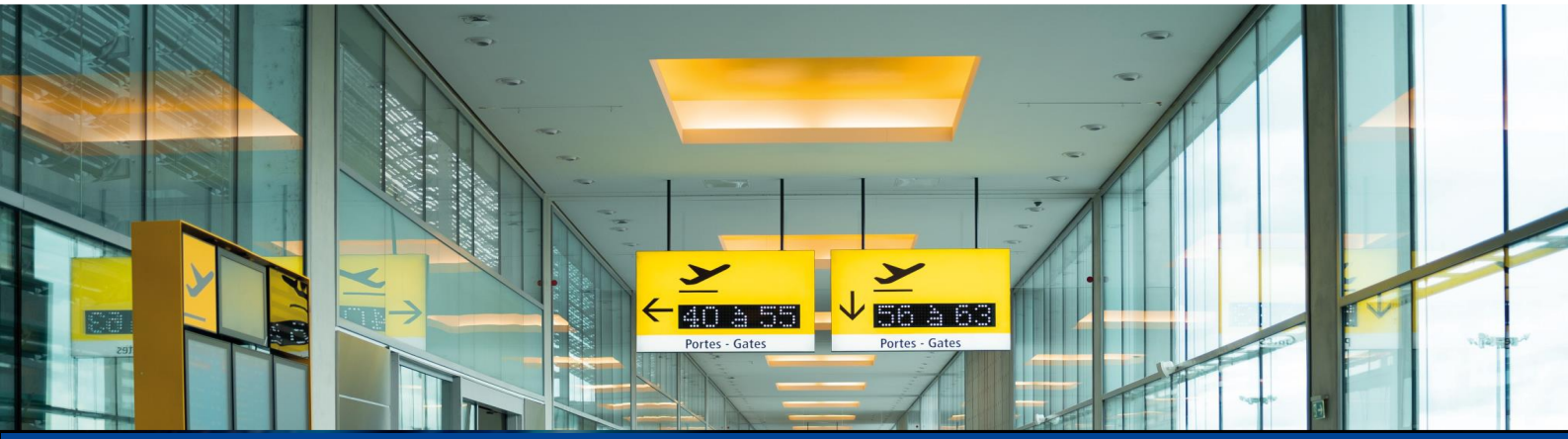
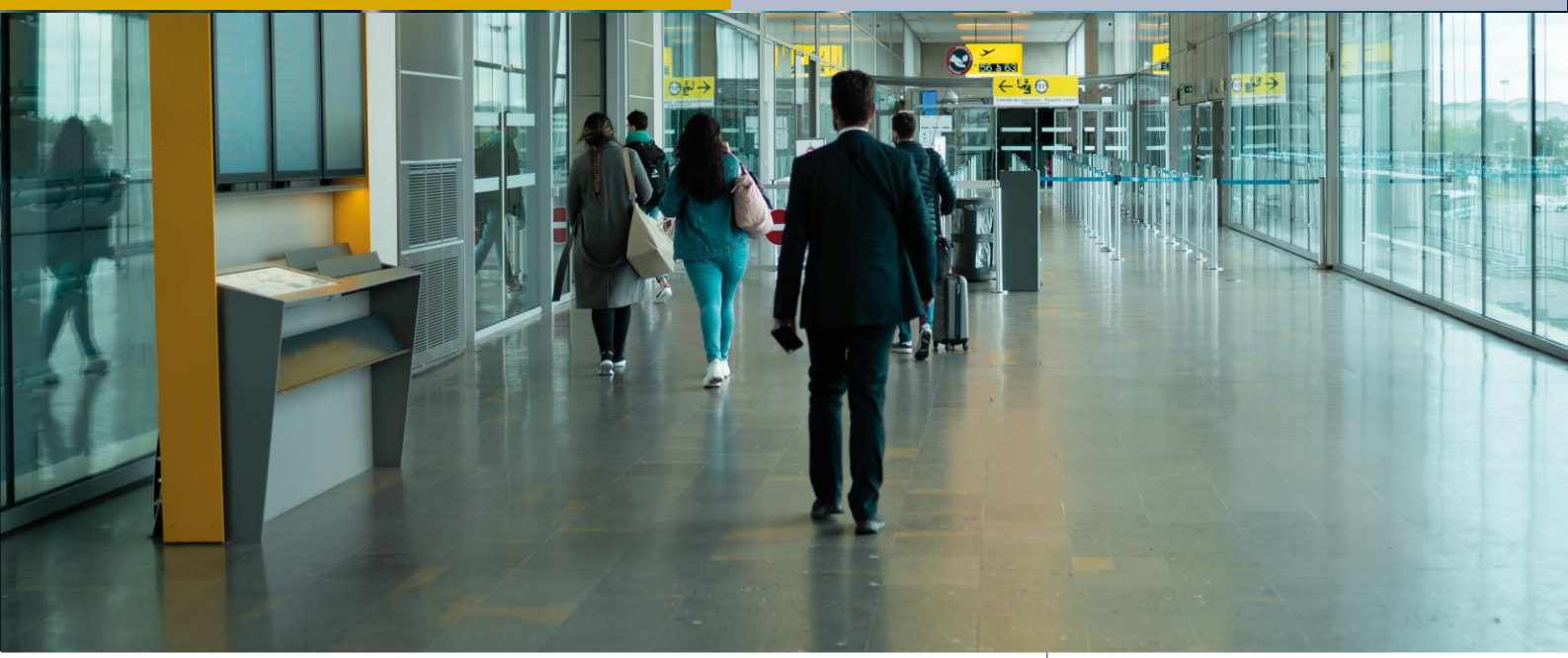


Enabling Seamless Travel to the European Union

Research Monitoring Report

December 2022



European Union Agency for the Operational Management of Large-Scale IT Systems in the Area of Freedom, Security and Justice

www.eulisa.europa.eu

eu-LISA

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About the Agency

THE EUROPEAN UNION AGENCY FOR THE OPERATIONAL MANAGEMENT OF LARGE-SCALE IT SYSTEMS IN THE AREA OF FREEDOM, SECURITY AND JUSTICE (EU-LISA)

eu-LISA is an EU Agency established to provide a long-term solution for the operational management of large-scale IT systems in the EU's Justice and Home Affairs domain, which are essential instruments in the implementation of the EU's border management and migration and asylum policies.

The Agency currently manages the **Schengen Information System (SIS)**, the **Visa Information System (VIS)**, and **Eurodac**. In addition to these, eu-LISA is developing the **Entry/Exit System (EES)**, the **European Travel Information Authorisation System** (**ETIAS**) and the **European Criminal Records Information System – Third-Country Nationals (ECRIS-TCN**). All these systems are being built and adapted to ensure overarching **systems interoperability** – improved access to information stored across all JHA information systems and more seamless identity management at EU level. To that end, dedicated interoperability components are being developed.

The Agency was established in 2011 by Regulation (EU) No 1077/2011 and began operation on 1 December 2012. In 2018, eu-LISA's mandate was expanded, as detailed in Regulation (EU) 2018/1726.

eu-LISA's headquarters are in **Tallinn, Estonia**, and its operational centre is in **Strasbourg, France**. There is also a business continuity site based in **Sankt Johann im Pongau, Austria** and a Liaison Office in **Brussels, Belgium.**

Contents

Executive Summary

In the past two decades, the amount of people travelling internationally has more than doubled. During the same period, the legal and technical requirements for crossing international borders have also changed considerably, largely motivated by the **objectives of security, migration management and travel facilitation**. These new requirements have impacted the whole '**traveller continuum**', a phrase describing all the steps the travellers must follow to complete their journey, from the decision to travel abroad to the arrival at their chosen destination.

International travel to the EU is conditioned by a **set of legal frameworks** whose implementation and operation is facilitated by an **evolving architecture of large-scale IT systems** in the JHA domain. First is the **EU common visa policy**, identifying third-country nationals that are visa-exempt and those that are required to hold a visa for entering the EU's border-free area – the Schengen Area. This policy is supported by the Visa Information System (**VIS**), operational since 2011, used by the Member States for sharing data on visas. Additionally, the EU applies common border checks on persons, in particular using the Schengen Information System (**SIS**), enabling national authorities to share 'alerts' on people who may be wanted by the police or declared missing. What is more, since 2017, the EU has launched a wide range of initiatives to support the **integrated management of its external borders**. This programme includes the Entry/Exit System (**EES**) for recording the time and place of entry of third-country nationals, and also the European Travel Information and Authorisation System (**ETIAS**), a pre-authorisation system for visa-exempt third-country nationals. Finally, to ensure the interoperability of these systems, the EU is in the process of upgrading SIS and VIS, in conjunction with the development of several essential components that will constitute a **new interoperability architecture for the EU's IT systems** in the domain of Justice and Home Affairs.

The EU is in the process of digitalising its border management procedures, with **a view to achieving overarching interoperability across all JHA information systems,** to deliver a seamless traveller experience.

As the first step of the **traveller journey**, the process of acquiring authorisation for travelling to the EU is currently undergoing a significant review in order to **fully digitalise the Schengen visa procedure by 2025**. This digitalisation is set to streamline the visa application process to a considerable degree, with a view to **reduce the cost for both travellers and visa-issuing authorities alike**. In the past couple of years, the EU has tested various digital solutions to prepare for this digital transformation, including an online visa application platform, and a visa application chatbot. As regards IT systems, ETIAS will introduce significant changes to the process of travel authorisation for people wanting to visit the EU. From its entry into operation in November 2023, it will be used to determine the eligibility of visa-exempt third-country nationals prior to their travel to the Schengen Area. Travellers will be able to pay for and submit their ETIAS application online via a dedicated website or using a mobile application, well in advance of their intended travel.

Nowadays, passengers are increasingly asked to submit their personal information ahead of travel, to allow for pre-arrival checks. Additionally, carriers have also been made responsible for ensuring, prior to departure, that their passengers are in possession of the travel documents required to cross the border upon arrival at their chosen destination. To support carriers in this task, the EU has developed a dedicated interface for automated queries in EES, ETIAS and the upgraded VIS.

The **biometrics enrolment** is an important element of the pre-border checks, in particular for EES, and may be one of the bottlenecks that travellers will face. To make this process as easy and convenient as possible, several research projects have worked on developing self-service and handheld, both for the travellers and the border control authorities.

In addition to facilitating travel authorisation and pre-border check processes, several new technological concepts are being developed to streamline border checks. Most prominent among them are such concepts as **digital identity and digital travel credentials**, paving the way for international travel without the need to show or check a physical travel document. Additionally, **automated border control systems**, such as e-gates, now in widespread use, are also being upgraded, benefiting from the latest progress in biometric acquisition systems. However, the research community is still actively working to mitigate the known weaknesses of such systems, such as demographic fairness.

In recent years, the international travel community has demonstrated that they are ready to offer travellers a fully seamless experience, most commonly when travelling by air. However, new concepts and technologies that are being developed should be applicable to all modes of transport and various types of border-crossing scenarios. Together they carry the potential to **make the seamless traveller journey a reality** for the largest share of travellers than ever before.

Introduction

International travel has been consistently increasing at a high pace in the past decades, despite an abrupt halt to all travel caused by the COVID-19 pandemic in 2020. In 2002, global travel stood at 715 million,[1] reaching 1.4 billion in 2018.[2] Prior to the pandemic, international tourist arrivals to Europe increased from 475.5 million in 2006 to almost 750 million in 2019.[3] Despite the temporary disruption caused by the pandemic, international travel has resumed its pre-COVID growth trajectory: in the first nine months of 2022, international tourism showed a robust performance, with arrivals reaching 63% of pre-pandemic levels. During this period, Europe continued to lead the rebound of international tourism, reaching 81% of pre-pandemic levels[4]. What is more, the COVID-19-related travel restrictions prompted the international travel stakeholders to prioritise the development and implementation of **measures facilitating contactless travel**, one of the critical elements for ensuring a seamless traveller journey.

