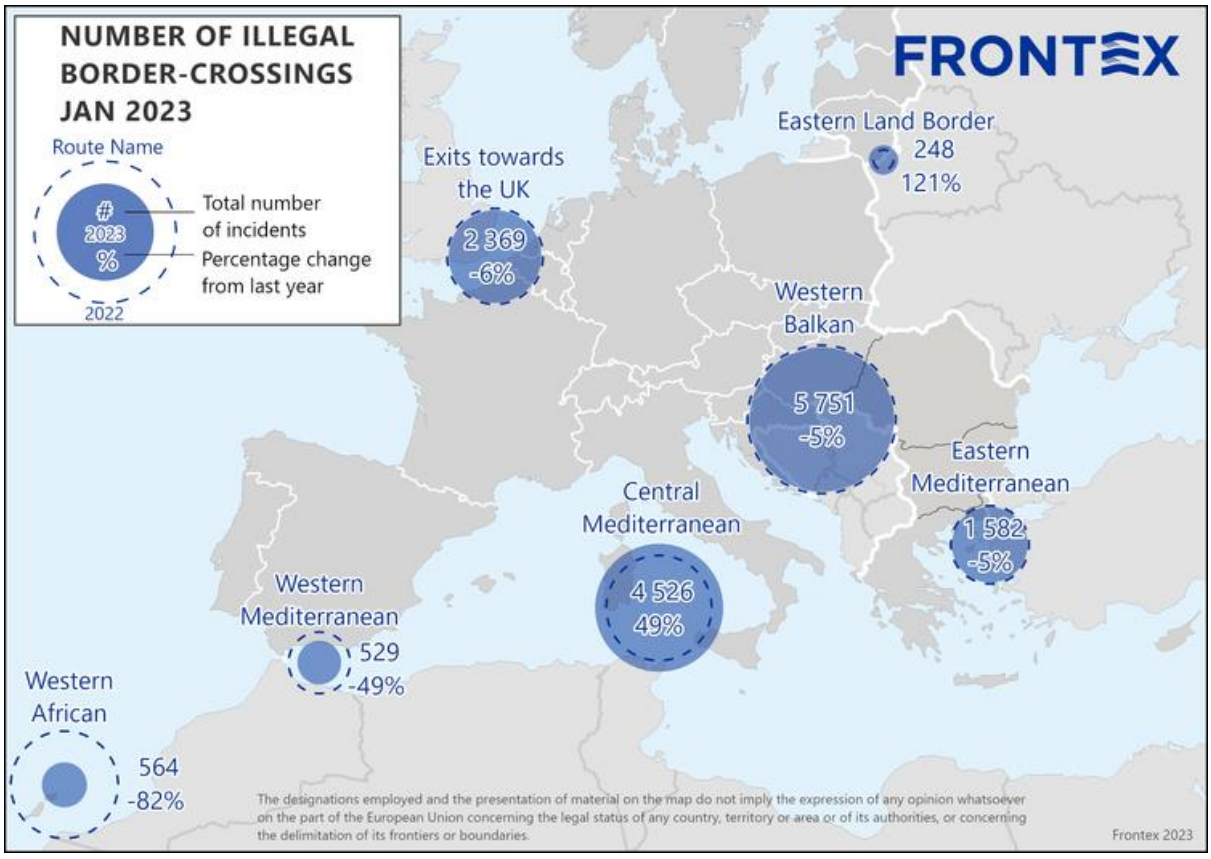

Figure 3 Illegal border-crossings January 2023 (source: Frontex)

Last year, EU and Schengen associated countries faced unprecedented challenges at their external borders. These have ranged from the state-organised migration perpetrated by Belarus from 2021 onward to Russia's invasion of Ukraine in February 2022. The later caused record numbers of refugees arriving in the European Union. These events, along with the steadily increasing number of irregular crossings, demonstrate the need for strong and effective European Border and Coast Guard, with Frontex as strong supporter of Member States.

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The **Western Balkans route** continued to account for the largest number of all the crossings (43% of the total in January), although the situation compared with last year remains largely unchanged (5% decrease year-on-year).

The **Western African** and the **Western Mediterranean routes** saw the biggest drops in detections in the first month of the year, 82% and 49% respectively, mainly due to harsh weather conditions affecting departures.

Another reason for this decrease is the increased patrolling and preventive activities implemented by the non-EU countries, primarily Morocco. In the coming months, deteriorating seasonal weather conditions in the Mediterranean will continue to affect illegal border-crossing attempts leading to a decrease in arrival numbers.

Meanwhile, the **Central Mediterranean route** saw the largest increase of detected irregular migrants compared to the same month of last year. The total number rose by half to 4 500. Migrants on this route continue to depart from Tunisia, Libya and Türkiye.

Despite the high number of arrivals, weather conditions significantly influenced the number of incidents registered in the Central Mediterranean. People smugglers exploited good weather to organise departures.

In the **English Channel**, over 2000 irregular border crossings were detected on exit, including both attempts and successful crossings. Over 50 different nationalities were recorded in the Channel, most of them from the Middle East, Albania and the Horn of Africa.

Route	January-December 2022	December 2022	Jan-Dec 2021/Jan-Dec 2022	Top nationalities
Western Balkans	145 600	8 944	+136%	Syria, Afghanistan, Türkiye, Tunisia
Central Mediterranean	102 529	7 760	+51%	Egypt, Tunisia, Bangladesh, Syria
Eastern Mediterranean	42 831	1898	+108%	Syria, Afghanistan, Nigeria, Congo (Kinshasa)
Western Mediterranean	14 582	784	-21%	Algeria, Morocco, Syria
Western African	15 462	468	-31%	Morocco, Senegal, Guinea, Ivory Coast
Exits towards the UK	71 081	2 875	+37%	Afghanistan, Iraq, Albania

Figure 4 Comparison of illegal border crossings January 2022 vs January 2023 per route

On 24 February 2022, Russia launched a military aggression against Ukraine. Since then, millions of people have fled the war, seeking refuge in EU countries and in the Republic of Moldova. As of January 2023, 4 million Ukrainian refugees were benefitting from temporary protection in the EU.

According to the European Union Agency for Law Enforcement Cooperation (Europol), any of the organised crime groups involved in migrant smuggling are 'polycriminal' and engage in a range of other criminal activities, including document counterfeiting, property crime, drug trafficking, excise

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fraud, and trafficking in counterfeit goods. Other forms of organised crime posing security problems at EU borders include weapons smuggling and trafficking in human beings (THB).

As some of these individuals may pose a threat to internal security, the role of Frontex and European border authorities in monitoring their cross-border movements is increasingly important. Given the scale, severity and cross-border nature of these security threats, integrated border management (IBM) remains a strategic priority for the EU.

IBM is a concept that consists of five elements:

- Border control (checks and surveillance);
- Detection and investigation of cross-border crime;
- Inter-agency cooperation for border management and international cooperation;
- Coordination and coherence of activities of MS and institutions;
- Four-tier access control model: this model supports the detection and investigation of cross-border crime through a combination of measures in third countries, cooperation with neighbouring countries, border control at the external border, and control measures within the Schengen area.

By assigning strategic importance to border security, the EU aims to ensure that EU citizens' freedom and security are protected in full compliance with the Union's values, including the rule of law and fundamental rights. Border security is central to two of the European Commission's Ten Priorities for Europe[1], and two of the three strategic priorities set out in the European Agenda on Security[2].

Under the European Agenda on Migration, since the height of the migration crisis in 2015 a number of measures have been taken to reinforce the security of the EU's external borders and to support the national border guards deployed by MS. One such measure was the creation in October 2016 of a European Border and Coast Guard (EBCG), comprising Frontex and the various national authorities responsible for border management at the MS level. The role and activities of the Agency have been strengthened with, for example, a new Rapid Reaction Pool of 1 500 border guards and other officers being placed at the Agency's, alongside a Rapid Reaction Equipment Pool consisting of helicopters, vessels and other equipment to carry out rapid border interventions.

Additional measures have been taken to improve situational awareness at the EU's external borders and to support the detection of cross-border crime. For example, for the next long-term EU budget 2021-2027, the European Commission is proposing to devote €16 billion to help maintain and further enhance the EU's leadership in space by allocating €9.7 billion for Galileo and European Geostationary Navigation Overlay System (EGNOS), the European's global and regional satellite navigation systems, €5.8 billion for Copernicus, the EU's Earth Observation programme, and €500 million to develop new security components. This involves supporting the European Border Surveillance System (EUROSUR) by providing real-time data on activities on land and sea around EU borders. Satellite data has already been used in combination with ship reporting systems to identify smugglers and save lives at sea.

6.1 Target Markets & Trend Analysis

As stated before, border security is carried out to enhance countries' protection of external borders from the illegal movement of weapons, drugs, contraband, and people. In addition, border security and surveillance help to ensure lawful entry and exit of people and goods; thus, represent a crucial

[1] These priorities are 'justice and fundamental rights' and 'migration'. See European Union (2015).

[2] These priorities focus on supporting a strong EU response to terrorism and foreign fighters and on tackling serious and organised crime, which both pose cross-border challenges. See European Commission (2015e).

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factor for homeland security, economic prosperity, and national sovereignty. Recent increase of threats to borders are expected to gear up the market growth over the future. The security systems offer several benefits, such as keeping records of information, enabling nations against terrorism & investigation activities in commercial sectors, and external threats at different locations. The usage of these systems is considerably high even in the military sector. The reason behind this is the rise in threat of terrorism, human trafficking. irregular immigration and cross-border interferences.

Global market trends forecast continuous increase in market demand and growth. According to a recent report by "Border Security Market Size & Share Analysis - Growth Trends & Forecasts (2023 - 2028)" [3], the border security market is anticipated to grow from USD 35.25 billion in 2022 to USD 66.68 billion in 2028, registering a Compound Annual Growth Rate (CAGR) of 10.49% during the forecast period.

OrbisResearch.com [4] has published "Border Securitys market 2021-2028: Emerging Growth Factors, Trends, Leading Players and In-depth Segmentation" market report to its research database, where redefines the market scenario differentiating the current market scenario from the past and future. The global Border Security market report analysis factors influencing the regional segmentation such as geo-political relations, macro and micro-economic factors and geographic advantage which form the basis of the global competitive landscape regionally classified.

Figure 5 Border Security Market - Growth Rate by Region (2023 - 2028) Source: Mordor Intelligence

Asia-Pacific is expected to lead the market during the forecast period. This is primarily due to ongoing border issues between India – Pakistan, India – China, and China-Japan, among others. China is one of the largest countries in Asia that has territorial issues with Taiwan, India, North Korea, Malaysia, South Korea, Indonesia, Japan, the Philippines, and Vietnam. Figure 5 shows expected 2023-2028 growth rate of border security market by worldwide regions.

Besides threats-based drivers, technological innovation in border security system has also facilitated border security and surveillance at remote locations from a precise point of view. This is further increasing the implementation rate of advanced security systems with larger product features and improved performance with respect to existing legacy systems, thus leading modern societies to continuous and increasing investments in the security sector.

Global security service revenues are forecast to increase 4.4% per year to $295 billion in 2026, with most growth occurring in the first half of the forecast period due to strengthening economic environments as the impact of the COVID-19 pandemic fades [5].

In Europe, also according to Ecorys research agency, in Europe the security industry generates annual revenues of EUR 191 billion and employs approximately 2.3 million people. The big picture of the market is composed of Public security products and services, Private security services and Cyber

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security products and services. However, in the EU zone, the market classification follows the NACE (Nomenclature des Activités Économiques dans la Communauté Européenne) categorization, which is a nomenclature of economic activities grouped by macro and micro industrial sectors.
In fact, according to the EU market classification, it has been identified the FLEXI-cross target market to be the Security and Investigation Activities under the NACE code [6] of N80. More specifically, and based on the products and services the platform can offer, the best reference target market sub-classification of FLEXI-cross is the Security Systems Service Activities subsector under the NACE code of N80.2.
According to EUROSTAT[3], the last available official sector data in terms of existing companies, total turnover and employment are of 2020. The following, extracted from EUROSTAT table [SBS_NA_1A_SE_R2] , shows the Security Systems Service Activities sector size:

Table 5 Security Systems Service Activities sector size in 2020 (Source: EUROSTAT)

Indicators	Size (figures for the EU in 2020)
Number of Enterprises	11.000
Total Turnover (Million €)	9.274,7
Production value (Million €)	8.113
Value added at factor cost (Million €)	4.534,2
Gross operating surplus (Million €)	1.178,4
Number of Employees	12.4573

In terms of sector revenues and participation to European Gross Domestic Product (GDP), we notice an overall growth from 2011 until 2018 with a small drop in 2012-2014 due to the international economic slow-down and the consequent decrease in overall expenditures. The following graph illustrates this situation:

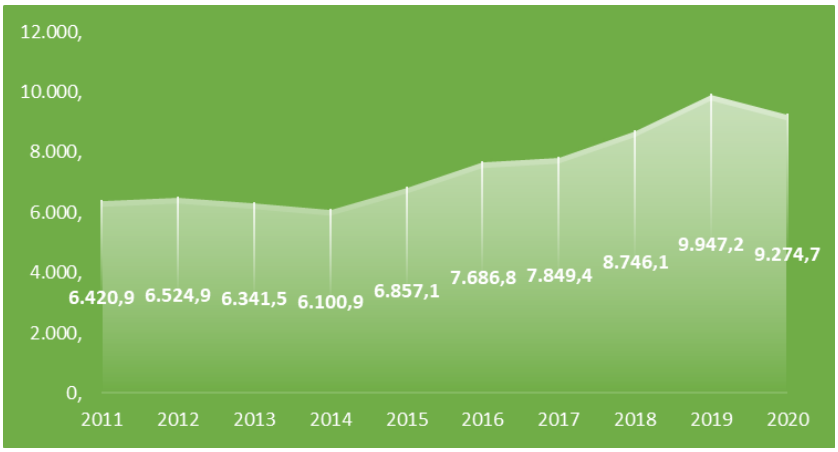

Figure 6 Security Systems Service activities market growth in Europe in the period 2011 – 2020 (Million €)

3 https://ec.europa.eu/eurostat/databrowser/view/SBS_NA_1A_SE_R2__custom_6986099/default/table?lang=en [Last access: 23/07/2023]

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Taking into consideration the specific situation of the countries part of the FLEXI-cross project, the Security Systems Service Activities sector breakdown and evolution in terms of total revenues and participation to European GDP is as follow:

Table 6 Security Systems Service market growth in 2011-2020 in countries involved in the FLEXI-cross project (Million €)

GEO/TIME	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
European Union	6.420,9	6.524,9	6.341,5	6.100,9	6.857,1	7.686,8	7.849,4	8.746,1	9.947,2	9.274,7
Germany	458,0	484,0	522,8	599,0	624,1	746,5	796,3	789,5	1.040,7	761,6
Greece	69,4	61,6	39,4	31,1	34,9	34,0	50,6	54,7	60,0	57,0
Italy	53,0	57,9	70,5	75,1	84,0	102,4	98,1	170,9	180,0	174,4
Cyprus	0,0	0,0	0,0	0,0	:	0,9	1,3	1,5	1,9	2,3
Romania	26,5	31,0	37,6	45,0	55,9	62,0	72,6	87,7	105,7	113,7

In addition, the following Figure 7 illustrates the distribution and growth of the number of enterprises operating in the Security Systems Service Activities sector by countries involved in FLEXI-cross:

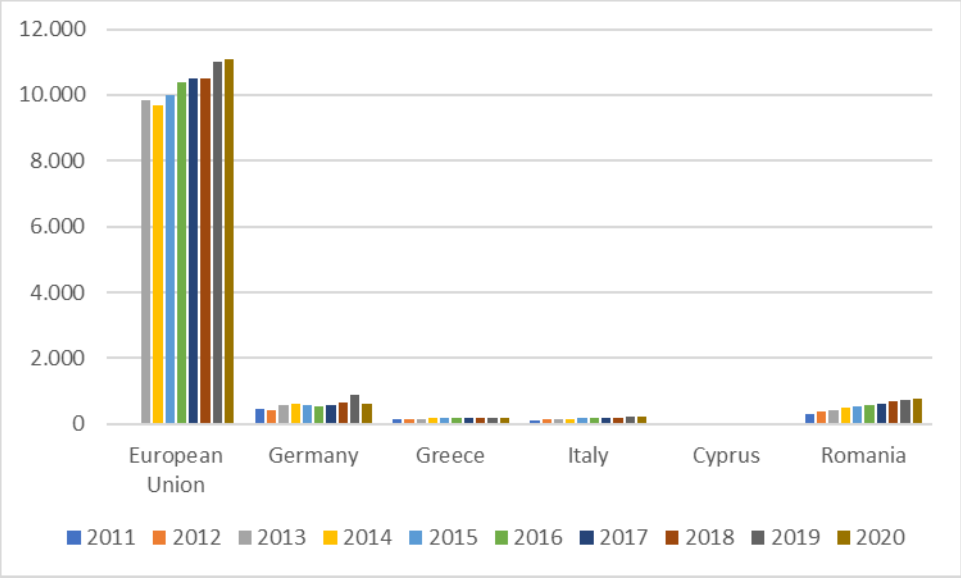

Figure 7 Evolution of the number of enterprises in the Security Systems sector by FLEXI-cross involved countries

6.2 Market Segmentation

Dimensional analysis offers various market segments defining the Border Security market structure comprising of the products offered which typically enlists the range of products offered by the Border Security market, processing technology applied segment identifies the different techniques implemented for processing and manufacturing, end-users and applications state the industries utilizing the benefits of the products the Border Security industries produce. The thorough classification of the different market segments is meant to provide an internal as well as external outlook focusing on the key functionalities and the competitive advantage that can be attained with adoption of trending strategies.

In order to well analyse the segments of target relevant market, it is important to identify the main aspects categorising the security industry products and services offered. In fact, the first

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categorization is related to well understanding the difference between the security industry and security market:

- **Security industry** which is understood to encompass private enterprises (and research institutions) that are engaged in or that support the development and supply of products and services that provide solutions and capabilities used in the delivery of security functions.
- **Security market** which is understood to encompass public and private actors that procure and/or consume products and services supplied by the security industry in order to perform security functions, whether on their own behalf, for third parties, or for the wider security of society.

Therefore, in terms of segmentation, the analysis of the security market composition can be based on three segments:

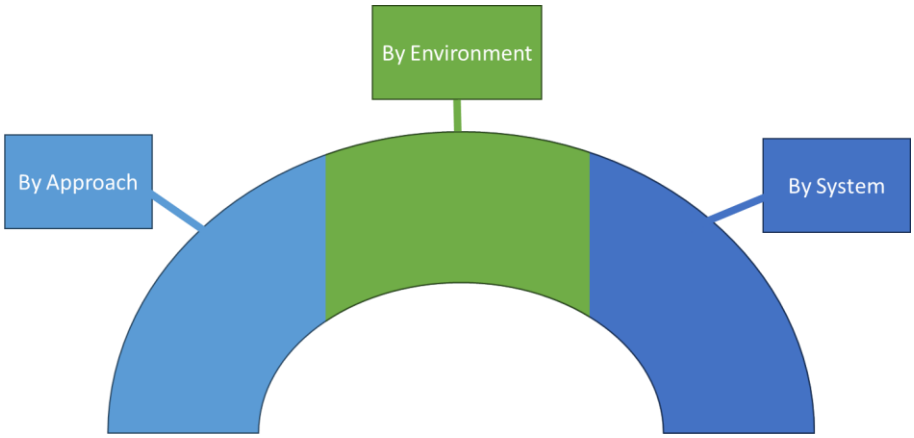

Figure 8 Border Security System Market Segments

(I) By Approach

The analysis of the security market composition can be based on two approaches:

- **Threat-based approach**: (i.e. the risks and threats for European external borders) which is translated into market segments demanding security products and services in order to face insecurity risks and threats. This approach shall identify also existing and emerging security risks and threats that require new solutions (new segment) to be introduced in the market.
- **Actor-based approach**: (i.e. the resources employed to respond to risks and threats that are the causes of insecurity) which defines existing security products and services that are employed by sector players in order to mitigate society insecurities.

As a result, the following market segmentations have been identified:

A. Threat-based segmentation:

- **Criminality**: market segment composed of security products and services concerning illegal activities conducted over the borders against property and persons for monetary gain. The main aspects of criminal activity that are of concern from a security policy perspective relate to organised crime engaged in serious criminal activities (e.g. drug trafficking, illicit goods, human trafficking, smuggling, arms trafficking).
- **Terrorism**: market segment composed of security products and services relating both to terrorist action undertaken by (international) terrorist organisations.
- **Espionage**: market segment composed of security products and services concerned with economically motivated attempts to obtain information and data (e.g. industrial espionage) or be undertaken for political or ideological reasons.
- **Illegal Migration**: market segment composed of security products and services concerned with risks relating to illegal and irregular migration flows in Europe.

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- **SaR**: market segment composed of security products and services concerned with the operations of the search for and provision of aid to people who are in distress or imminent danger.
- **Environmental disasters**: market segment composed of security products and services relating to major accidental or criminal environmental disasters that may happen in the seas (including, for example, release of chemical or radiological materials) or failures in critical infrastructure.