During the past two decades, and particularly in the aftermath of the September 11 attacks in the United States, many countries, including the Member States of the European Union, increased the security requirements related to inbound international travellers in the effort to combat terrorism and cross-border crime.[5] To protect the external borders of the Schengen Area, the EU adopted the **integrated border management** (IBM) approach.[6]

With regard to international travel, the EU's overarching political objective is to **facilitate travel for legitimate travellers**, while also stepping up prevention and detection of illegal migration and cross-border crime, in conjunction with the effective management of migratory flows. As a result, many EU Member States and border agencies are facing the dual challenge of accommodating more and more travellers, while at the same time increasing the security requirements for travel authorisations and border-crossing. In practice, this means using advanced IT systems for conducting additional checks on a larger number of travellers.

Furthermore, travellers are increasingly being asked to **register their travel well in advance of departure** (e.g., through electronic travel authorisation systems), in some cases with an additional requirement to submit their biometric data, e.g., as part of a visa application. Over time, some of these new requirements have started to negatively affect the travelling experience, either because of delays and uncertainty in visa application procedures, or because of longer queues at the borders. In some cases, increasing waiting times at border control points may also lead to temporary relaxation of border checks,[7] often to the detriment of larger security objectives.

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[1] V. Peric (2005) **Tourism and Globalisation**, Proceedings of the 6th International Conference '*Managing the Process of Globalisation in New and Upcoming EU Members',* Faculty of Management Koper, University of Primorska, Slovenia, 24–26 November 2005.
[2] World Tourism Organization – UNWTO (2019) **International Tourism Highlights**, 2019 Edition.
[3] Statista (2020) **Number of international tourist arrivals in Europe from 2006 to 2020**.
[4] UNWTO (2022) **World Tourism Barometer and Statistical Annex**, November 2022.
[5] For example, the European Council stated in December 2001 that: '*Better management of the Union's external border controls will help in the fight against terrorism, illegal immigration networks and the traffic in human beings*.'
[6] Communication from the Commission to the Council and the European Parliament – **Towards integrated management of the external borders of the member states of the European Union**, COM(2002)0233 final, 7 May 2002
[7] Article 9 of the **Schengen Borders Code**, i.e. Regulation (EU) 2016/399 of the European Parliament and of the Council of 9 March 2016 on a Union Code on the rules governing the movement of persons across borders (Schengen Borders Code), OJ L 077 23.3.2016, p. 1.

To improve the traveller experience, international stakeholders – the transport industry, tourism industry, and related international organisations – decided to start working towards a concept of '***seamless travel***'. The World Travel and Tourism Council has formulated the following broad definition: '*Seamless travel is defined as a journey during which the traveller no longer needs to present travel-related documents (e.g., boarding passes) or identification documents (e.g., passport) multiple times to a variety of stakeholders at different checkpoints in their journey*'.[8]

Seamless travel
is defined as a journey during which the traveller no longer needs to present travel-related documents or identification documents multiple times to a variety of stakeholders at different checkpoints in their journey.

During the COVID-19 pandemic, the travel industry made significant efforts to enhance traveller confidence, e.g., by providing contactless check-in services at airports. In the aftermath of the pandemic, such contactless services are becoming the standard for the international travel industry.[9] For example, some of the technological solutions that are being developed in preparation for the launch of the Entry/Exit System (EES) (e.g., automated border control gates, contactless biometric capture, contactless screens, etc.) aim to provide travellers both a seamless and contactless experience. Several of these technological solutions are presented in this report.

This report aims to present an overview of how the EU envisages the seamless travelling experience in the context of international travel to and from the EU. By outlining legislative and technological developments, the report highlights how novel technological solutions can support in making the international travel experience more seamless. The report starts out by describing the European context for international travel, from the regulatory and technical perspectives, and defines the concept of '***travel continuum***', which will be used to further elaborate on the seamless traveller experience. Next, the report will describe the EU's most recent legislative and technological developments that will support the vision of seamless travel at the three main steps of a traveller's journey: first, the travel authorisation, then pre-border checks, and finally, border checks at the entry and exit points of the Schengen Area.

In addition to desk research, this report builds on the following information sources: eu-LISA Annual Conference[10] and Industry Roundtables,[11] recent projects and studies, and consultation with eu-LISA experts on biometric technologies, business processes, and the interoperability architecture for the domain of Justice and Home Affairs (JHA).

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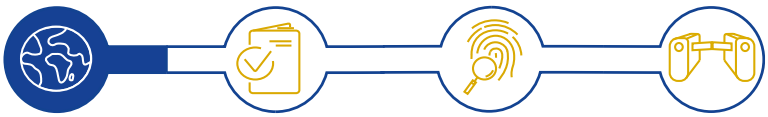
[8] World Travel and Tourism Council (2020) **Global Guidelines for Safe & Seamless Traveller Journey**, December 2020.
[9] M. Khan, *et. al.* (2022) **Impact of COVID-19 Pandemic on Tourists' Behavior and Preferences: A Critical Insight**, South Asian Journal of Social Sciences and Humanities, Vol 3, Issue 4, pp. 123-137.
[10] eu-LISA Annual Conference '*10 Years as The Digital Heart of Schengen*', 13 October 2022. For more information, please visit **https://www.eulisaconference.eu**.
[11] eu-LISA Industry Roundtable is a biannual event for presenting most recent technological advancements related to large-scale IT systems in border management. For more information, please visit **https://www.eulisaroundtable.eu**.

1. The EU context



1.1. Legal and technical framework

One of the goals of the EU is to constitute and ensure an **area of freedom, security and justice**.[12] In order to ensure EU citizens the freedom of movement within this territory, also known as the **Schengen Area**[13], the Member States have abolished internal border controls, while also adopting common policies on travel visas and external border controls for non-EU citizens, commonly referred to as third-country nationals.

The Schengen Area encompasses 27 European countries and three microstates.

EU Member States: Austria, Belgium, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Slovakia, Slovenia, Spain, and Sweden. *

* Ireland has opted out of joining the Schengen Area, Croatia joined on 1 January 2023, whereas Bulgaria, Cyprus, and Romania are set to join in the future.

Non-EU countries: Iceland, Norway, Switzerland and Liechtenstein are associate members, as are European microstates – Monaco, San Marino, and the Vatican City.

For the purposes of ensuring the efficient functioning of this area of free movement, the EU has established the following measures:

- common policy on visas and other short-stay residence permits,
- checks on persons crossing the external borders of the Schengen Area, and
- measures for the establishment of an integrated management system for external borders.[14]

These measures are implemented through a number of policies and frameworks, which all have an effect on border-crossing and the facilitation of travel, constituting the basis for the success of the seamless travel approach.

For over 30 years, the EU has developed and operated several large-scale IT systems to ensure the effective functioning of the Schengen Area. These systems, such as the **Schengen Information System (SIS)** and the **Visa Information System (VIS)**, constitute the underlying technological framework for facilitating international travel to and from the EU.

As of 2019, the EU has been developing several new systems, such as the **Entry/Exit System** (**EES**), and the **European Travel Information and Authorisation System (ETIAS**), that will significantly change the existing framework to accommodate future needs. EES relies on the use of biometrics for the identification of travellers, requiring an enrolment process prior to entering the Schengen Area.

[12] Article 67 of the **Treaty on the Functioning of the European Union**, OJ C 326, 26.10.2012, p. 47–390.
[13] For more information about the Schengen Area and related EU policies, please visit **https://home-affairs.ec.europa.eu/policies/schengen-borders-and-visa/schengen-area_en**.
[14] Article 77 of the **Treaty on the Functioning of the European Union**, OJ C 326, 26.10.2012, p. 47–390.

Common visa policy

The EU's **common visa policy**[15] establishes a common list of countries whose citizens must hold a Schengen visa for entering the Schengen Area. Currently, this list includes over 100 countries,[16] while over 60 countries have been granted a visa exemption, representing a compound population of around 1.4 billion people.[17]

The EU's **Visa Code**,[18] setting out procedures and conditions for issuing short-stay visas for visits to the Schengen Area that last for a maximum of 90 days in any 180-day period, mandates the Member States to collect the biometric identifiers of visa applicants, including facial images and fingerprints.[19]

In 2019, the last full year before the COVID-19 pandemic, the EU Member States issued more than 15 million Schengen visas, while rejecting around 1.7 million applications.[20] The Commission regularly assesses the list of visa-exempt and visa-required countries, and can propose a review of existing visa exemptions. This has a significant impact on international travellers, as the visa application process can be a lengthy one, and its outcome is not always certain.

Figure 1. The EU's common visa policy as it applies to the rest of the world.
Source: European Commission, DG HOME.
Credit: EC-GISCO, Administrative boundaries ©Eurogeographics ©UN-FAO.

[15] For more information about the EU's common visa policy, please visit **https://home-affairs.ec.europa.eu/policies/schengen-borders-and-visa/visa-policy_en**.
[16] **Regulation (EU) 2019/592** of the European Parliament and of the Council Of 10 April 2019, amending Regulation (EU) 2018/1806 listing the **third countries whose nationals must be in possession of visas** when crossing the external borders and those whose nationals are exempt from that requirement, as regards the withdrawal of the UK from the Union, OJ L 103, 12 April 2019, p. 1.
[17] Based on **World Bank population data** for the year 2021.
[18] **Regulation (EC) No 810/2009** of the European Parliament and of the Council of 13 July 2009 **establishing a Community Code on Visas (Visa Code)**, OJ L 243, 15 September 2009, p. 1.
[19] Article 13 of the **EU Visa Code**.
[20] Statistics on short-stay visas issued by the members of the Schengen Area, European Commission, Directorate-General Migration and Home Affairs (DG HOME). For more information, please visit **https://home-affairs.ec.europa.eu/index_en**.

Back in 2002, the European Council considered the establishment of a common identification system for visa data as a priority measure to combat illegal immigration, and as part of the gradual introduction of coordinated, integrated management of external borders.[21] To facilitate the processing of visa applications, the **Visa Information System (VIS)** was established by Council decision of 8 June 2004. In July 2008, the EU adopted the VIS Regulation,[22] and the system entered into operation in October 2011. VIS is a central system that records data on short-stay visa applications (i.e., alphanumeric data of the applicant and visa requested, facial image and fingerprint data, and if applicable, links to other applications) to facilitate the exchange of data on visa applications and decisions between Schengen countries, including consulates in non-EU countries. VIS is also used at the EU's external border crossing points to verify the visa holder's identity, and the validity of the visa.

Border checks on persons

Upon the establishment of the Schengen Area in June 1985, the Member States agreed to take complementary measures at its external borders '*to safeguard internal security and prevent illegal immigration*' by third-country nationals (TCN).[23] Subsequently, the Member States agreed on a common definition of border checks on persons, initially subjecting citizens of Schengen countries to minimal checks, while applying more rigorous checks on third-country nationals. With the gradual digitalisation of border management, border checks started to include automated checks of other information systems and databases in the JHA domain.

The first of those systems was the **Schengen Information System (SIS)**,[24] allowing national law enforcement and border control authorities to conduct automated searches, as well as share and consult alerts on persons that may be wanted for arrest or are declared missing, among other categories. The first version of SIS entered into operation in 1995, with additional functionalities introduced in 2013, including the possibility of adding fingerprints and photographs to alerts. In March 2018, SIS was further upgraded with the addition of the Automated Fingerprint Identification System (AFIS), enabling the identification of people based only on fingerprints. Following the entry into operation of VIS in 2011, SIS is used at the EU's external borders for identification of visa holders, based on fingerprint data, in conjunction with checks of visa validity in VIS.