B. Actor-based segmentation:

- **Public Authorities**:
  - Authorities for Civil Security, who have the mission to control border security, sea traffic, fishery, historic sites, nature conservation areas, environment and SaR, as well as to fight against crime and terrorism. This segment is composed of Central government agencies, national and regional LEAs who have very specific product requirements to help them identify, tackle and prosecute perpetrators of crimes. In general, this segment includes: Coastal Guards, Border Police, and First Responders.
  - Defence & Intelligence, which is a specialised sub-segment of the wider public-sector security segment. This segment has the most demanding requirements, since defence & intelligence organisations buy expensive, complex products that have been accredited by bodies such as CESG or NATO, and buy services from organisations with top security clearance levels. Sales cycles can be lengthy, as procurement can be susceptible to changes in regime, funding or strategy on the buy-side. Importantly they generally buy from a relatively small group of prime contractors (typically large IT services generalists or defence contractors). This segment includes Intelligence services and military bodies (Navies).
- **Private sector:**
  - Security companies: such as costal security organisations in the private sector to carry out surveillance and sea traffic operations for private areas (for example leisure private ports). This customer segment has high contracting power, the sales cycles can be long and complex, and they require long term projects.

(II) By Environment

- **Ground**,
- **Aerial**,
- **Underwater**

(III) By System

- **Laser Systems**,
- **Radar Systems**,
- **Camera Systems**,
- **Perimeter Intrusion Detection Systems**,
- **Unmanned Vehicles**,
- **Wideband Wireless Communication Systems**,
- **Command and Control (C2) Systems**,
- **Biometric Systems**,
- **Others**.

6.3 Target Users and Customers

The main typical users of Information and Communication Technologies (ICT) solutions and services for the border security sector are large bodies (at European, national, and regional levels such as

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navies, coast guard and border authorities). We consider also potential users' small local agencies and private operators; thus, resulting in a large number of purchasing orders but of smaller value.
Typically, security organisations, especially the governmental ones, demand high-end products and services that have a large industrial impact in order to demonstrate the effectiveness of security solutions. As a result, it is highly recommended to consolidate the security consortium (which includes large companies operating in the security sector, the ICT sector and with public bodies, therefore having a good reputation within this sector) as the key aspect for properly addressing these end users. Moreover, in some cases across Europe, the acquisition in the public sector is not centralized where each of these organisations and agencies has its own budget and autonomy to decide on what products and services to buy, resulting in multitude of specific needs for each potential customer present in the market.
In this scenario, the **initial market targeted** for the commercialisation of FLEXI-cross would be the **EU market**; in particular **Romania**, **Greece**, **Cyprus**, **Italy**, **Germany,** and **Moldavia** will be the countries targeted at first for twofold reasons: on the one side the project consortium already has a business network in these countries thanks to the presence of project partners; on the other side these countries invest huge amounts in the security sector especially in innovative systems like the FLEXI-cross platform.
However, the project consortium sees excellent business opportunities also in other EU countries and outside EU as well, in Western countries such as US or Canada for higher attention to the border security lifecycle and the consistent growth of the ICT related applications market.
At this stage, we have identified the following initial target customers for FLEXI-cross platform (Figure 9):

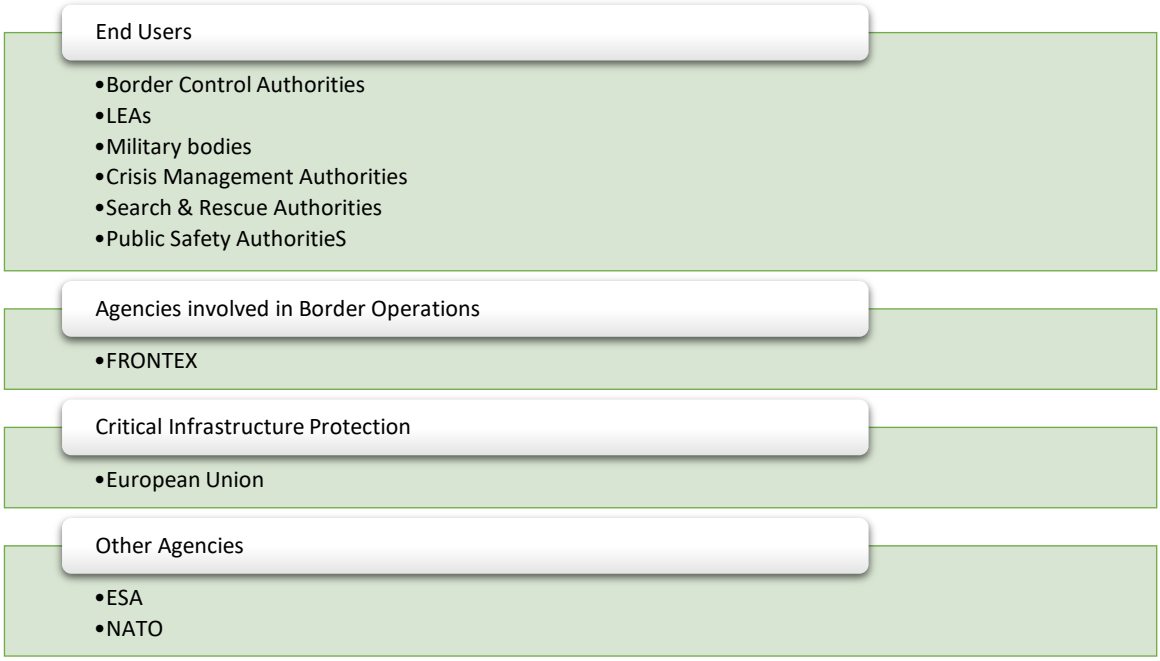

Figure 9 FLEXI-cross Main Target Customers Segments

6.4 Competition

The market is highly fragmented and is dominated by global defense systems and technology providers. The majority of the geographic regions have also local players who are equally strong and provide smaller sub-systems of a larger network/project in partnership with the global leaders. Local players in North America and Middle East & Asia are particularly threatening the global leaders, as

they aim to provide an all-round solution at a fraction of the cost quoted by these global leaders, without compromising on quality or reliability.
At global level, the main competitors are presented in Table 7:

Table 7 FLEXI-cross main competitors

Company	Country	Main Business
BAE Systems	UK	British multinational defence, security, and aerospace company.
Controp Precision Technologies Ltd	Israel	CONTROP Precision Technologies Ltd. is a privately owned company headquartered in Hod HaSharon, Israel, that specializes in the development and production of Electro-Optical/Infrared (EO/IR) systems for intelligence, surveillance, reconnaissance and targeting missions for air, land, and maritime applications including Homeland Security, Defense, and more.
Elbit systems	Israel	An international high technology company engaged in a wide range of programs throughout the world. It develops and supplies a broad portfolio of airborne, land and naval systems and products for defense, homeland security and commercial applications.
Flir systems	US	It designs, develops, and distributes technologies that enhance perception and awareness, bringing innovative sensing solutions through thermal and visible-light imaging, video analytics, measurement and diagnostic, and advanced threat detection systems.
Israel Aerospace Industries Ltd	Israel	IAI is a leader in defense, aerospace, and commercial markets, it leverages state-of-the-art technology and decades of combat-proven experience delivering solutions to national defense and security challenges.
Lockheed Martin Corporation	US	Lockheed Martin is a global security and aerospace company principally engaged in the research, design, development, manufacture, integration and sustainment of advanced technology systems, products and services.
Northrop Grumman Corporation	US	Northrop Grumman Corporation is an American global aerospace and defense technology company.
Raytheon company	US	The Raytheon Company is a major U.S. defense contractor and industrial corporation with core manufacturing concentrations in weapons and military and commercial electronics.
Thales	France	hales is a global technology leader with more than 77,000 employees on five continents. The Group is investing in digital and “deep tech” innovations – Big Data, artificial intelligence, connectivity, cybersecurity and quantum technology – to build a future we can all trust. In the markets of defence and security, aerospace and space, digital identity and security, and transport, Thales provides solutions, services and products to help its customers – companies, organisations and governments – to carry out their critical missions.
Saab AB	Sweden	Business Areas are: Aeronautics, Dynamics, Surveillance, Support and Services, Industrial Products and Services and Kockums (Shipyard).

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Company	Country	Main Business
Leonardo	Italy	Leonardo develops multi-domain capabilities in the Aerospace, Defence and Security sector. The company plays a prominent role in major international strategic programmes and is a trusted technological partner of governments, defence agencies, institutions and enterprises. Innovation, continuous research, digital manufacturing and sustainability are the cornerstones of Leonardo's business worldwide.
Safran	France	Safran is an international high-technology group, operating in the aviation (propulsion, equipment and interiors), defense and space markets. Its core purpose is to contribute to a safer, more sustainable world, where air transport is more environmentally friendly, comfortable and accessible. Safran has a global presence, with 83 000 employees and sales of 19.0 billion euros in 2022, and holds, alone or in partnership, world or regional leadership positions in its core markets. Safran undertakes research and development programs to maintain the environmental priorities of its R&T and innovation roadmap.

6.5 SWOT Analysis

STRENGTHS	WEAKNESSES
• Next-generation improved situational awareness with a focus on delivering a complete and useful comprehension of the situation at sea; • New operational capabilities to supplement current solutions; • Support users along the complete lifecycle of situations at sea, from the observation of elements in the environment up to detection of anomalies and aids to planning; • Enables collaboration among adjacent and cross-border agencies operating in the maritime surveillance sphere (Navies, Coast Guards, Customs, Border Polices) in order to pull resources towards the same goal, leading to cost efficient usage of existing resources; • Strong experienced and well-known end-users within the consortium; • Foster a dynamic eco-system of users and providers, allowing new data fusion services, based on a "distilled" knowledge, to be delivered to different actors at sea by the integration of a wide range of data and sensors;	• System exhibits a high degree of maturity, however, it lacks compared to commercial products as it is a prototype resulting from a research project; • Need for further investment for validating functional requirements and non - functional requirements, including robustness, stability and scalability in a fully operational environment; • IPR and licensing is highly fragmented; • Assistance outside the consortium might be needed in order to increase the chances of a successful system exploitation; • Lack of a long period of field-testing and real-life demonstration, feedback and reputation.