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[21] European Council, **Presidency Conclusions**, 21 and 22 June 2002, Seville, Spain.

[22] **Regulation (EC) No 767/2008** of the European Parliament and of the Council of 9 July 2008 concerning the **Visa Information System (VIS)** and the exchange of data between Member States on short-stay visas (VIS Regulation), OJ L 218 13.8.2008, p. 60.

[23] **Schengen Agreement**, signed on 14 June 1985, by Belgium, Germany, France, Luxembourg and the Netherlands. The countries agreed to gradually remove controls at their internal borders and to introduce freedom of movement for all nationals of the signatory countries, other EU Member States and some non-EU countries.

[24] The legal framework for the development of SIS was provided by the **Convention implementing the Schengen Agreement** of 14 June 1985 between the Governments of the States of the Benelux Economic Union, the Federal Republic of Germany and the French Republic on the gradual abolition of checks at their common borders, originally signed on signed on 19 June 1990, OJ L 239, 22.9.2000, p. 19–62. For more about SIS, please visit **What is SIS and how does it work?**

Integrated border management

From 2014 to 2016, the EU faced an unprecedented migration crisis due to the large number of people fleeing the war in Syria and other crisis areas, resulting in an increase of irregular crossings at the EU's external borders. During the same period, several devastating terror attacks were committed in the territory of the European Union. These events led to several important changes affecting the checks on persons at the external borders of the Schengen area.

The extension of systematic checks to all persons entering and exiting the Schengen Area affected travellers in terms of increased waiting times at the border crossing points, although they **appeared to be proportional to the benefit for internal security**.

In 2015, against the backdrop of terror attacks in Europe, the presence of thousands of EU citizens in Syria and Iraq (with the aim of supporting terrorist groups) was identified as a major security threat. This led the Commission to propose **amending the existing Schengen Borders Code** in order to introduce systematic checks on all travellers at the external borders of the Schengen Area, including for EU citizens. This proposal led to the modification of the Schengen Borders Code in March 2017.[25] This change had a significant effect on the traveller experience by increasing the number of people subject to additional checks at EU borders. In May 2022, the Commission concluded that the extension of systematic checks on all persons entering and exiting the Schengen Area affected travellers mainly in terms of increased waiting times at the border crossing points, although they appeared to be proportional to the benefit for internal security.[26]

In April 2016, the European Commission published a communication on 'Stronger and smarter information systems for borders and security',[27] outlining the need to '*strengthen the EU's border management, migration and security cooperation frameworks and information tools in a comprehensive manner*'. This included the importance of improving existing JHA information systems, which led to the revision of both SIS and VIS. Additionally, the Commission proposed the development of several new systems to complement the existing ones, such as the **Entry/Exit System** (**EES**), the **European Travel Information and Authorisation System (ETIAS**), with a view to achieving **interoperability between all JHA information systems**, in particular by developing a single search interface (i.e. European search portal, ESP) to facilitate the work of border guards by enabling searches across all JHA systems and databases.

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[25] **Regulation (EU) 2017/458** of the European Parliament and of the Council of 15 March 2017 amending Regulation (EU) 2016/399 as regards the reinforcement of checks against relevant databases at external borders, OJ L 74, 18.3.2017, p. 1–7.

[26] European Commission (2022) **Report from the Commission to the European Parliament as regards the reinforcement of checks against relevant databases at external borders introduced with Regulation (EU) 2017/458 amending Regulation (EU) 2016/399**, COM(2022) 302 final.

[27] Communication from the Commission to the European Parliament and the Council '**Stronger and Smarter Information Systems for Borders and Security**', COM(2016) 205 final.

The first of the new JHA information systems, the **Entry/Exit System (EES)**[28], is scheduled to enter into operation in 2023. EES will replace the physical checking and stamping of passports at Schengen Area border crossing points with the electronic recording of the date, time and place of entry (or refusal thereof) and exit of all third-country nationals travelling to or from the EU. In addition, EES will calculate the duration of authorised stay, and generate alerts upon the expiry of authorised stay in the Schengen Area.

The second of the new JHA information systems, the **European Travel Information and Authorisation System (ETIAS)**[29] will be mandatory for visa-exempt third-country nationals. As of 2023, they will have to request pre-authorisation before entering the Schengen Area. ETIAS will allow the Member States to verify whether the presence of the third-country national in question poses a security, illegal immigration or high epidemic risk. For a more detailed overview, please refer to section 2.4 on ETIAS.

Finally, to ensure interoperability between all JHA information systems – SIS, VIS, EES, and ETIAS – the EU adopted two separate **Interoperability Regulations** in May 2019. The first establishes a framework for interoperability between EU information systems in the field of **borders and visa**,[30] and the other for systems interoperability in the field of **police and judicial cooperation, asylum and migration** [31] .[32]

Pursuant to these regulations the JHA interoperability framework will comprise the following components:

European search portal (ESP), acting as a single search window enabling simultaneous query of all JHA information systems and seamless retrieval of necessary information,

Common identity repository (CIR), the shared storage for biographical and biometric data on third-country nationals (TCN) collected from VIS, EES and ETIAS,

Multiple-identity detector (MID) for checking whether the queried identity data exists in more than one system, enabling the detection of multiple identities linked to the same biometric data,

Shared biometric matching service (sBMS) that will enable the querying and comparison of biometric data from multiple JHA systems.

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[28] **Regulation (EU) 2017/2226** of the European Parliament and of the Council of 30 November 2017 **establishing an Entry/Exit System (EES)** to register entry and exit data and refusal of entry data of third-country nationals crossing the external borders of the Member States and determining the conditions for access to the EES for law enforcement purposes, and amending the Convention implementing the Schengen Agreement and Regulations (EC) No 767/2008 and (EU) No 1077/2011, OJ L 327 9.12.2017, p. 20.

[29] **Regulation (EU) 2018/1240** of the European Parliament and of the Council of 12 September 2018 **establishing a European Travel Information and Authorisation System (ETIAS)** and amending Regulations (EU) No 1077/2011, (EU) No 515/2014, (EU) 2016/399, (EU) 2016/1624 and (EU) 2017/2226, OJ L 236 19.9.2018, p. 1.

[30] **Regulation (EU) 2019/817** of the European Parliament and of the Council of 20 May 2019 on **establishing a framework for interoperability between EU information systems in the field of borders and visa** and amending Regulations (EC) No 767/2008, (EU) 2016/399, (EU) 2017/2226, (EU) 2018/1240, (EU) 2018/1726 and (EU) 2018/1861 of the European Parliament and of the Council and Council Decisions 2004/512/EC and 2008/633/JHA, OJ L 135 22.5.2019, p. 27.

[31] **Regulation (EU) 2019/818** of the European Parliament and of the Council of 20 May 2019 on **establishing a framework for interoperability between EU information systems in the field of police and judicial cooperation, asylum and migration** and amending Regulations (EU) 2018/1726, (EU) 2018/1862 and (EU) 2019/816, OJ L 135 22.5.2019, p. 85.

[32] These two Interoperability Regulations also cover the European system for the comparison of fingerprints of asylum applications (Eurodac), and the European Criminal Records Information System – Third-country Nationals (ECRIS-TCN), but they do not fall in the scope of this report.

As a separate component, the **central repository for reporting and statistics (CRRS)** will provide cross-system statistical data and analytical reporting on all systems for policy, operational and data quality purposes. For an overview of the JHA systems interoperability architecture, see Figure 2 below.

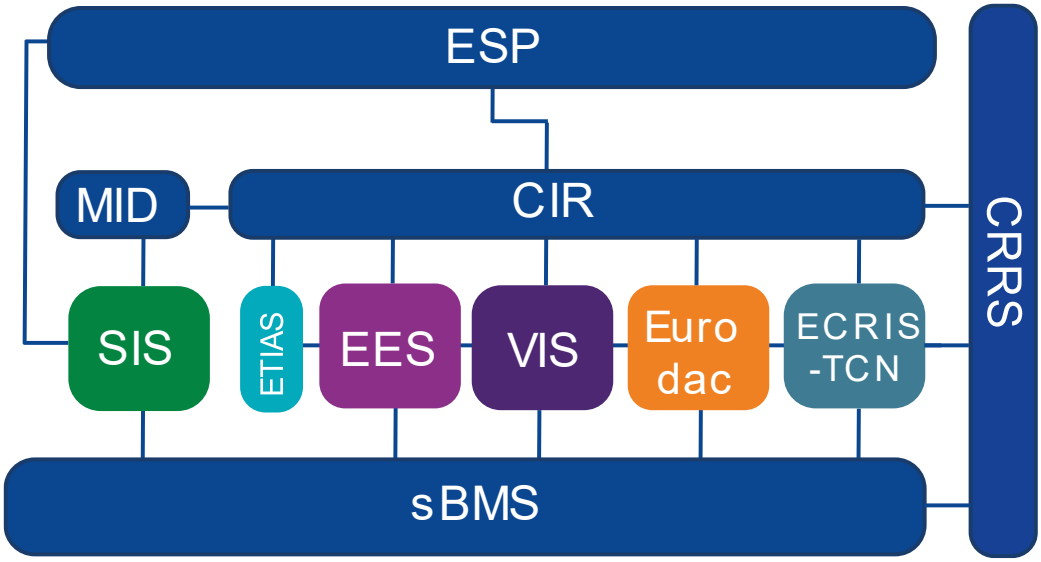

Figure 2. The JHA systems interoperability architecture.

During the past decades, the EU's legal and technical framework in the area of visa and border management has evolved considerably, introducing additional steps and checks for all categories of travellers, including biometrics enrolment and the advance registration requirement for some of them. This has resulted in increased waiting times at border crossing points, which is not conducive for facilitating seamless travel. However, the EU's objective of achieving overarching systems interoperability in the JHA domain has led to the revision of existing legal frameworks to provide the necessary technical architecture to mitigate the possible negative effects of new border control measures. This next stage of evolution will be fully achieved with the entry into operation of EES, ETIAS and all JHA interoperability components.

1.2. The travel continuum

The travel continuum can be understood as encompassing all steps that a traveller must follow to complete their journey, from the decision to travel abroad to their arrival at the destination. In the case of international travel, it also includes the specific requirements for travel authorisation and crossing of international borders.

In a report introducing the *Known Traveller Digital Identity* concept, the World Economic Forum presented an overview of the various steps comprising the traveller journey.[33] Although the report focused on air travel, it can be extended to other modes of transport as well. Among other things, the report identified the following 'pain points':

- visa application and screening,
- booking,
- security screening,
- departure gate and exit control,
- arrival,
- border security.

In 2020, the OECD published a report outlining four areas that need to be taken into account when discussing safe and seamless travel.[34] As presented in Figure 3, the report highlighted the high importance – exceeding 80% – of **visa requirements and acquisition**, as well as **digital traveller identity**.[35]

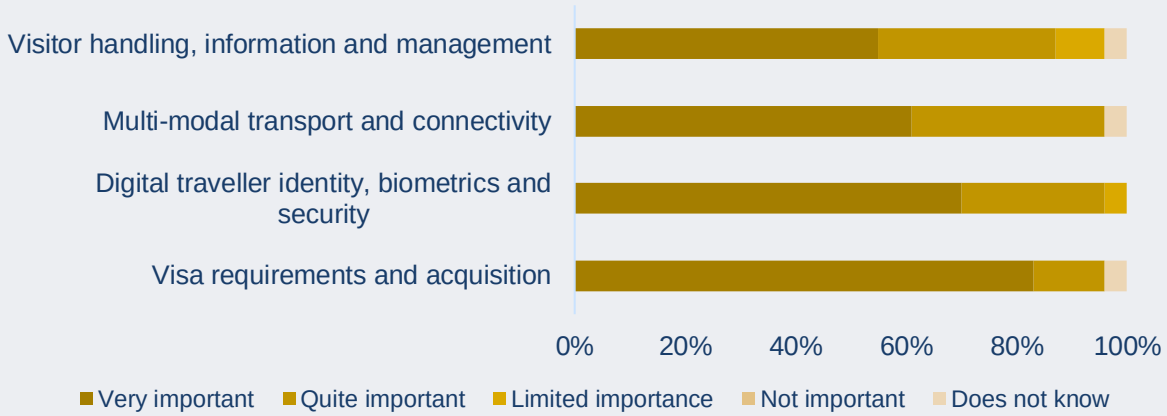

Figure 3. Areas affecting seamless travel

There is a clear correspondence between the most important points in the traveller journey and the EU's large-scale JHA information systems developed and operated by eu-LISA.

[33] World Economic Forum (2018) **The Known Traveller. Unlocking the potential of digital identity for secure and seamless travel**, January 2018.
[34] OECD (2020) **Safe and seamless travel and improved traveller experience**, OECD Report to G20 Tourism Working Group, OECD Tourism Papers.
[35] According to the report, a '*survey of G20 countries sought a comparative reaction to these topics, by asking countries to indicate the relative importance they would place on the (above) areas for action in improving seamless travel to destinations in your country*'.

Figure 4 outlines the traveller continuum from the perspective of third-country nationals planning a short-stay visit to the Schengen Area. This setup will apply following the entry into operation of EES and ETIAS in 2023, while also taking into account other relevant initiatives known at the time of writing this report.

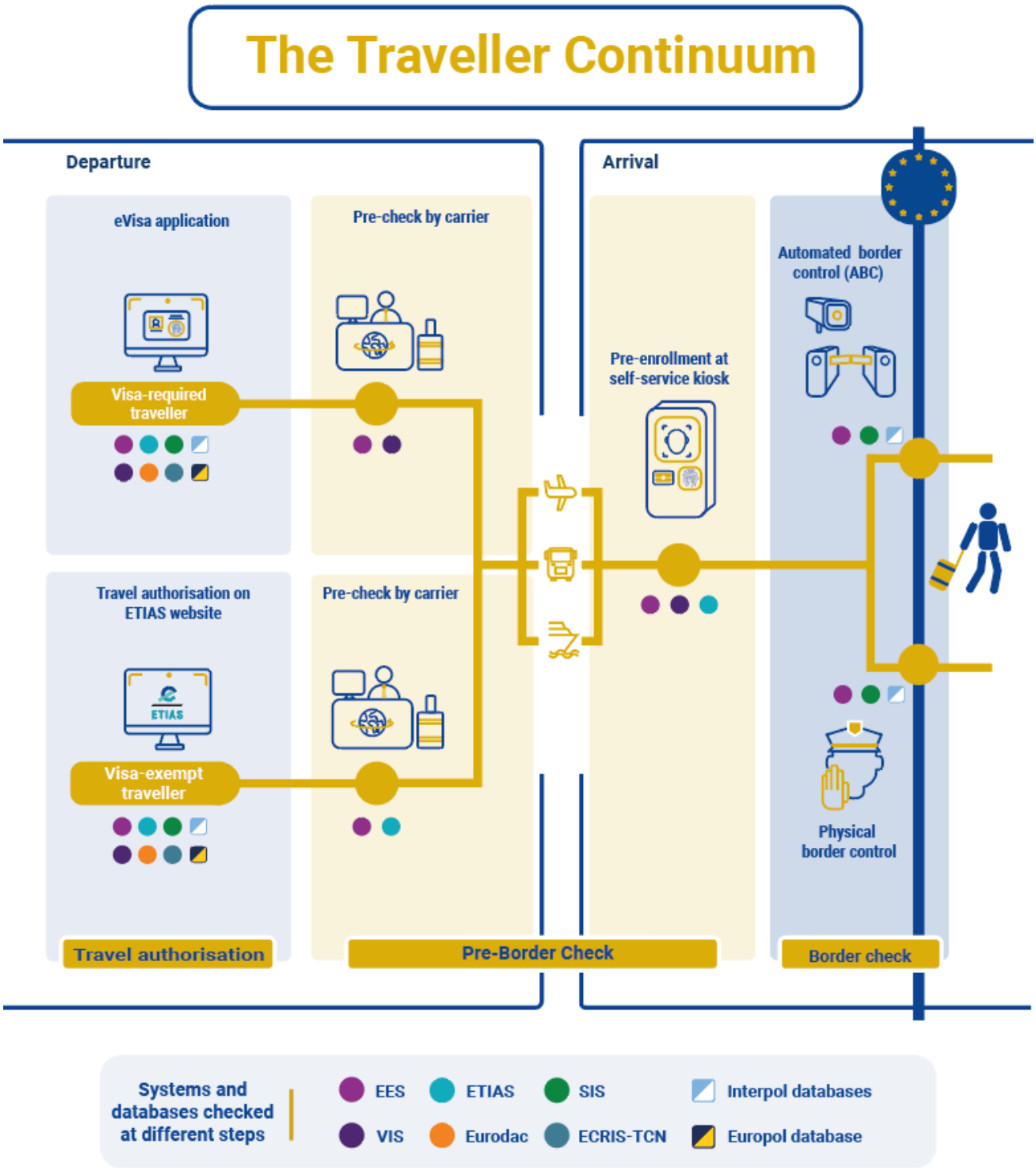

Figure 4. Illustration of the travel continuum from the traveller's perspective once the systems and initiatives presented in this report become fully operational. Please note that the illustration does not apply to third-country nationals who are holders of residence permits, long-stay visas, and other exceptions detailed in Article 2 of Regulation (EU) 2017/2226 establishing the Entry/Exit System (EES).

2. Travel authorisation

To enter the Schengen Area, third-country nationals must be in possession of a valid travel authorisation (i.e., visa) for the entire duration of their stay. Those third-country nationals who are exempt from the obligation to apply for a Schengen visa, must obtain pre-authorisation via the **European Travel Information and Authorisation System (ETIAS)**, starting from November 2023 when it will enter into operation.

When planning to travel abroad, acquiring travel authorisation is one of the first steps in that process. The convenience and user-friendliness of the application process is one of the determining factors behind the decision to travel abroad. Prospective travellers experiencing or perceiving difficulties in the travel authorisation process may decide to abandon or change their travel plans, and opt for another destination instead.

In 2018, the European Tourism Association conducted a survey among Indian nationals considered in to analyse the Schengen tourist visa process. The results indicated that 55 % of people who considered travelling to the Schengen Area did not complete their visa application, with 30 % abandoning the idea even before applying, and 25 % giving up during the application process. The survey highlighted the costs and perceived practical difficulties as the main reasons for people deciding against travelling to Europe, and estimated the annual losses to the European tourism industry at USD 1 billion.[36]

These negative impacts can be mitigated by visa liberalisation.[37] However, the travel authorisation process can also be significantly improved by technology, and the EU is already transforming this process by way of digitalisation. As of November 2023, visa-exempt travellers must apply for travel authorisation through ETIAS. For visa-required travellers, the planned digitalisation of the visa process is expected to ensure a more seamless travel experience as well.

2.1. Digitalisation of the Schengen visa procedure

Travel and tourism are important sectors of the European economy,[38] directly contributing 3.9 % of the EU's GDP and employing 11.9 million people in 2018.[39] From 2009 to 2018, the number of applications for Schengen visas increased from 10.2 million to over 16 million.

For many third-county nationals, the visa application is the first step in their travelling journey to the EU. Compared to other countries, the Schengen visa application procedure is quite complex and cumbersome.[40] For example, Australia, New Zealand, the UK, and India offer digital visas for short-term visits or stays.[41]

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[36] European Tourism Association (2018) **Visas cost European tourism industry $1 billion**, 10 October, 2018.
[37] European Migration Network (2019) **Impact of Visa Liberalisation on Countries of Destination**.
[38] European Commission (2020) **New EU visa rules – Questions and Answers**, 31 January 2020.
[39] European Parliament (2022) **Fact Sheets on the European Union – Tourism**, March 2022.
[40] **Proposal for a Regulation** of the European Parliament and of the Council amending Regulations (EC) No 767/2008, (EC) No 810/2009 and (EU) 2017/2226, Council Regulations (EC) No 1683/95, (EC) No 333/2002, (EC) No 693/2003 and (EC) No 694/2003 and Convention implementing the Schengen Agreement, as regards the **digitalisation of the visa procedure**, COM(2022)658 final, 27 April 2022.
[41] **Impact Assessment Report** Accompanying the document Proposal for a Regulation of the European Parliament and of the Council as regards the digitalisation of the visa procedure, SWD(2022)658 final, 27 April 2022.

Due to the complexity of the application process and the increasing number of applications, many EU Member States outsource some of the visa services to external service providers, e.g., processing of visa applications, including biometric data capture. Currently, around 90 % of short-stay visa applications are submitted through third-party external service providers, incurring additional costs to the Member States and visa applicants.

The digitalisation of visa processing will **reinforce internal security** of the Schengen area, while also ensuring a **more seamless traveller journey**.

By **digitalising the visa application process**, the EU will be able to offer all stakeholders a more seamless traveller journey, while also strengthening the internal security of the Schengen Area in the process.[42] Although some Schengen countries have already set up national portals to digitalise the visa process, some important elements remain paper-based (e.g., affixing the visa stickers to the travel document), creating '*pain points*' for all main stakeholders, such as requirement to pick up documents from consulates in person. This also means that relevant authorities must procure, transport and store visa stickers that must be filled in and affixed. Moreover, the use of stickers also carries a considerable security risk, as they can be stolen and used for making counterfeit visas.

To address these issues and to ease burden on international travellers, the EU is planning to **fully digitalise the Schengen visa procedure by 2025** as announced by the Commission with the EU's New Pact on Migration and Asylum.[43] This digitalisation will address the remaining two paper-based elements: the **visa application process** and the **visa sticker**. In April 2022, the Commission issued a proposal addressing the digitalisation of the visa procedure, in particular introducing an online platform for EU visa applications, and the replacement of the visa sticker by a digital visa.

2.2. EU online visa application platform

Visa application portal

In its legislative proposal, the EU Commission outlined how an online visa application platform would support the Visa Information System (VIS). The proposed visa application platform would collect all information required from applicants, and ensure that all requisite procedural steps are completed.

The Commission's visa digitalisation proposal is supported by a study on the feasibility and implications of alternatives for digitalising the visa procedure.[44] The study recommended to run a **pilot project for the proposed visa application platform** to test and demonstrate its feasibility. This pilot was successfully carried out by eu-LISA, the Commission, and select Schengen Countries between October 2020 and January 2022.

[42] European Commission (2019) **Study on the feasibility and implications of options to digitalise visa processing. Final Report**, Directorate-General for Migration and Home Affairs, September 2019.
[43] **Communication from the Commission on a New Pact on Migration and Asylum**, COM(2020)609 final, 23 September 2020.
[44] European Commission (2019) **Study on the feasibility and implications of options to digitalise visa processing. Final Report**, Directorate-General for Migration and Home Affairs, September 2019.

The project partners designed, developed and tested a user-friendly, secure and interactive online visa application platform prototype. The project demonstrated that a single online application platform could provide a harmonised, digital and seamless visa procedure for people interested in applying for a Schengen visa.