• Strong technical progress beyond the state of the art, based on advanced data fusion services and big-data analytics; • Real-time operation management for advanced operation command integrated with IoT devices and Sensors; • Ready to deploy platform accommodated in Virtual Machine; • User friendliness and self-explanatory toolkit; • High interoperability and changeability due to system's modular architecture and loosely coupling of components; • Robust security mechanisms for authentication and authorization; • Privacy by design and compliance with ethical principles and privacy and the current data protection legislation.	
OPPORTUNITIES	**THREATS**
• Growing need of next-generation situational awareness tools fusing data under uncertainty, integrating data from multiple sources, and employing Artificial Intelligence (AI) and machine learning for the support to decision making; • Compulsoriness of privacy and legal compliance approaches in case of tools dealing with personal data; • Developed components aligned with the individual exploitation / business plans of the participants; • Data availability: Data stemming from heterogeneous sources are now, more than ever ready to be exploited in various contexts; • Technology maturity and availability of infrastructure capable of supporting such a system (deep architectures, big data management infrastructures, IoT, etc.).	• High barriers to entry to the target market as it is very specific and controlled by few historical big players; • Domain highly influenced by geo-political factors; • Increasing constraints about data collection and processing, and privacy.

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7 FLEXI-cross Exploitation Plans

7.1 Individual Exploitation Plans

Exploitation is seen as a key enabler for the success of the FLEXI-cross project. Hence all partners are aware of, and are committed to, the exploitation of the project's results. It is a paramount principal in exploitation activities to make use of the results of the project to create value within the participating organizations and thus to improve their competitive advantages.
In order to develop a project exploitation plan in the second period, in this first period some key aspects related to the exploitation activities were collected from each partner according to their point of view linked to the project and to their organization (Table 8).

Table 8 Exploitation elements collect from each FLEXI-cross partner

Exploitation aspects	Explanation guidance
Activities linked to the project	*Describe how your are linked to the project. Do you have a dedicated business unit? Why are you interested in participating in the project?*
Competitive advantage	*Describe your (s) competitive advantage (s) (e.g. dream team, existing customers, existing collaboration, long last experience in research project)*
Exploitation expectations	*Describe your exploitation expectations in terms of impact on the market and plans for the technology used/implemented in the project (for example already commercialized, will be newly introduced in the business line, need further R&D, cannot be exploited singularely, not exploitable, etc.)*
Feasibility	*Describe if there are some barriers hinder profitability, if the right skills are availabel within your activities in the project*

In the next paragraphs are reported the exploitation aspects highlighted by each partner.

7.1.1 ENG

Activities linked to the project

Engineering Ingegneria Informatica S.p.A. is the project coordinator. ENG is also in charge of Legal, Ethical and Security Management issues, hence its contribution to the project management activities, guarantees the compliance of the project's output with the declarations done in the description of action. ENG will also be involved in the pilot in Romania for the management and checks in GALATI sea port, as well as being responsible for WP2, with special attention to the secure and reliable data processing tools. Leveraging its wide experience in commercial marker, ENG will also lead the exploitation and sustainability of the FLEXI-cross solutions.

Competitive advantage

Engineering is the Digital Transformation Company, leader in Italy and expanding its global footprint, with around 15,000 associates, with over 70 offices spread across Europe, the United States, and South America and global delivery.

The Engineering Group, consisting of over 70 companies in 14 countries, has been supporting the continuous evolution of companies and organizations for more than 40 years, thanks to a deep

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understanding of business processes in all market segments, fully leveraging the opportunities offered by advanced digital technologies and proprietary solutions.

With a strong and relentless focus on Innovation, through our R&I division that comprises over 450 researchers and data scientists (and a global innovation network of universities, startups, and research firms), the Group continues to invest in international R&D projects while exploring groundbreaking technologies and developing new business solutions. The Group continuously invests in human capital, with the internal "Enrico Della Valle" IT & Management Academy, which provides continuous upskilling and reskilling paths for both company employees and stakeholders, with over 32,000 training days per year.

The Engineering Group boasts a diversified portfolio built around proprietary solutions, best-of-breed market solutions, and managed services, and continues to expand its expertise through M&As and partnerships with leading technology players. Our 40+ years presence in all market segments (from Finance to Healthcare, from Utilities to Manufacturing and many more) has allowed us to build deep knowledge of business needs and anticipate them by exploring constantly the evolution of technologies, especially in the field of Cloud, Cybersecurity, Metaverse, Artificial Intelligence and Data.

This unique approach positions Engineering as a key player in the creation of digital ecosystems that bridge the gap between different markets, while developing composable solutions that ultimately foster a continuous Business transformation.

Exploitation expectations

ENG expectations are strictly linked to obtain a continuous staff training, strategic acquisitions (M&A), to constantly update and increase our capabilities.

Through the participation to the FLEXI-cross project, ENG aims to position itself as a strategic and fundamental partner also to maintain and continuously evolve our stakeholders' technologies, helping them to achieve their goals and preserve the value of assets and investments.

Feasibility

Engineering Ingegneria Informatica S.p.A. in the ENG R&I Department has a dedicated business unit for the Border Security that has the mission of developing new solutions and promoting research outcomes to business units. The Border Management and Defence research unit ha several experiences as projecy coordinator as well as participation in several projects in the security fields (e.g. PYTHIA, SOLOMON, EFFECTOR, MARISA, ANDROMEDA). These internal expertises allow us to carry out the project activities without any barriers.

7.1.2 BEIA

Activities linked to the project

We are interested in technology development utilizing cutting-edge procedures and technologies based on prediction algorithms and telecommunications technology.

Competitive advantage

Our competitive advantage is that we are one of Romania's leading providers of ICT solutions and services for cloud communications and IoT telemetry. Over 5,000 turn-key projects for advanced IT and communications solutions are among the company's references.

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Exploitation expectations

BEIA will be able to sell the platform in a basic scenario as a nationwide SaaS service platform to public & private stakeholders in the smart IoT domain. In the extended scenario, BEIA will commercialize the smart services developed within the Balkan/Danube region through BEIA's sales and partners' network.

Feasibility

None

7.1.3 EBOS

Activities linked to the project

eBOS has a dedcated team of project managers and developers that work only for EU funded project, and this what made eBOS be recognized as a leading reasearch and development institution.
Our activities not only seek to improve existing systems to keep them competitive but also explore radically new solutions and technological breakthroughs. Our aim is to identify new and emerging technologies and leverage them to deliver cutting-edge, robust and cost-effective engineering solutions.
Our participation in the project is to brainstorm and explore new applications for the emerging technologies that eBOS is specialized in (IOT, AI, intelligent/dynamic dashboards, cybersecurity...) and to invest our experience for the sake of improving the intra borders between european countries with the aim to ease the life of the european population and to make europe a safer place

Competitive advantage

eBOS has a Long history of engaging with international research and technology organisations, industrial leaders, universities and SMEs to drive collaborative technological innovation.

With an increasingly comprehensive portfolio of software solutions, investments in R&D&I are crucial to us. The development of our product portfolio as a specialist software powerhouse has equipped us with core competencies which we deploy in R&D&I projects. We fuse the knowledge and innovation gained from our participation in research and innovation projects into the development of innovative applications and solutions.

Exploitation expectations

in eBOS we aim to exploit the technologies that shall be used within the project to enhance our software products and expand our customer base, especially public authorities that are looking to use technlogy for improving their operation, and to make their procedure more efficient.
We will be exploiting our commercial product for dashboards, we will customize and personalize this product in order to tailor a unique human machine interface that shall integrate all the emerging features the flexicross toolkit aims to deliver

Feasibility

eBOS experience in the development of intelligent/dynamic dashboard, coupled with our participation in more than 42 research project with leading companies/universities/research centers makes us one of the leading software providers. This is capable to overcome any barrier for our contribution to the project activities and to further enhance/propose solutions if challenges are faced.

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7.1.4 WINGS

Activities linked to the project

WINGS is primarily linked to the project via the development activities related to the Greece-Bulgaria border crossing use case, which WINGS leads from the technical perspective. Different solutions are leveraged and extended such as OBU-based monitoring and predictive analytics, AI/ML and computer vision solutions for security, abnormal behaviour analysis, etc, smart user interfaces and dashboards for users, etc.

Competitive advantage

WINGS has build throughout the years a very powerful team of cutting edge research individuals and teams, participating for more than 20 years in state-of-the-art ICT projects. The solutions and products' portfolio of the company resulted from such as advanced solutions and continue to be constantly improved by the ever growing number of customers, requirements, and features introduced by the different technology and management teams of the company.

Exploitation expectations

Addressing but not limited in the security domain, WINGS' solutions and particularly the products, platforms and devices related to the Transport and Logistics domains (WINGSChariot, WINGSPark, WINGS OBU) will be considerably enhanced via the new features list introduced by the FLEXI-cross project use case requirements.

Feasibility

WINGS' constant growth during the last decade is achieved via a continuous need to make the most out of the challenges and requirements set in different domains, by numerous public/private customers, and more than 100 European or national projects. To this end, no barriers are identified towards achieving the already set targets.

7.1.5 HOLO

Activities linked to the project

Holo-Light is a technical partner in this Flexi-Cross project. Holo-Light will bring (not develop or otherwise) the relevant hardware units for AR vizualization of the border crossing functionalities produced in this project. More importantly, Holo-Light will develop and provide the AR software solutions to meet the latter needs. Holo-Light is interested in participating in this project in order to better apply our AR (and streaming) software solutions and expertise in the market of border security. Havning a diverse range of use cases for our products and company expertise is beneficial from a market perspective for future endeavors.

Competitive advantage

Holo-Light has a extensive history in participating in European funded research projects. To date, Holo-Light has engaged in 12 EU Horizon Programme research projects. Therefore, the needed scientific and technical infrastructure, both in terms of knowledge and personell, is present and operational. Furthermore, the proven expertise and quality of Holo-Light's VR/AR products in the global industrial market is an advantage for this project.

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Exploitation expectations

The AR sofware solution(s) produced for this Flexi-Cross project are currently envisioned to contribute to our market impact indirectly. The solutions produced here are to be use-case tailored and thus adapted from Holo-Light's core product(s) and therefore will not be commericalized directly following termination of the project. However, the impact from such an experience will contribute to the repertoire of knowledge and expertise which Holo-Light can bring to the market (i.e., customer base) and could therefore be used as intellectual and developmental substrate for future R&D endeavors or customer products in the future. Such endeavors will serve as Holo-Light's exploitation measures.

Feasibility

Barriers to profitability are currently not predicted given the current status of the project.

7.1.6 ICCS

Activities linked to the project

Activity 1: design and development of a face recognition mobile application (Tool 1)
Activity 2: design and development of a tethered UAV system for unusual pattern extraction (INUS-UPE platform) (Tool 2)
Activity 3: analysis and evaluation of the project's trial results and lessons learned

Competitive advantage

Tool 1: Face recognition mobile application, Tool 2: INUS-UPE platform for unusual pattern extraction ICCS leverages its wide experience in UAV & terrestrial surveillance applications, facial recognition and biometrics, embedded systems and sensors, , ML/AI algorithms, etc. Also, has a great experience and active participation in EU R&D projects, acting as coordinator, technology provider, system architect, technical and scientific manager.
Tool 1: Provides a portable, modular, robust and efficient mobile face recognition application, that adopts in real time sophisticated algorithms for person verification and identification, with the capability to be used in several uses cases in the security, border management, crisis management/emergency response and civil protection domain.
Tool 2: Provides a modular, flexible, and efficient tethered UAV system that performs in real time sophisticated unusual pattern extraction in the edge. Such tool has the capability to be used in several uses cases in a continuous operation mode (with constant power supply) aspect in the security, border management, crisis management/emergency response and civil protection domain.