During all phases of the pilot project, the traveller's user-experience remained the focal point of the requirements. The project applied a specific design thinking methodology, the Experience Design Framework, to map the user journeys for the visa application process. The initial design phase identified and analysed the pain points for different categories of travellers to be used as input for the platform mock-ups. The validation of the mock-ups was then done through testing in assisted and unassisted scenarios. Based on the results, the project developed a digital application prototype, including such functionalities as appointment booking, payment of visa fee, as well as application management for consular and national authorities. In June 2021, the prototype underwent a month of rigorous testing by three Member States (Finland, France and Greece) at their consulates in China (Beijing and Shanghai) and Belarus (Minsk). Three user profiles were tested: applicant, central authority/consulate, and external service provider. At the end of the test period, all stakeholders demonstrated a high acceptance rate of the prototype, with the visa applicant interface considered as particularly user-friendly.

The online visa application portal will provide the maximum digitalisation of the application process as one of the major advantages for travellers. The person will have to visit a consulate, or an external service provider facility only for the initial enrolment of biometrics (i.e., facial image and fingerprints). In case they have already submitted their biometrics in the preceding five years, the system would use existing data, rendering the visa application process fully digital.

Overall, the project highlighted multiple benefits arising from the digitalisation of the visa process, while also providing valuable recommendations for its future development. In the context of seamless travel, the project proposed setting up a single landing page for all third-country nationals travelling to the EU, and covering all requirements related to the Schengen visa, as well as EES, and ETIAS. The Member States welcomed these findings and recommendations, which also highlighted numerous benefits for consular services, including cost savings.

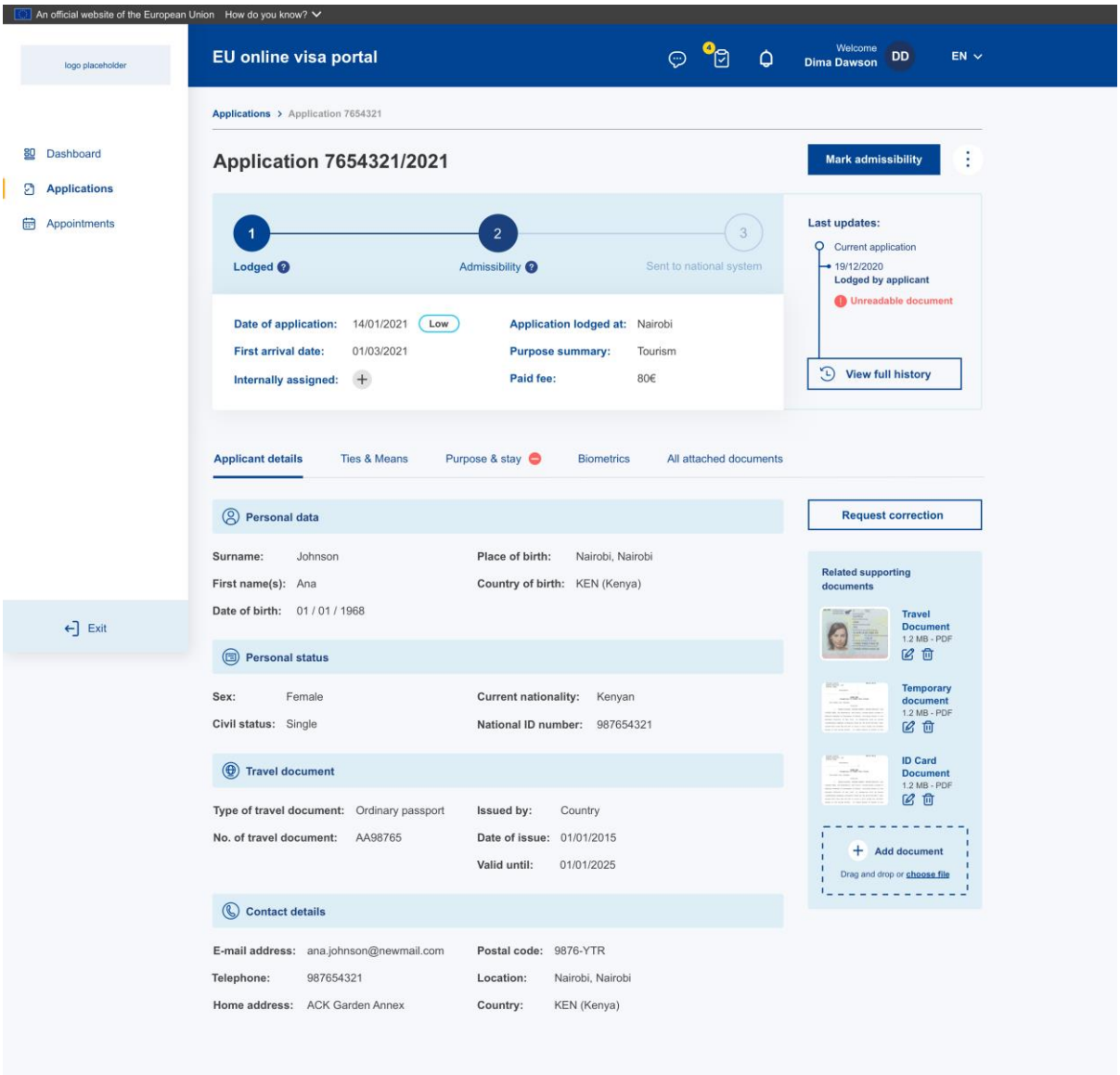

Figure 5. Illustration of one of the functions of the eVisa prototype.

Visa application chatbot

Processing visa applications is time-consuming and costly for Member State consular services and for central administrations. One of the most critical elements in this process is responding to requests from third-country nationals regarding their visa application. According to some estimates, national authorities receive questions for around 10 % of the applications. In 2019, when Schengen countries received close to 17 million visa applications, consular authorities had to process close to two million queries. However, a significant share (ca. 10-20 %) of these queries are generic and can be covered by an automated system – a chatbot for replying to applicant queries.

The **VisaChat pilot project** was launched by the European Commission in collaboration with Member State authorities and eu-LISA, and ran from the summer of 2021 until the spring of 2022. To demonstrate the added value potential of a visa application chatbot, the project aimed to design and demonstrate a chatbot application capable of answering questions related to Schengen visa procedures in compliance with the EU Visa Code.

The ultimate objective of the chatbot project was to alleviate the workload of consular officers by significantly reducing the number of information queries received either by telephone or email, and potentially also shorten the processing time of visa applications. These objectives can be achieved if the chatbot is able to provide high-quality information in response to queries, and is significantly faster and easier to use than referring to frequently asked questions (FAQs), e-mail or making a phone call.

The scope of the chatbot project was initially focused on responding to generic questions (FAQs) in a limited number of languages, specifically English and French, using a **supervised approach**. At the proof-of-concept stage, other languages were included using an **unsupervised approach** and machine translation capabilities. In the future, users will be able to interact with the chatbot using both text and speech in all EU languages. In addition, machine translation capabilities will enable the chatbot to provide support also in languages of third-country nationals. The chatbot is also expected to have built-in learning capabilities relying on machine learning approaches to allow the utilisation of user feedback and interactions for continuous improvement.

The **supervised approach** involves the creation of a data set of standard replies in every language that is used by the chatbot. Depending on the language selected by the user, the system consults the database for responses in a specific language to provide an answer. A fully supervised approach is only feasible with a small set of languages, and requires continuous maintenance of data sets in all languages.

The **unsupervised approach** requires a data set in only one language, and answers in all other languages are generated by utilising machine translation capabilities (e.g., eTranslation service maintained by the European Commission). The system relies on one core language (e.g., English), while requests and responses are translated to and from the core language, respectively. The quality of responses depends on the quality of the machine translation tool with a specific language pair, i.e., the quality of responses in less commonly used languages will likely be lower.

The chatbot was developed as a **modular solution using open-source technologies** to ensure that it would be open to various vendors and technologies, and could be deployed on a cloud or on-premises infrastructure, allowing both decentralised (via Member States portals) and centralised (via the future e-Visa portal) implementation. Particular consideration was given to personal data protection; however, as the scope of the chatbot was initially limited to generic questions, as a precaution, the chatbot explicitly asked applicants not to divulge any personal data.

The development of a **fully functioning chatbot** is one of the steps towards the full digitalisation of the Schengen visa application procedure. In line with the overall plans of the European Commission on visa digitalisation, a visa chatbot will be developed as a fully functional application for the EU's online visa application platform. As the EU agency responsible for JHA information systems (including VIS), eu-LISA is considered to oversee the development of the platform together with the chatbot application. Given the generic nature of the chatbot technology, there is potential to expand the scope of the chatbot to other JHA information systems, such as EES and ETIAS.

2.3. Digital visa

As part of the initiative to fully digitalise the Schengen visa procedure, the Commission has also proposed to abandon the **visa sticker** by 2025. Current regulations require a visa sticker to be affixed to the physical travel document. First introduced in 1995, the Schengen visa sticker has been revised several times; however, serious risks remain, in particular counterfeiting. What is more, production and management costs related to visa stickers remain high for the Member States and the consular services.

Now that visa information is already registered in VIS, the Commission has decided that foregoing the use of visa stickers would actually improve the internal security of the Schengen area, while also considerably reducing the administrative burden on Member State central administrations and consular services.

For the traveller, this would mean that they would not have to surrender their passport during the visa application process, which is an important gain in terms of convenience, and often in cost savings as well. According to the Commission's estimates, the fully digitalised application process would save the applicants 31 euros out of a total of 74 euros spent per application on average.

2.4. European Travel Information and Authorisation System (ETIAS)

Scheduled to enter into operation by November 2023, ETIAS is a pre-travel online authorisation system for visa-exempt third-country nationals travelling to the Schengen area. The system comparable to similar systems implemented in the USA (ESTA[45]), Canada (eTA[46]), and Australia (ETA[47]).

Pursuant to the ETIAS Regulation, '*the system would* ***determine the eligibility of visa-exempt third-country nationals prior to their travel to the Schengen Area****, and whether such travel poses a security, illegal immigration or high epidemic risk'*. [48] Thus, ETIAS has been designed for checking the information on travellers, via an online application, before they start travelling to the EU. ETIAS is expected to bring additional security benefits to the EU Member States, in particular in the context of land border crossings, where no other systems exist for the sharing of information prior to the crossing of the EU's external border, as opposed to analogous systems in the context of air and sea travel, i.e., the Advance Passenger Information (API) or Passenger Name Records (PNR).

The overarching systems interoperability between ETIAS and the EU's other JHA information systems, as well as Europol and Interpol data, will enable automated checks of SIS, VIS, Eurodac,[49] EES, ECRIS-TCN,[50] as well as Europol data and Interpol databases on Stolen and Lost Documents (SLTD) and Travel Documents Associated with Notices (TDAWN).

As a result, relevant authorities will be able to verify automatically, among other things:

- whether the travel document is reported lost or stolen,
- whether the visa applicant is subject to a refusal of entry in SIS,
- whether the applicant is recorded as an overstayer in EES.

Although ETIAS will introduce an additional requirement for visa-exempt travellers, it has been developed with the goal of travel facilitation, and therefore, it will serve as an important component of the EU's vision of seamless travel. In particular, the ETIAS application process was required to be simple, affordable, fast and without additional steps for the vast majority of cases.[51] Also, contrary to a visa application, no biometric enrolment will be needed when applying for ETIAS authorisation. Furthermore, ETIAS will also reduce the risk of third-country nationals being denied entry once arrived at border crossing points.

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[45] U.S. **Electronic System for Travel Authorization**
[46] Canada's **Electronic Travel Authorization**
[47] Australia's **Electronic Travel Authority**
[48] **Regulation (EU) 2018/1240** of the European Parliament and of the Council of 12 September 2018 **establishing a European Travel Information and Authorisation System (ETIAS)** and amending Regulations (EU) No 1077/2011, (EU) No 515/2014, (EU) 2016/399, (EU) 2016/1624 and (EU) 2017/2226, OJ L 236 19.9.2018, p. 1.
[49] **Eurodac (European Asylum Dactyloscopy Database)** is a large-scale IT system to facilitate the management of asylum applications by storing and processing the digitalised fingerprints of asylum seekers and irregular migrants who have entered the Schengen Area.
[50] **European Criminal Records Information System for Third-country Nationals (ECRIS-TCN),** once operational, will be a centralised system that allows EU authorities to check whether TCNs or stateless persons have criminal records in other Member States.
[51] **Proposal for a Regulation** of the European Parliament and of the Council **establishing a European Travel Information and Authorisation System (ETIAS)** and amending Regulations (EU) No 515/2014, (EU) 2016/399, (EU) 2016/794 and (EU) 2016/1624, COM(2016) 731 final, 16 November 2016.

Through the dedicated ETIAS website or mobile application, travellers will be able submit and pay for their application online well ahead of departure. The dedicated website and the mobile application will be available in all the official languages of the EU and developed with the aim of providing easy access and convenience to end-users. In addition, information will also be available in the official languages of those visa-exempt third countries whose nationals have to register through ETIAS. What is more, ETIAS will notify the users of the approaching expiry of their travel authorisation, reminding them to submit a new application in due time.

3. Pre-border checks

In general, the current approach to border management is to encourage the submission of passenger information well ahead of departure to **facilitate pre-arrival background checks**. To ensure an efficient process, this approach prioritises passenger assessment and identity verification as early as possible, before they even reach the border crossing point.[52]

To implement this approach, the carriers are responsible for ensuring that passengers arriving at points of entry are in possession of the requisite travel documents for entering the Schengen Area. In Europe, this obligation exists since the Schengen Convention of 1990,[53] which has been complemented by subsequent regulations over the years.[54] In case a passenger is denied entry at the external border of the Schengen Area, the carriers are responsible for transporting them back to the country of departure.

The imposition of this obligation on carriers is not unique to the European Union, several other countries have been developing their own systems for pre-border checks or travel authorisation checks in the country of departure. For example, airlines flying to and from Australia must share advance information on passengers and crews using the Advance Passenger Processing (APP) system.[55] Similar pre-border checks are essential functionalities of EES and ETIAS, and both systems have a technical communication channel designed to be interfaced with the IT infrastructure international carriers, with the additional possibility of access via a dedicated webpage or a mobile application.

The **concept of pre-border checks**, or pre-departure checks, is relatively well-established in the context of air travel, where it is common for travellers to present their travel documents to the carriers first at check-in and then again before boarding the aircraft. However, it is not as common in the context of sea travel and crossing land borders. This is particularly true for land border crossing points, as travellers often arrive at the border without prior notification, significantly limiting the opportunity for conducting a proper pre-border check.

The **Schengen Borders Code**, amended by EES Regulation, provides for a possibility to *'pre-enrol data in a self-service system*'; however, the data must be verified by a border guard prior to being recorded in EES. In order to anticipate and minimise any possible delays that may result from the introduction of new requirements, the EU has developed and tested a wide range of new processes and equipment (e.g., self-service kiosks for biometric enrolment) to be used at border crossing points.

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[52] eu-LISA (2021) **Contactless Travel in post-COVID Times: Enhancing the EU Security Ecosystem**, eu-LISA Industry Roundtable summary report, June 2021.

[53] **The Schengen acquis – Convention implementing the Schengen Agreement** of 14 June 1985 between the Governments of the States of the Benelux Economic Union, the Federal Republic of Germany and the French Republic on the gradual abolition of checks at their common borders, OJ L 239, 22.9.2000, p. 19–62.

[54] Additional legal bases: **Directive (EU) 2016/681** of the European Parliament and of the Council of 27 April 2016 on the use of **passenger name record (PNR) data** for the prevention, detection, investigation and prosecution of terrorist offences and serious crime, OJ L 119, 4.5.2016, p. 132–149; **Council Directive 2004/82/EC** of 29 April 2004 on the obligation of carriers to **communicate passenger data (API directive)**, OJ L 261, 6.8.2004, p. 24–27; **Council Decision (EU) 2021/121** of 28 January 2021 on the position to be taken on behalf of the European Union in reply to the State Letter sent by the International Civil Aviation Organization (ICAO) as regards Amendment 28 to Section D of Chapter 9 of Annex 9 to the Convention on International Civil Aviation**,** OJ L 37, 3.2.2021, p. 6–9.

[55] Australian Border Force – **Advance Passenger Processing (APP)**.

3.1. International Carrier Interface to the EU's JHA systems

Under the Schengen Convention, international carriers are obligated to check the travel documents of their passengers. To support this process, both EES and ETIAS have been designed to include a single interface for linking up with the IT systems of international carriers, opening the door for seamless international travel by design (EES for holders of single- and double-entry visas, and ETIAS for visa-exempt passengers).

Similarly, the revised VIS, scheduled to enter into operation in 2025, includes a provision enabling international carriers to query VIS for multiple-entry visas, long-stay visas, residence documents and transit visas, facilitating the travel of third-country nationals holding those types of visas or permits.[56]

The entry into operation of **EES, ETIAS and the revised VIS** will support carrier staff in making informed and accurate decisions regarding boarding refusal at the gates, while also reducing uncertainty for travellers. In practice, the interface will allow international carriers to query the relevant EU's JHA information systems – EES, ETIAS and VIS – prior to boarding, at the earliest 48 hours in advance, and receive a straightforward 'OK/NOT OK or N/A' reply from the systems, as illustrated in Figure 6.

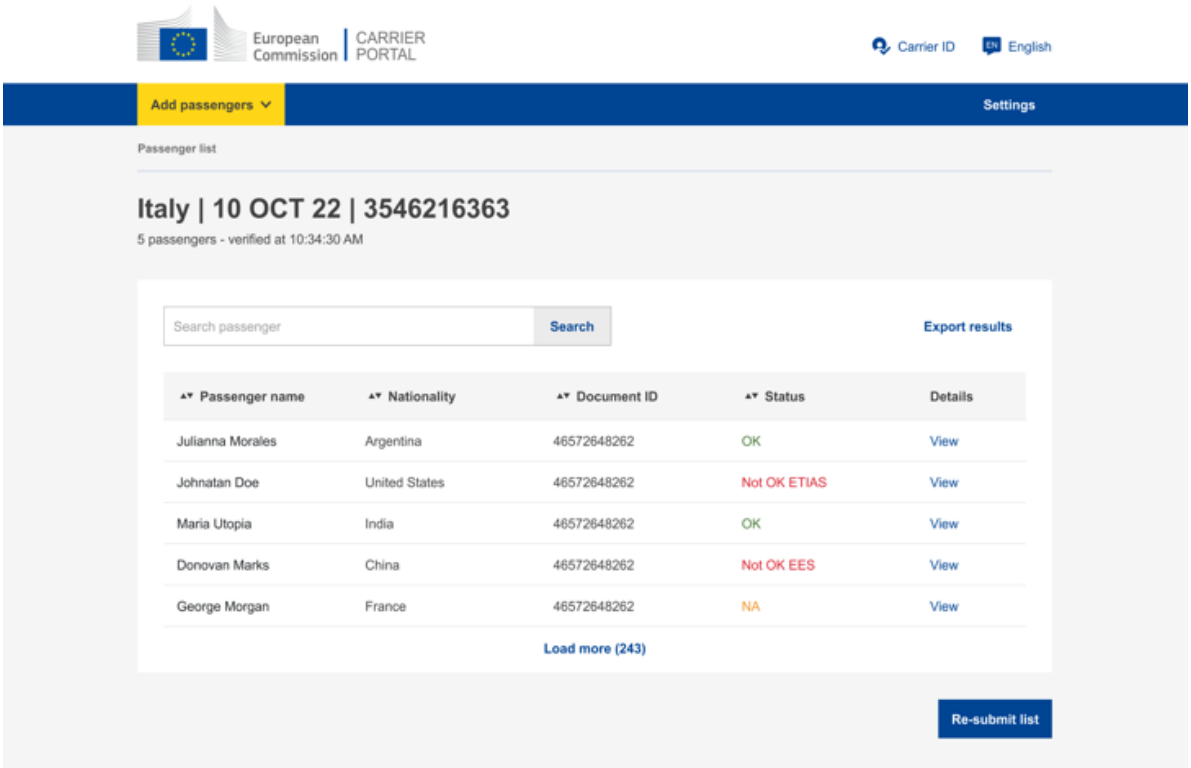


Figure 6. Answers from EES and ETIAS to queries submitted via the Carrier Interface.

[56] **Impact assessment** accompanying the 'Proposal for a Regulation of the European Parliament and of the Council amending Regulation (EC) No 767/2008, Regulation (EC) No 810/2009, Regulation (EU) 2017/2226, Regulation (EU) 2016/399, Regulation XX/2018 [Interoperability Regulation], and Decision 2004/512/EC and repealing Council Decision 2008/633/JHA, Commission Staff Working document, SWD(2018)195 final, 16 May 2018.

Depending on the category of travellers – visa-exempt or visa-required, queries made to the following JHA systems via the carrier interface will confirm:

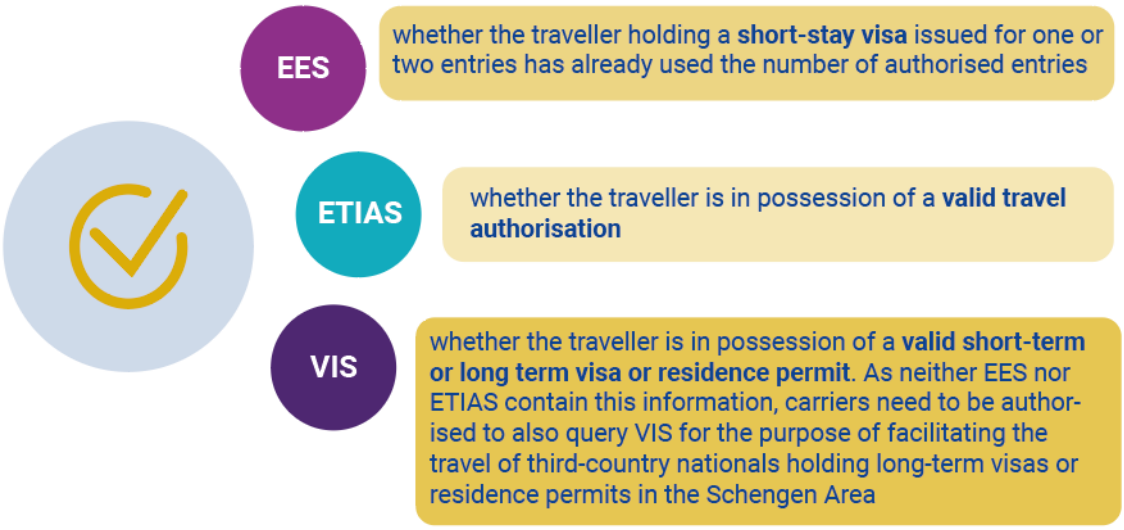


Figure 7. JHA systems checked by the carrier interface for third-country nationals after full implementation of EES, ETIAS, and revised VIS.