Exploitation expectations

Tool 1: Face recognition mobile application, Tool 2: INUS-UPE platform for unusual pattern extraction ICCS is interested to exploit both tools in future R&D projects (not direct commercial activities) in the security, border management, crisis management/emergency response and civil protection domain. Both tools are expected to be demostrated in operational enviroment in the Flexi-cross project's trials achieving a TRL7 and/or TRL8

Feasibility

Tool 1: Face recognition mobile application, Tool 2: INUS-UPE platform for unusual pattern extraction ICCS is a public, non-profit research institute and has no direct commercial activities. Both tools are functional prototypes, designed and developed in the Flexi-cross project. ICCS is sole owner (100%) of the Software, while the HW of both tools are based on COTS components.

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7.1.7 KEMEA

Activities linked to the project

KEMEA will bring into the attention of some of the below mentioned organizations the final results of the project as well as the developed platform for future exploitation opportunities. KEMEA will exploit the FLEXI-cross toolkit and all its components to enhance its research expertise, consultancy services and portfolio in the relevant security domain.

Competitive advantage

KEMEA is a scientific, consulting and research agency, whose purpose is to conduct theoretical and applied research and to perform studies, particularly at the strategic level, on security policies. Being a member of several European associations and organizations it represents the Greek Government as a member of the "**European Security Research and Innovation Forum (ESRIF)**". Amongst other associations and organizations, KEMEA is a member of the "**Public Safety Communication Europe Forum (PSCE)**", the "**European Association of Research and Technology Organizations**" and has signed a Memorandum of Understanding (MoU) with the **ENLETS** community (European Network of Law Enforcement Technology Services). Since 2016, KEMEA is **a Framework Partner of CEPOL** for the coordination and implementation of training activities and learning products. KEMEA is also **a founding member of the European Organisation for Security (EOS)**, which was created in 2007 by European private sector providers from all domains of security solutions and services. Its members represent all relevant domains of the economy (ICTInformation and Communication Technologies, civil security, energy, transport, finance, services and research) across 13 different European countries. In addition to that, since 2016, KEMEA is a member of the **European Association of Research and Technology organizations (EARTO)**, which is a non-profit international association established in Brussels that represents the interests of Europe's RTO community towards European institutions and offers its members opportunities for networking and professional improvement. The members of EARTO make a major contribution to strengthening economic competitiveness and social development in Europe by supporting product, process and service innovation in all branches of industry and services, public and private. KEMEA is involved in the activity of the Security Research Working Group of the Association (EARTO SRG) joining forces to promote joint initiatives in the field of Homeland Security research programming and innovation strategies with the largest and most prominent European research institutions. Last, but not least, since 2019 KEMEA is the designated focal point between the Hellenic Police and the **European Border & Coast Guard Agency (Frontex) on Research and Innovation matters.**
To meet the growing needs of the security and law enforcement practitioners and related academia, KEMEA has participated in research projects of the Horizon 2020 – the Research and Innovation Framework Programme of the European Commission – ever since it was launched; part of the H2020 is devoted to "Secure Societies – Protecting freedom and security of Europe and its citizens". KEMEA's objective in this context, is not only the development of new technologies or the application of emerging technologies, but also the understanding of associated phenomena and the development of more effective policies. Under this area of work, within the EU and including the results of 2021, KEMEA currently ranks first in terms of both net EU contributions and number of EU-funded projects (67 projects).

Exploitation expectations

KEMEA is interested in bringing new solutions and training methodologies to the Hellenic Ministry of Citizen Protection. They will validate new solutions and build synergies with Border Authorities and scientific community. They will bring the FLEXI-cross toolkit to the attention of the Hellenic Ministry

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of Citizen Protection. Having strong links, under its constitutional law, with all Ministry supervised entities and to European associations and organisations (e.g., ESCO, EENA, Europol, CEPOL ENLETS).

Feasibility

The incorporation of FLEXI-cross toolkit into the daily operational business of the Hellenic Police is a top priority and challenge of KEMEA's exploitation plan. The scope is to have the toolkit prototypes up and running for at least one year after as convincing argument towards the development of new commercial project ideas by the Hellenic Police in the implementation of the National Programme for the Internal Security Fund for the programming period 2020-2027 and Integrated Border Management Fund – Border Management and Visa Instrument (2021-2027).

7.1.8 GIBP

Activities linked to the project

The General Inspectorate of Border Police of the Republic of Moldova is the law enforcement agency responsible for enforcing security at the international border. The compliance of the GIBP mandate and project outputs is guaranteed by using modern technologies to enhance security, reliability, and privacy during cross-border checks. Advanced control mechanisms for securing and protecting people's fundamental rights and personal data through a comprehensive data governance framework are the zero priority to ensure the safety and protection to EU border. Within the project GIBP seeks to find and use new solutions and technologies at the railway borders interested in implementing the FLEXI-cross system and managing it effectively to achieve its intended goals.

Competitive advantage

N/A

Exploitation expectations

N/A

Feasibility

N/A

7.1.9 IGPF

Activities linked to the project

Being a law enforcement agency IGPF doesn't have a dedicated business unit. We are interested to participate in this project from the point of view of using new solutions and new technologies in border management.

Competitive advantage

N/A

Exploitation expectations

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N/A

Feasibility

N/A

7.1.10TCCFR

Activities linked to the project

We are interested in facilitating rail transport through digitalization and technology development.

Competitive advantage

Our competitive advantage is that we are the only data transport rail operator and that we operate the most widespread telecom network in Romania, over 6.000 km of optical fiber. We would desire a closer collaboration with the rail freight companies.

Exploitation expectations

Need further R&D (research and development)

Feasibility

Needs further skills training

7.1.11ATG

Activities linked to the project

Tehnopol is involved in the implementation of the project by supporting to the end-user providing the challenges, solution requirements, personnel for trials and solutionb validation. We do not have a business unit.

Competitive advantage

Tehnopol is an economic-social development agency of the local authorities in the city of Galati.

Exploitation expectations

ATG expects to provide real-life input of the challenges that the FLEXI-cross tries to tackle, aiding in the development process, and, in the end, to provide a “birds eye view” of the solution deployment using its already existing surveillance system.

Feasibility

Tehnopol is a non-profit organization, our activity does not generate profit.

7.1.12HPOL

Activities linked to the project

The Hellenic Police is participating in the project as an end user. Participates in the project to improve document control capabilities and the duration of the control process.

Competitive advantage

The Hellenic Police is the only agency that carries out border controls.

Exploitation expectations

Faster and more thorough border controls.

Feasibility

Need for portable equipment and as fast an internet connection as possible.

7.2 Exploitation plan analysis

Based on the information collected and presented in the previous section 7.1, an aggregated analysis has been conducted.
As shown in Figure 10, the FLEXI-cross consortium has a prevalent presence of end users (42%) and SMEs (33%).

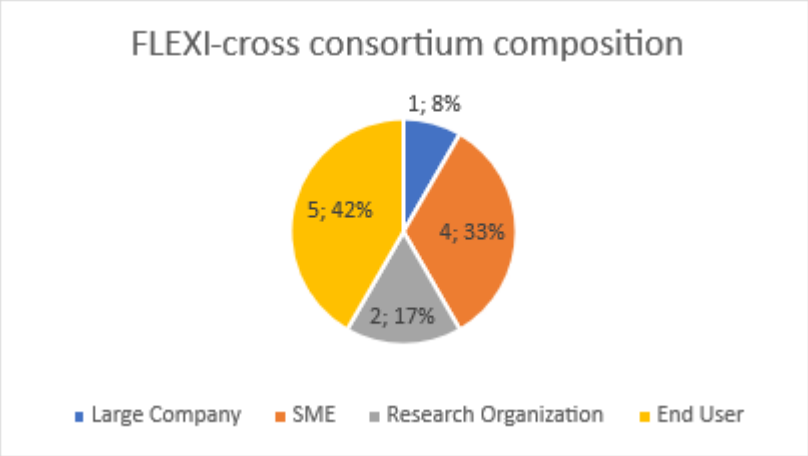

Figure 10 Analysis of the FLEXI-cross consortium composition

In a manner consistent with the composition of the consortium, it also emerges (Figure 11) that the main activities related to the FLEXI-cross project are solution usage (42%) and technology development (34%).
For what concern the advantages (Figure 12), most of the project partners (41%) indicated to be a leading provider with respect to the activities to be carried out in the project. Instead, the 25% see their portfolio of solutions as a competitive advantage. Then follow the presence of a powerful team and the experience as leading provider, 17% both.
The Figure 13 shows that the partner expectations are mainly linked to the development of new features and the participation in new future research projects, both 17%. The partners are also interested to strategic positioning into the domain and in the market.
Finally, the aggregated analysis showed that in this initial phase, the majority of partners did not detect any barriers (67%). But it emerged that some technological and lack of skills could be influencing the usage of the FLEXI-cross solution (Figure 14).