Technically, this is implemented through the development of a '**carrier interface**' as described in the EES and ETIAS regulations. This carrier interface constitutes an essential element for operating both EES and ETIAS, and also the revised VIS, once operational. Ultimately, the carrier interface will allow carriers to connect to the three JHA systems – EES, ETIAS and VIS – via a secure web service to access a dedicated read-only database, updated on a daily basis via a one-way extraction of the minimum necessary data stored in EES, ETIAS, and later also VIS. The web service will ensure an automated process for this system-to-system connection.

In addition to this system-to-system interface, allowing carriers to query JHA information systems, the carrier interface will also be available via an additional web interface on a public internet website, or through an application for mobile devices.

3.2. Pre-enrolment and self-service systems

The introduction of the Entry/Exit System (EES) is expected to increase queues and waiting times at the border crossing points to the Schengen Area, especially for entries at land and sea borders. This assessment was made in a report, published in March 2019, by the **EES working group on ICT solutions for external borders (sea/land)**.[57] This increase in waiting times is mainly due to the additional tasks related to the enrolment of travellers into EES and the verification of their biometric data. This issue is expected to be particularly critical immediately after the entry into operation of EES, when all eligible TCN travellers will have to be enrolled in EES for the first time. However, the situation is expected to normalise afterwards, once the majority of third-country nationals have been enrolled in the system. Live tests with non-trained participants in the Czech Republic showed that the EES enrolment process in the self-service kiosk took on average 89 seconds per traveller.[58]

The EES working group report also recommended that Member States should consider splitting traveller flows into two groups based on the obligation to undergo biometric enrolment, which is only necessary at first entry. This would allow returning visitors (i.e., those who have already registered in EES previously) to be processed separately.

The report also put forward the idea for the 'pre-registration' by regular travellers who are already registered in the EES and could **pass through the 'fast lane'**, thereby facilitating the overall flow of travellers at the border crossing points. However, the report concluded that this option needed further analysis from legal perspective.

Self-service kiosks at Prague airport. Photo taken from a presentation by the Czech Republic at the eu-LISA Industry Roundtable in October 2022. For more, please refer to footnote No 58.

[57] **Report by the eu-LISA EES Working Group on ICT Solutions for External Borders (sea/land)**, 26 March 2019.
[58] **Presentation on the implementation of EES in the Czech Republic in cooperation with air carriers and airport operators,** delivered at the eu-LISA Industry Roundtable in October 2022

The main added value of this approach is the enrolment and verification of biographic and biometric data in advance, leaving the border guards to only perform the final checks at the border crossing points.

Taking into account the provisions of the Schengen Borders Code regarding **supervision by the border guards** of facial images taken live etc., the EES working group recommended offering the opportunity to pre-enrol alphanumeric and biometric data. Ideally, that should be done in a controlled environment that would provide assurance on the quality of biometric data. A similar approach was also envisaged for ferries and cruise ships. The main added value of this approach is the enrolment and verification of biographic and biometric data in advance, leaving the border guards to only perform the final checks at the border crossing points. Relieving border guards from the requirement to perform these time-consuming tasks of biometric data acquisition, would allow them to focus on other critical tasks, while also significantly improving traveller flows at land borders. In addition, this approach will address sensitive issues related to ethical, cultural and religious aspects.

In order to test solutions for reducing the **duration of the EES enrolment process**, Frontex and the French Ministry of the Interior have launched a joint pilot project at the port of Saint-Malo, on the English Channel coast of France. The project, launched in December 2022 and expected to be finalised in March 2023, will test biometric enrolment with non-EU citizens visiting the Schengen Area for a short stay, with a view to measuring the impact and duration of the self-registration process on overall traveller processing times. Participants are invited to volunteer and answer a standard border control questionnaire via a dedicated website and a mobile application, before or while travelling by ferry from the UK to the Port of Saint-Malo. The project's outcomes and lessons learned will offer valuable insights for the European Commission and the EU Member States in further developing biometric pre-enrolment systems for the Schengen Area.[59] In parallel, several Member States work on a number of additional pilot projects, in order to facilitate border crossings towards the Entry into Operations of the EES.

The EES Regulation specifies also the use of **self-service kiosks for pre-enrolment**, and a similar amendment was also added to the Schengen Border Code. In order to use self-service systems for pre-enrolling biometric data in EES, the third-country national must have a travel document with a chip containing the person's facial image and fingerprints. Thus, the legal framework is ready for this option.

[59] Frontex (2022) **Frontex and France run pilot project to ease travel across borders**; press release, 23 November 2022.

In the past couple of years, European border control agencies, in collaboration with the industry, have run several pilot projects to test and validate the use of self-service systems for EES enrolment. In November 2021, the European Border and Coast Guard Agency (Frontex) concluded an EES pilot project at Schengen land border crossing points in Bulgaria and Spain, simulating the EES environment with self-service kiosks for biometric enrolment (as illustrated in the box below)[60]. Based on the results of these pilot projects, several EES-compliant self-service products have already been introduced to the market and being deployed at border crossing points to the Schengen Area, in anticipation of the entry into operation of EES.

Frontex pilot project: Entry/Exit System at land borders[61]

In preparation for the entry into operation of EES, Frontex implemented a pilot project to test new technologies for EES processes at land border crossing points (BCPs). The project was carried out in 2021 in close cooperation with eu-LISA, the Commission's Joint Research Centre (JRC), the EU Agency for Fundamental Rights (FRA), and **two hosting Member States – Bulgaria and Spain**. The pilot project focused on border control officials testing the EES system, particularly its **biometric enrolment and verification workflows**, using novel technological solutions to facilitate seamless border crossing in three BCPs: one in Spain (BCP La Línea for entry/exit procedures) and two in Bulgaria (BCP Kapitan Andreevo for entry, and BCP Kalotina for exit procedures).

Self-service kiosk and biometric corridor used in the Frontex pilot project for testing EES at the EU's external land border crossing point in La Línea, Spain. Source: Frontex.

[60] Frontex (2021) **Frontex pilot project: Entry/Exit System at land borders**; press release, 5 November 2021.
[61] Frontex (2022) **Results of Research & Innovation Activities Report 2021**.

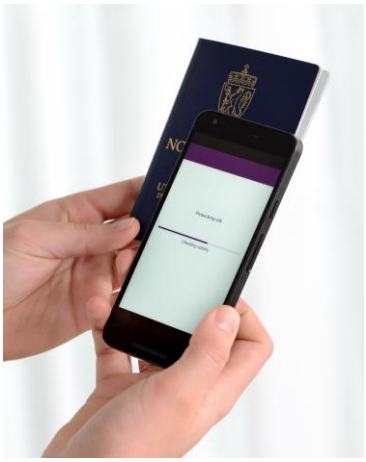
The tested solutions included **four self-service system (SSS) kiosks** and **two biometric corridors** at each crossing. More than 15,000 travellers (mainly pedestrians) participated in the pilot project as volunteers, using self-service kiosks and mobile systems to register their biometric data, which was reconciled in a mock-up EES database integrated with the national border checks systems of the hosting Member States.

Main findings

- The pilot project demonstrated that the **presence of assistants**, who helped manage queues and biometric enrolment at self-service kiosks, was **instrumental for maintaining a smooth traveller flow and overall efficiency of the process**, while also enabling the border guards to focus on the supervision of border check activity at the self-service kiosks and in the biometric corridor. Although requiring more human resources, this setup proved **more efficient** compared to the alternative of processing each traveller individually in manual booths. Over time, with system adaptations and travellers becoming familiarised with the system, it will be possible to reduce the proportion of border guards to travellers.
- Compared to pre-EES processes, in all cases the average time spent on processing was significantly longer, which is understandable considering the requirements for collecting additional data. However, compared to the alternative of queueing to the manual booth, the self-service kiosks contributed to the **reduction of queue pressures** and provided a more dynamic traveller experience.
- The pilot project demonstrated that **clear communication and interaction with travellers** through different means (i.e., signage, information panels, assisting personnel and a dedicated website) are key for ensuring the success of these new border processes.

In current use cases, the EES pre-enrolment is primarily done at border crossing point (BCP) facilities, which is a **controlled environment**, particularly in the case of air travel. However, it is envisaged that in the future, pre-enrolment could be done remotely, well ahead of arrival at the border crossing point, further facilitating the process for travellers.

Taking cue from the technical capabilities offered by commercial **smartphones**, the industry has also developed mobile applications that are able to turn a personal smartphone into a remote passport scanner, facilitating data transfer to a trusted environment. For example, the smartphone camera can be used to scan the machine-readable zone (MRZ) and the visual inspection zone (VIZ) of the passport, and also extract biometric data from the radio-frequency identification (RFID) chip, using the smartphone's near-field communication (NFC) reader.[62] However, this scenario is currently not considered possible for the submission of biometric data to EES because the regulations require that self-service systems must be operated under the supervision of a border guard.



Source: Robin Smits, ReadID, presentation at the eu-LISA Industry Roundtable in June 2022. For more information, please refer to footnote No 63.

[62] Presentation by Robin Smits, ReadID '**Mobile Identity Verification. Technological solutions for self-service systems in the context of EES**', presented at the eu-LISA Industry Roundtable in June 2022.

3.3. Enrolment of biometric data

The enrolment of biometric data is an important element of the pre-border checks, in particular for EES. However, it may also develop into a bottleneck for travellers. As airport facilities are able to ensure a consistently good and **controlled environment** (e.g., light, temperature, etc.) for the acquisition of biometric data, the majority of airports are planning to install self-service systems in the near future. On the other hand, many land border crossing points are expected to face challenges, e.g., with travellers crossing the border by car. For such cases, the EES working group recommends capturing biometric data under controlled conditions,[63] taking advantage of new opportunities for the facilitation and automation of biometric capture that require less human supervision and ensure faster service for travellers.

Mobile devices for biometrics enrolment

The EES working group report on ICT solutions for external borders (sea/land) highlighted **handheld equipment** that can be used on the move by a single border guard as one of the technological solutions to facilitate EES entry into operation[63].

The industry has been developing new solutions to offer more **flexibility and portability** to border control agents to accommodate their needs in a growing number of scenarios. In addition, mobile equipment used at the borders for the enrolment of biometrics must also meet the necessary data quality criteria for the EU's JHA information systems. What is more, the industry has also greatly benefited from the considerable increase of power capacity and battery performance of handheld mobile devices to produce smaller, more autonomous and durable portable biometrics scanners for border guards.

While airports are able to ensure the necessary conditions for biometric data acquisition, **many land border crossing points will face challenges**, for example with travellers crossing the border by car.

As part of the 2021 EES pilot project carried out by Frontex in Spain, a **tablet-based handheld device** was developed as a proof of concept for a portable enrolment and identity verification tool. The technical solution was able to process both first-time enrolment and also verification in EES of returning third-country nationals. The device could also read and verify travel document data (MRZ and chip), perform EES queries, capture live facial images and verify them against the picture stored on the passport chip. The four-month pilot project processed more than 15,000 travellers, achieving a significant reduction of border-crossing times, especially in the case of first-time EES enrolments.

The Dutch Police has also developed a **smartphone application for EES enrolment** of third-country nationals arriving at the port of Rotterdam, whether from cruise ships or ferries (see box below). The future deployment of similar solutions would considerably facilitate the experience of third-country nationals requiring registration in EES.

[63] **Report by the eu-LISA EES Working Group on ICT Solutions for External Borders (sea/land)**, 26 March 2019.