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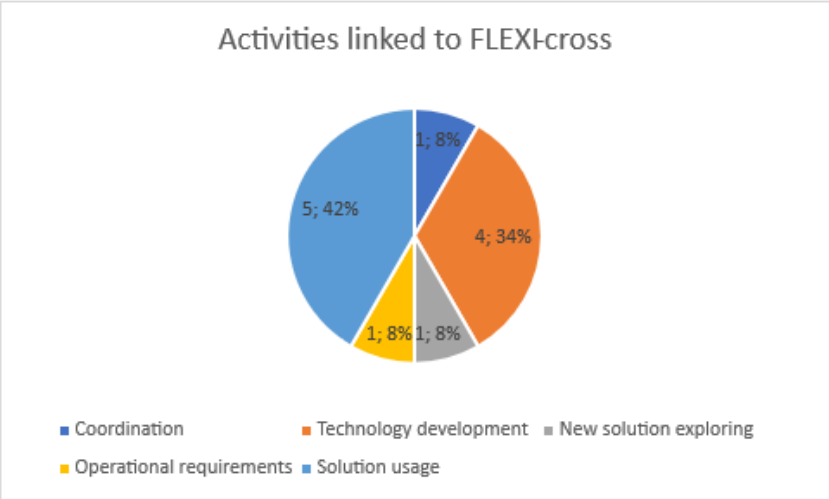

Figure 11 Analysis of the activities linked to the FLEXI-cross project

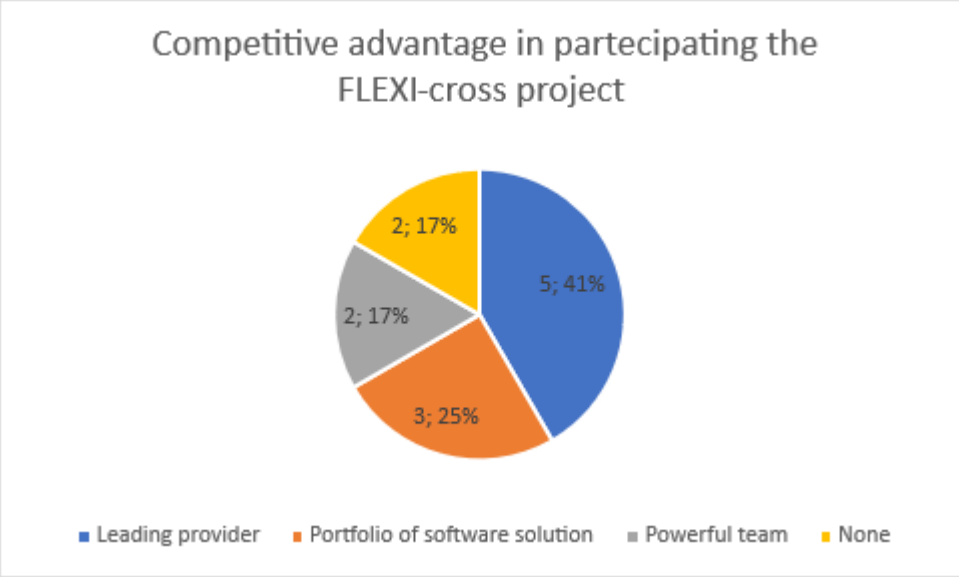

Figure 12 Analysis of the competitive advantages of the partner in the FLEXI-cross consortium

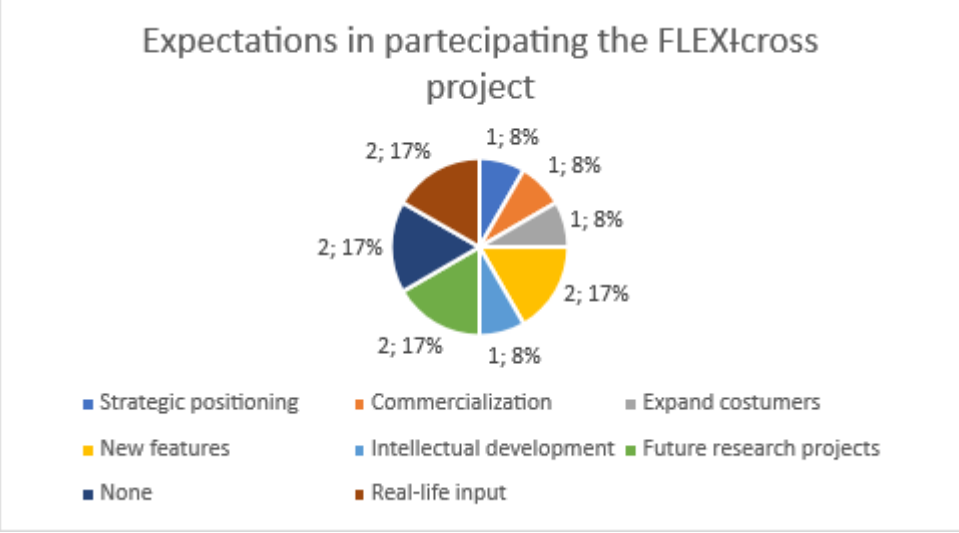

Figure 13 Analysis of the partners' expectations in participating FLEXI-cross project

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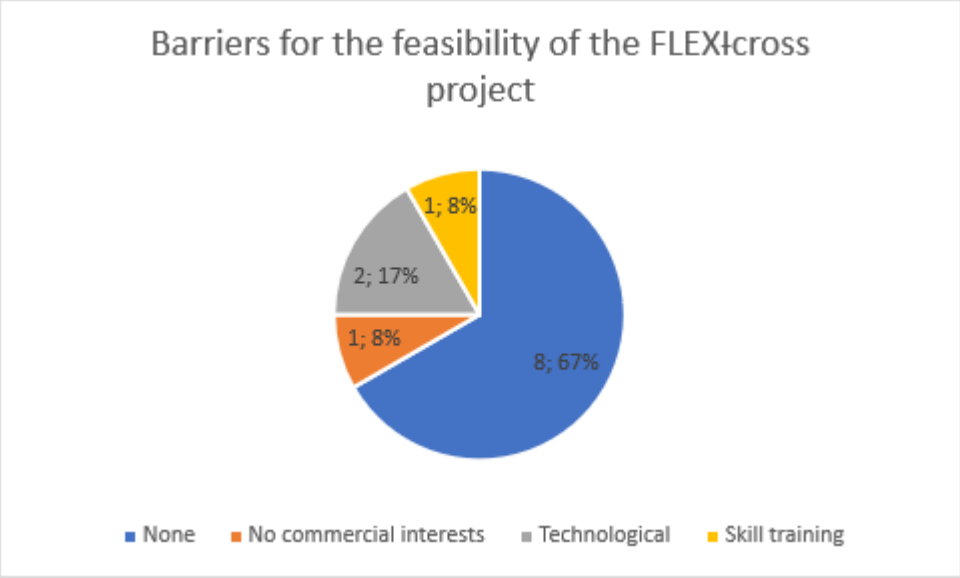

Figure 14 Analysis of the barriers to the FLEXI-cross feasibility

7.3 Preliminary Joint Exploitation Paths

7.3.1 Role definition

As anticipated in section 7.2, the consortium is defined by several heterogeneous entities: there are SMEs (BEIA, eBOS, WINGS, HOLO) and private companies (ENG) who are interested in a commercial exploitation of the framework; research organization (KEMEA, ICCS) that can be interested in dissemination of scientific relevance and contributing to industrialisation of services. And finally, a set of target users and customers (GIBP RM, IGPF, TCCFR, ATG. HPOL) that are interested in deploying and operating FLEXI-cross system.

According to this division of the project partner's exploitation activities can be initially classified into:

- Evaluation of FLEXI-cross system, further development of the platform (customization to specific users' needs).
- Participation in the events to promote FLEXI-cross system: workshops, seminars, trainings, trade fairs & conferences.
- Publication of joint articles, case studies in the scientific journals and magazines.
- Commercial exploitation of the framework.
- Legal, ethics and privacy consulting.
- Spin-off exploitation: creation of a spin-off company that will take care of FLEXI-cross system evolution, maintenance, availability, billing and sales. As a separate entity that will result as the outcome of the project.

Therefore, the roles of every entity in the exploitation of the results will depend on the type of partner.

7.3.2 Delivery and deployment model

Several deployment models are considered, depending on the costumers' requirements. FLEXI-cross system can be exposed to customers in the cloud. In this model, the platform will be deployed in the cloud and users will access the services via APIs, web services and/or browser.

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There might be particular cases where the platform needs to be installed in-premise for customers with specific requirements and constraints. Also, for some cases the user cannot outsource data outside established borders (organization, region, country), in this case the platform can be deployed into a cloud environment provided by the customer or the governmental agency so that users with these requirements can benefit from the platform. Concluding the delivery and deployment model will in principle be offered as a service in the cloud but the framework needs to be adaptable to case-by-case requirements, taking into account the singularity of every particular customer.

7.3.3 Pricing Licensing policy

The licensing model will be differentiated, depending on the deployment and commercial exploitation model. In our opinion is it early to define price ranges and usage costs of the services, which will be analysed and provided in the last version of this deliverable D4.6.
Licensing model needs to provide a correct balance to attract potential customers and/or other funding possibilities in order to obtain a commercial benefit from FLEXI-cross system.
A Free licence may be considered to be provided to FLEXI-cross end-users in order to further test the system in long-term operational scenarios: this license may be limited to a period of time after the end of the project. This type of license will be used as a hook to attract potential customers and convert them into satisfied, paying customers.
Commercial licenses will be divided into temporal subscriptions and/or in-house licensing. The temporal subscription model will allow a customer to perform analysis at a reduced price (can be adapted on a case-basis) for a given period of time (e.g. one year). This type of license will provide access to a bucket of FLEXI-cross services, selected depending on each user interests and requirements.
Finally, the last model is the in-house license or ad-hoc license model. This model should be adopted in the other cases where FLEXI-cross system needs to be installed into customer's premises. This license model can be composed also by deployment costs, installation, customisation, support, training, development of ad hoc analytical features and other particular requirements from the customer. Due to the specificity of this type of license the cost and agreements will be performed on a case basis.

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8 FLEXI-cross Initial Business model

As stated in the GA, during the proposal stage, an initial business model for FLEXI-cross has been developed and summarised as presented following the well-known "business model canvas" (BMC) methodology to be used as a key reference for the definition of the business model.

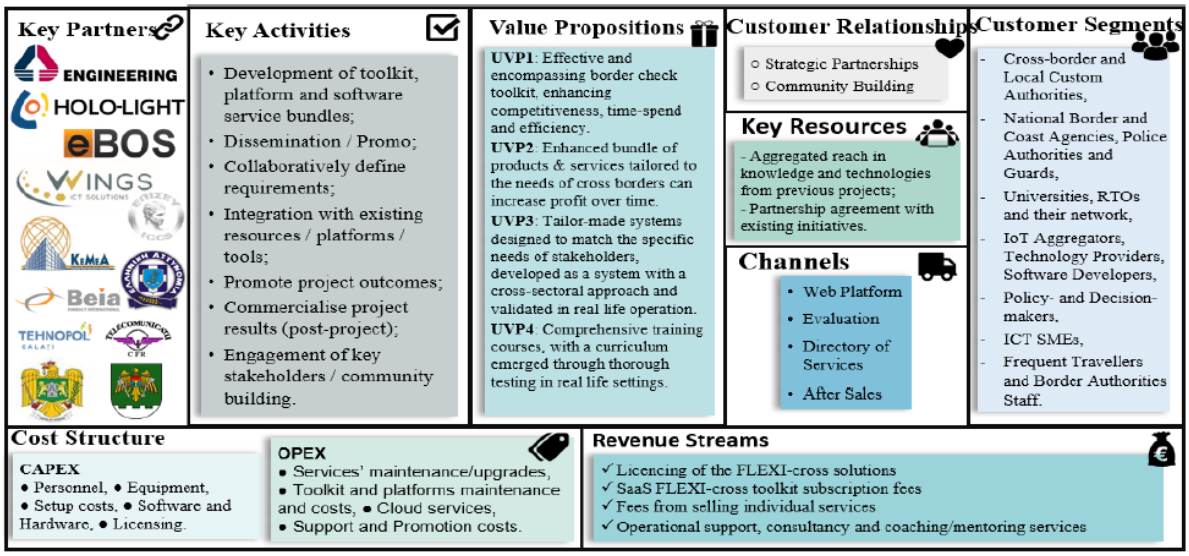

Figure 15 Initial FLEXI-cross business model at proposal stage

Among the existing business models, the Lean Canvas will be adopted. The Lean Canvas is an adaptation of Business Model Canvas by Alexander Osterwalder which Ash Maury created in the Lean Startup spirit (Fast, Concise and Effective startup) [7]. Lean focuses on problems, solutions, key metrics and competitive advantages and fits better in R&D Projects. The Lean Canvas comprises 9 blocks (Figure 16), described as follows.

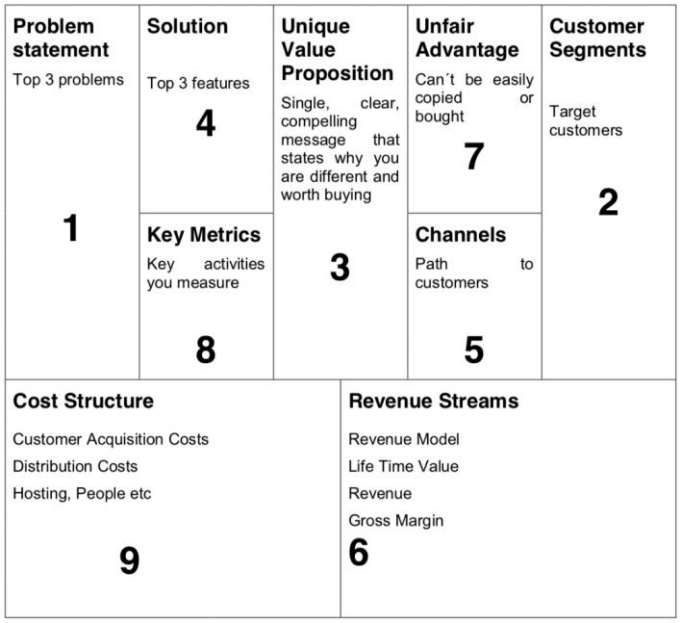

Figure 16 Lean Canvas blocks

The order showed in the figure is important in order to describe the model.

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1. **Problem**: Description of an issue currently existing, which needs to be addressed. It provides the context for the business model and generates the questions which the value proposition aims to answer.
2. **Customer Segments:** Customer segments are the community of customers or businesses that you are aiming to sell your product or services to.
3. **Unique Value Proposition**: A single and compelling sentence that makes everybody understands why you are far better (your features need to be compelling to the customers).
4. **Solution**: Outline the main features of your solution. What you do, that the others do not do and is what matters to the clients.
5. **Channels**: How will you reach your customers?
6. **Revenue streams**: Which will be the main revenue streams when the solution is ready for the market (e.g., direct sales, licensing, pay per use, etc.).
7. **Unfair advantage**: What gives you an advantage in front of the competition? Something that can´t be easily copied or bought.
8. **Key metrics**: Key activities you will measure to track the success (e.g., units sold, users registered, retaining users, paying customers, number of complaints, etc.).
9. **Cost Structure**: Which will be the main costs when the solution is ready for the market (e.g., customer acquisition costs, distribution costs, hosting, people etc.).

In accordance with the definition of these 9 blocks, the goal is to build a FLEXI-cross business model based on the project activities carried out. One or more project tasks can be associated with each block. The Figure 17 shows the information that can be used to complete the FLEXI-cross business model that will be improved in the final version of this deliverable (D4.6) that is expected by M36:

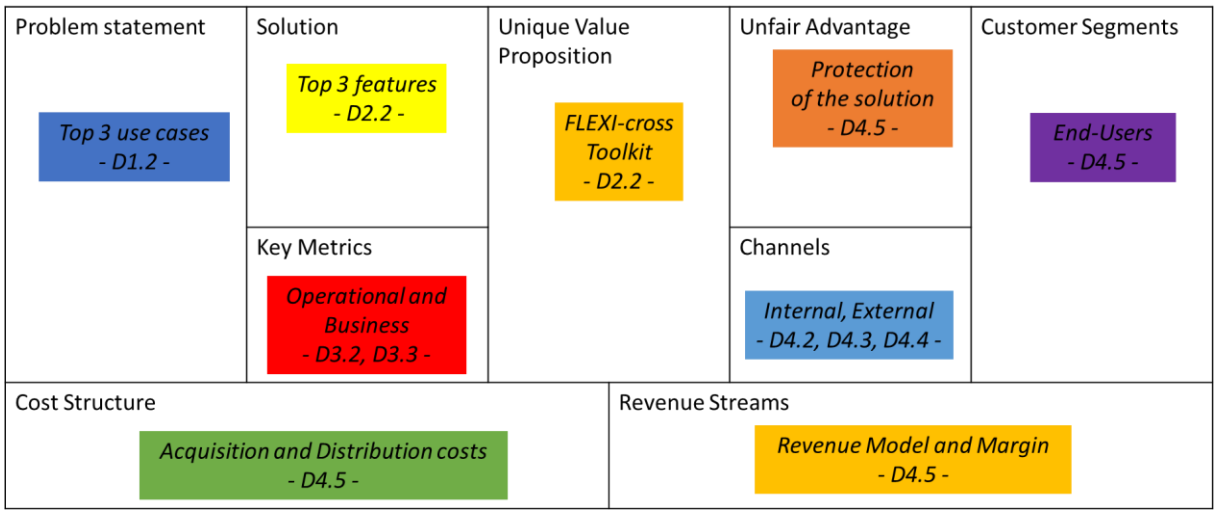

Figure 17 Business Model template VS FLEXI-cross information to be used

The initial definition of the business model is described below according to the statement in the Grant Agreement.

1. Problem Statement

The increasing importance of pan-European passenger and freight transport, both in terms of financial as well as societal impact, is showcased by the adoption of the EU vision of Trans-European Transport Network (TEN-T), which will connect and enhance trade and tourism among European nations as well as between EU nations and neighbouring countries. Such enhanced mobility will intensify border-crossings of citizens and goods, which in turn will generate a significantly increased load on customs

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and security procedures, calling for smarter, more effective and cost-efficient solutions for border checks.
Human trafficking, irregular crossings and contraband smuggling is a major concern for EU, which will only intensify with the realisation of the TEN-T vision.
The need for increased security, privacy and protection at EU borders becomes even more critical under such circumstances.

2. Customer Segments

- Cross-border and Local Custom Authorities
- National Border and Coast Agencies, Police Authorities and Guards
- Universities, RTOs and their network
- IoT Aggregators, Technology Providers, Software Developers
- Policy and Decision-makers
- ICT SMEes
- Frequent travellers and Border Authorities Staff.

3. Unique Value Proposition

The FLEXI-cross project targets the deployment and continuous validation of a toolkit of innovative border checking solutions, in real operational environments. These solutions will deliver increased security and reliability of border checks for people and goods, while enhancing and improving the border management capabilities.
The resulting flexibility and dynamicity of border check planning will offer novel capabilities such as dynamic deployment of checkpoints and support via mobile applications for border personnel, while guaranteeing high level of security, privacy of personal data and protection of people's fundamental rights. The design and architecture of the implemented solutions will be based on the analysis of the technical and service requirements of the EU border authorities (e.g., Frontex) and will offer seamless integration with existing systems and devices currently utilised by them.

4. Solution

- Toolkit platform and software service bundles
- Integration with existing resources/platforms/tools
- Engagement of key stakeholders

5. Channels

- **Own**: taking advantage of the consortium contacts to present FLEXI-cross Toolkit directly to the customers.
- **Indirect**: presenting the solution to brokers that could be interested in the solution for themselves but also could play a role of intermediaries to other European agencies.

6. Revenue Streams

FLEXI-cross has a specific singularity as research project. It has been envisioned almost ad-hoc for the end-users. According to the CA, Art 9.4, results shall be granted to a member of the consortium on Fair and Reasonable conditions.
In addition, FLEXI-cross could make profit in a more standard Profit and Loss (P&L) way offering additional services. The FLEXI-cross results are owned by consortium members, who can easily turn this into revenue streams. The revenue streams below are not mutually exclusive, so it is possible to mix them and use more than one to balance between two main goals: gaining users and increasing revenue:

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- Installation of the software on-premises to the customer´s infrastructure.
- License fee: which gives customers the right to use the software during an agreed period of time.
- Technical support: maintenance.
- Updates and evolutive improvements.
- Consulting services: these are extra services as customization to provide solutions to specific requirements.

7. Unfair Advantage

We understand Unfair Advantage as something that protects our solution of being easily copied or replicated in front of the competition.
As first approach, all the partners have the intention of releasing their components as proprietary software. This point will be confirmed by the end of the project.
Closed source would protect FLEXI-cross System from copying, changing, or emulating its features.

8. Key Metrics

These are the key activities that we are going to use as measure to track the success of the Go-to-Market strategy:

Operational Metrics	Business Metrics
• Increased performance in detection compared to current systems. • Increased cross-sector preparedness and collaboration. • Increased intelligence of illicit and dangerous material transported in postal/courier flows. • Number of private/public investors attracted to the proposed solutions. • Number of new stakeholders engaged through the project's communication channels	• Number of existing regulations and standards that FLEXI-cross will contribute to • Number of EU funded projects liaising with FLEXI-cross • Number of stakeholders comprising the valorisation board of the project • Number of organized workshops/public events related to the core activities of the project. • Number of additional domains in which the developed technologies can also be used

9. Cost Structure

FLEXI-cross ***Toolkit Implementation Costs:***

- FLEXI-cross Development: Costs related to FLEXI-cross development.
- FLEXI-cross System Integration: Analysis, Design, Development, Testing, Deployment and Roll-out of the Platform + Contingencies.
- Hardware Costs to be sustained: Radars and sensors.
- Software Costs to be sustained.

FLEXI-cross ***Toolkit Operating Costs:***

- Infrastructure Operating Costs: Facilities, Hosting, Personnel, Service Desks Support.
- IT Helpdesk Support: Cost for maintaining a Help Desk Support
- Hardware Maintenance.
- Software Maintenance.
- Connectivity Costs.

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Non-Technical Costs:

- Salaries (administration, outsourcing, etc.);
- Utilities (electricity, gas, water, phone, internet, etc.);
- Rents (premises, offices, etc.);
- Transport.
- Communication.
- Marketing activities to promote FLEXI-cross (events, congresses, fairs, workshops, etc.).

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9 Significance of FLEXI-cross to the Wider Impacts

The proposed FLEXI-cross pathway towards impact is based on three temporal level of observation (Figure 18):

1. Medium-term impact: Expected Outcomes KPIs (eoKPIs)
2. Long-term impact: Expected Impact KPIs (eiKPIs)
3. Wider impact: Societal, Economic, and Scientific aspects.

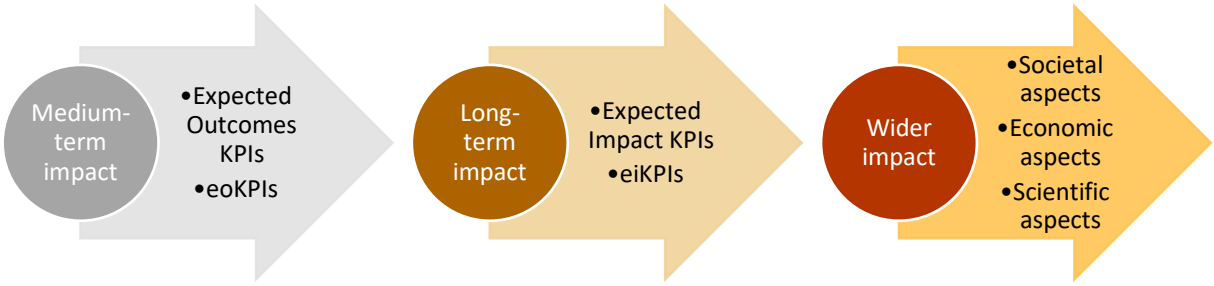

Figure 18 FLEXI-cross pathway towards impact

Medium and long term KPIs will be described in the deliverables *D3.2 Report on intermediate experimentation results of the FLEXI-cross trials* and *D3.3 FLEXI-cross trial results analysis, evaluation & lessons learned*.
The wider impacts are characterized in the following paragraphs:

- Societal Wider Impacts (SoWI)
- Economic Wider Impacts (EWI)
- Scientific Wider Impacts (SWI)

For each wider impact, starting from the definition stated in the Grant Agreement, a general statement plus the FLEXI-cross approach will be described in order to give a preliminary basis for the analytical work that will be done in the deliverable *D4.6 Final commercialisation and impact generation report* (M35).

9.1 Societal aspects

From Grant Agreement
FLEXI-cross helps border authorities across Europe take full advantage of sophisticated border checking solutions, aiming to deliver more dynamic, effective, cost-efficient, and innovative services for the benefit of the society. More specifically, the expected societal impact of FLEXI-cross will be related to the following aspects: (a) Improved security for the European citizen due to improved border-checking processes of the EU borders and the collaboration of involved stakeholders. FLEXI-cross is directly affecting citizen safety, by offering flows optimization, flexible planning and increased security/reliability of cross-border checks, remote cargo inspection & risk assessment of moving vehicles (cars, trucks, trains, ships), as well as remote seamless biometric check and verification of travellers.; (b) FLEXI-cross will contribute towards the protection of human lives by providing tools and methodologies to prevent, detect, mitigate and react to threats at borders. The Europe's society's resilience and all threats faced at the borders, promote life, liberty and European values. The vulnerability of the European member states is a major challenge which today's society is confronted with.; (c) Improved capacities for public and private sector to demonstrate innovative ideas that have

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not been extensively tested and validated in real operational conditions. This will help to rapidly scale up their technologies and products. By communicating the vision and the results of this project, more organisations and Agencies will be further motivated to adopt and use high end security products and services to their roadmap. During the project duration where the different phases of the plot timeline are addressed, the tools that will be assessed as well as the operational models have to comply with the data protection legal framework (taking into account the General Data Protection Regulation 679/16/EU) and must follow the directives respecting the personal data protection. FLEXI-cross will address ethical issues from the outset in a consistent and coherent way. By the design and deployment of tools and operational models we will consider and deal with all ethical and legal issues that may arise.

General statement

It is essential to understand that many of the effects caused by a policy, program, or project may be *non-monetary* in nature. These non-monetary impacts are more likely to be observed in a cost-benefit analysis (CBA) where there exists market failure. Market failure is often not considered in private sector CBA. This is driven by impacts that may not be considered the responsibility of the private sector and therefore fall on the public sector. One good example of this issue is related to externalities.

FLEXI-cross approach

The FLEXI-cross policy innovation has been described in section 4. Social and policy regulation, regulation gaps, and improvement have been described. These aspects will be increased in the final version of the deliverable *D4.6 Final commercialisation and impact generation report* (M35).
The ethical issues are covered in the dedicated work package *WP6 Ethics requirements*.

9.2 Economic aspects

From Grant Agreement

FLEXI-cross project, through the delivery of enhanced flow of information, processes and novel solutions, promotes good management and coordination within and among Member States, end-users, industries and stakeholders, which is essential in developing the border-checking economy as efficiently and sustainably as possible. In addition, an active operational common information sharing environment for the EU borders domain is an effective and cost-efficient way of safeguarding EU interests. Another important aspect is related to the potential growing of employment levels in the EU area, considering the high level of technological innovation in the borders checking domain introduced with FLEXI-cross; the consequent benefits for the EU Industries involved in the project and; the future opportunities arising from the commercialization and evolution of the product. FLEXI-cross solutions contribute to seamless and resource-efficient transport of people and goods between EU and (transport-wise) neighbouring countries, thus improving the economic prosperity and employment chances close to transport hubs as well as genuine border regions.

General statement

Wider economic impacts (WEI) comprise all effects that are not assessed appropriately in conventional cost-benefit analysis (CBA). These effects are generated by market imperfections, in the view of neo-classical equilibrium theory. In real economies such imperfections are not exemptions but frequent phenomena, e.g., stemming from increasing returns to scale or scope, or structural changes of products and industrial processes. Although the existence of WEI is not in question, they are usually not considered in practical assessments of transport infrastructure investments because they can only be estimated with high uncertainty and – in industrialised countries in particular – they are assumed to be of negligible magnitude.

FLEXI-cross approach

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The FLEXI-cross economic aspects have been described in section 8 that is dedicated to the definition of the initial FLEXI-cross Business model using the "business model canvas" (BMC) methodology. This method will allow the consortium to clearly identify the 9 elements (i.e. Problem, Customer Segments, Unique Value Proposition, Solution, Channels, Revenue streams, Unfair advantage, Key metrics, Cost Structure) from all the results achieved in the other work packages and tasks according to Figure 17.

9.3 Scientific aspects

From Grant Agreement

FLEXI-cross also impacts positively on academia, industry and technology providers and companies through matching requirements and capability gaps of end-users and promoting exploitation and collaboration. It aims to deliver concrete and measurable results and knowledge that are envisaged to influence the technological capabilities in border security, to affect standardization and to contribute to the exploitation of innovative end mature commercial products. The project aims at accelerating the inclusion of such technologies in the operational practices of the end-users and contributes to the imminent advances that they can bring in EU border security.

FLEXI-cross also aims at renovating the way the border authorities operate by applying processes and solutions that will place the public sector in the front line of innovation. More specifically, FLEXI-cross will help to transform the border guard authorities from a simple technology absorber to a constant technology and innovation generator and will contribute to the delivery of more efficient services for the safety and security of the citizens.

General statement

Scientific impact strengthens the relationship between the science community and society. A Scientific Wider Impact) SWI may be accomplished through the research itself, through activities that are directly related to specific research projects, or through activities that are supported by, but are complementary to, the project.

FLEXI-cross approach

The FLEXI-cross scientific aspects have been outlined in section 6, where an initial market analysis has been described, including trend analysis, market segmentation, and competitors. The evaluation of the trials, that will be performed from month 18 to month 34, will give several and new points to refine the work done in this deliverable. The related improvements will be described in the final version of the deliverable *D4.6 Final commercialisation and impact generation report* (M35).

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10 Conclusions

The initial outcomes of the current exploitation activities proposed by the Consortium partners have setup a good basis for the exploitation of FLEXI-cross expected assets. The deliverable has started with the definition of all aspects of FLEXI-cross system as-a-whole expected results, then the identification of the exploitable assets of the project along with a preliminary market analysis. This document has covered also IPR issues as they have been agreed in the initial signed Consortium Agreement, and which will need a final IPR agreement to be signed among partners by the end of the project. The final part of this deliverable has proposed a description of the individual exploitation plans and the elaboration of an initial considerations for the joint exploitation.

The market analysis on key segments and sectors related to border security products and services indicates an increasing potential, confirmed also in their application other relevant domains and industries. Thus, the results obtained in this initial market analysis and exploitation plan will constitute the basis for further study and analysis, confrontations, and negotiations with potential customers, and then will be fine-tuned and updated according to market evolvement during the life of the project.

It is of great importance to build solid interest of the partners towards a concrete exploitation of FLEXI-cross results. Exploitation must not only target sole assets owned by individual partners, but also the cross-exploitation of those provided by other partners and most importantly the integrated and innovative FLEXI-cross Toolkit as a whole. Thus, driving all the partners to work on building exploitation scenarios of individual assets to be exploited by more than one partner.

The final outcomes of the tasks *Task 4.2 Capacity building with national & EU border authorities and training activities* (leads by BEIA), *Task 4.3 Market analysis, Exploitation, Commercialisation and Sustainability* (leads by ENG), and *Task 4.4 Impact generation and business, social and policy innovations* (leads by EBOS) will be reported in the upgraded version of this deliverable *D4.6 Final commercialisation and impact generation report* (M35).

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Internal Deliverable Review Form

Grant Agreement No	101073879	**Acronym**	FLEXI-cross
Full Title	Flexible and Improved Border-Crossing Experience for Passengers and Authorities		
Start Date	01/09/2022	**Duration**	36 months
Project URL	https://flexicross-project.eu/		
Deliverable	D4.5		
Work Package	WP4		
Contractual due date	31/12/2023	**Actual submission date**	
Nature	R	**Dissemination Level**	PU
Internal Reviewer	HPOL		

Dissemination Level

x	PU: Public
	R-UE/EU-R: Restreint-UE/EU-Restricted
	SEN: Sensitive

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Topic	Answer	IF "No", classify as "Major" or "Minor" issues	Comments
1 Is the content and structure of the deliverable in accordance with the DoA?	Yes		
2 Is the content of the deliverable scientifically relevant?	Yes		
3 Is the content of the deliverable useful for the subsequent work on the project?	Yes		
4 Is the deliverable suitable to be submitted to the EC?	Yes		By addressing some commets and track changes
If not:			
4.1 Does it need formatting adjustments?	Yes		Normal style is different among sections. In some parts there is a spacing after the text, in some other parts not.
4.2 Does it need content adjustments?	No		
4.3 Does it need to be significantly refined (e.g. content improvement, structure changes, etc.)?	No		
Additional comments			
ENG – Revisions in track changes accepted. Comments addressed. Formatting style check through the whole report done.			