A simple solution for complex border crossing points: Smartphone application for EES enrolment

The port of Rotterdam is the largest cargo port in Europe. In addition to cargo ships, it also welcomes a significant number of cruise ships, while also serving as a busy entry point for ferries connecting continental Europe with the UK. In the aftermath of Brexit and with the launch of EES, Rotterdam's ferry port is set to face a major challenge if they want to ensure the disembarkation of passengers within the KPI of one hour. Currently, the necessary procedures (e.g., checks of documents and biometrics, checks against VIS and SIS) are performed by the police using a set of devices packaged in a portable suitcase – not a particularly convenient solution.

To tackle this challenge, the Dutch police developed a smartphone application for registering border-crossing third-country nationals in EES. This Android-based application can be used with **any standard mobile device** running the latest version of the Android operating system. After a three-month testing period as part of a proof-of-concept project, it is currently being developed into a fully-functioning production version. The proof-of-concept project tested the capture of 204 unique **facial images, using the smartphone's selfie-camera**, and the enrolment of 181 unique sets of **fingerprints, using a portable four-finger scanner** connected to the smartphone. The app is integrated with the user software kit (USK) provided by eu-LISA, enabling the verification of the quality of captured biometrics before they are sent to the system. The project showed that over 99 % of captured biometrics met the EES quality requirements. The application was developed by the internal development team of the Dutch Police and will be made available to other Member State authorities at no cost as an open-source code.

The mobile solution developed by the Dutch Police has the following advantages:

- it is portable and requires only a **standard Android smartphone with a selfie camera** and a **mobile fingerprint scanner** (it might be later extended to iOS devices as well),
- it is less expensive than the proprietary solutions offered by vendors,
- it performs the **complete EES enrolment procedure within ca 60 seconds**, stores data while network connection is not available, and transfers data to the central system when connection is restored. Thus, data collection can be done on a vessel, whereas registration in EES can be completed when the ship reaches port.

Considering the proliferation of advanced smartphones and their ever-increasing capabilities in terms of cameras and biometrics identification, the **use of personal devices for biometrics enrolment** in international travel processes has been extensively investigated and researched. Using personal devices in this process is seen as a convenient option for the travellers, and also as a low-cost solution for the national authorities.

In the context of biometric identification in the process of border-crossing, personal mobile devices generally have the technical capability to perform the enrolment of facial images, but they are not currently able to provide the required quality level for fingerprint images. However, when it comes to security, national authorities tend to consider personal devices as unsecure and untrustworthy for the purpose of biometric enrolment and identity verification. Moreover, biometric enrolment via personal devices would likely happen in unsupervised environments, increasing the risk of face presentation attacks. The protection of privacy and of personally identifiable information is also a key issue in this process, as it is for all biometric applications.[64]

Presentation attack: interaction between the attacker and the biometric data capture subsystem with the goal of interfering with the operation of the biometric system. In this context, the most typical attacks are the use of gummy fingers imitating the fingerprints of a legitimate user or the use of a face mask imitating the face of a legitimate user.

Reference: S. Marcel, M. Nixon, J. Fierrez and N. Evans, “Handbook of biometric anti-spoofing”, Springer, 2019.

Morphing attack: Face morphing is the combination of two or more facial images to create a facial image that will represent the facial characteristics of all individuals contributing to the morphing process. In a morphing attack, the recognition system is subverted by presenting an electronic machine-readable travel document obtained based on a morphed image, allowing the malicious actor to be identified as another person.

Reference: S. Venkatesh, R. Raghavendra, K. Raja and C. Busch, "Face Morphing Attack Generation and Detection: A Comprehensive Survey", in IEEE Transactions on Technology and Society, Vol. 2(3), pp. 128-145, 2021.

In recent years, the number of attacks with masks and video injection has increased. The risks associated with such **remote identity proofing** have been presented in a recent report by the European Union Agency for Cybersecurity (ENISA),[65] identifying and classifying most common types of attacks. According to the ENISA report, the main attacks on remote identity proofing systems today are low-tech with a low-probability of success; however, deepfake attacks are expected to rise in the future. The report also presented a list of countermeasures, such as presentation attack detection (PAD).

[64] B. Schneier (1999) **Inside Risks: The Uses and Abuses of Biometrics**, Communications of the ACM (Association for Computing Machinery), Vol. 48, No.8, 1999.
[65] European Union Agency for Cybersecurity – ENISA (2022) **Remote Identity Proofing - Attacks & Countermeasures**, January 2022.

The research community, national authorities and the industry are already proposing new concepts and solutions using the latest developments in cloud computing, cryptography and verified computing to overcome the limitations and threats to **remote identification with personal mobile devices**.[66]

One example is the identity verification solution – Genuine Presence Assurance – presented by iProov at the eu-LISA Industry Roundtable in June 2022. iProov has developed a technology for identity verification (i.e., enrolment of facial biometrics) using a personal mobile device that protects against a variety of attacks: (1) impersonation attacks (i.e., wrong person), (2) presentation attacks using physical artefacts during enrolment (e.g., masking), and (3) digital injection attacks, using synthetic imagery or morphs. The technology developed by iProov addresses all those attacks by injecting controlled illumination into the stream, which cannot be replicated by the attacker. This information – the reflection of different colour light – is then streamed as video together with the facial image to the iProov server to ensure presence assurance. In unsupervised biometric enrolment environments, the success rate of the iProov solution is 98%[67].

Privacy protection in biometric enrolment

As discussed by Bruce Schneier in his famous 1999 paper[68], one of the main drawbacks of biometric characteristics is that they are not secrets. More importantly, unlike passwords or security tokens (e.g., smartcards), they are characterised by **limited revocability and renewability**, i.e., it is not easy to revoke a biometric characteristic when a subject does not want to be recognised anymore or, to issue a new one, in case it has been compromised (e.g., data breach). In addition, if biometric characteristics are to be misused, they can potentially serve the purpose of identifying individuals across systems, e.g., a facial image sample which was initially acquired for access control purposes to a private building, if breached, could be used to conduct searches of that same individual on social media platforms, or on law enforcement databases.

The problem of privacy protection in **automated border control (ABC) systems** is particularly relevant with regard to biometric data as it can be used to recognise individuals automatically without them being aware of the identification process, e.g., face recognition, biometrics at a distance, etc. As a result, the misuse of such biometric information can have serious consequences for the subjects affected.

The biometric scientific community is actively engaged in the development of specific techniques to protect biometric data, which has led to the creation of a separate field of research within biometrics known as **biometric template protection** (BTP)[69]. As an example of the importance that this area of research is gaining, the International Organization for Standardization (ISO) has developed a specific standard ISO/IEC 30136[70], defining this type of algorithms, and giving specific protocols and metrics for their evaluation. The ISO/IEC 30136 standard promotes the storage of only protected templates.

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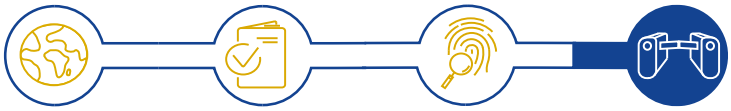
[66] Presentation by Vincent Bouatou (Idemia) '**How to Enhance Biometric Applications to Protect Privacy?**', delivered at the eu-LISA Industry Roundtable in June 2022.
[67] eu-LISA Industry Roundtable report '**Biometric Technologies in Identity Management and Verification**', June 2022, pp. 26-27.
[68] B. Schneier (1999) **Inside Risks: The Uses and Abuses of Biometrics**, Communications of the ACM (Association for Computing Machinery), Vol. 48, No.8, 1999.
[69] M. Gomez-Barrero and J. Galbally '**Reversing the irreversible: a survey on inverse biometrics**', ACM (Association for Computing Machinery) Computers and Security, Vol. 90, 2020.
[70] International Standard ISO/IEC JTC 1/SC 37 – **ISO/IEC 30136:2018 – Information Technology – Performance testing of biometric template protection schemes**, International Organization for Standardization, 2018.

4. Border checks



The pre-border checks and travel authorisation processes described in the preceding chapters are expected to facilitate the checks carried out by border control agents at the actual border crossing points to the Schengen Area. With more secure travel documents and visas, as well as advance information on travellers, most checks will be **carried out before the person reaches the border**.

These new pre-border processes will support border guards deciding to grant entry to individual travellers, thereby **expediting the border-crossing of bona fide travellers**. Furthermore, the overarching interoperability of the EU's JHA information systems will also support this process, enabling a single search window for border management systems to check relevant databases, while also contributing to the correct identification of persons in the different information systems. For example, pursuant to the Revised VIS Regulation[71], achieving systems interoperability between VIS and the other JHA information systems, will also enable automated checks of SIS, Eurodac, EES, ETIAS, and ECRIS-TCN, as well as Europol data and Interpol databases on Stolen and Lost Documents (SLTD) and Travel Documents Associated with Notices (TDAWN).

In addition to these benefits, several **new technological concepts** are being developed to further streamline border checks in support of the seamless travel approach. On the one hand, the travel industry stakeholders have developed novel solutions, such as **digital identity and digital travel credentials (DTC)** to facilitate international travel without the need to show and check physical travel documents. On the other hand, **automated border control** is also continually being improved, especially with the latest developments in the EU's JHA information systems for border management that are developed with a view to using automated border control (ABC) gates or e-gates for visa holders. Ultimately, it is the travellers who will benefit the most by getting to enjoy the freedom of movement throughout the Schengen Area.

In addition to technological solutions, the entry into operation of EES and ETIAS requires the adaptation of certain business processes at the Schengen border crossing points (especially at land and sea BCPs), as indicated in the report of the EES working group on ICT solutions for external borders (sea/land)[72] and the report on the eu-LISA Industry Roundtable held in October 2022[73].

4.1. Digital identity and digital travel credentials

The COVID-19 pandemic has intensified the debate on the digitalisation of identity management for travel, with various industry stakeholders suggesting the implementation of a single digital traveller identity. The World Travel Tourism Council's report on best practices for seamless and safe travel highlights the single digital identity for travellers as a prerequisite for seamless travel.[74]

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[71] **Regulation (EU) 2021/1134** of the European Parliament and of the Council of 7 July 2021 for the purpose of **reforming the Visa Information System**, OJ L 248, 13.7.2021, p. 11–87.
[72] **Report by the eu-LISA EES Working Group on ICT Solutions for External Borders (sea/land)**, 26 March 2019.
[73] eu-LISA (2022) eu-LISA Industry Roundtable '**EES, ETIAS and Carriers getting ready for the entry into operation**', October 2022.
[74] World Travel and Tourism Council (2020) **Global Guidelines for Safe & Seamless Traveller Journey**, December 2020.

Nowadays, the official personal identification documents are still physical, typically made of paper and plastic. The International Civil Aviation Organisation (ICAO), as a specialized agency of the United Nations, has established specifications[75] for two types of documents for international travel:

- **machine-readable travel document (MRTD)** is an official travel document issued by a state or organisation, used by its holder for international travel. The MRTD contains in a standardised format, various identification details of the holder, including a photo (or digital image) with mandatory and optional identity elements;
- **electronic machine-readable travel document (eMRTD)** must additionally contain a contactless integrated circuit chip with an antenna. The chip stores data from the electronic data page and the mandatory biometric data feature of the passport holder.

Recent debates in cross-border travel indicate a shift from physical documents to digital traveller identity concept. Indeed, when visas, travel authorisations, biographic and biometric data are all securely digitalised, and stored either in a database or in a chip, the need for a separate physical document can be questioned.

In recent years, various stakeholders in the international travel domain, from the ICAO to the travel industry, have introduced initiatives and ideas on how to practically implement the shift to using digital identity in international travel. Although the proposed solutions are wide-ranging, they all share the common purpose of facilitating a more seamless travelling experience. In 2021, the European Commission put forward an initiative for the digitalisation of travel documents,[76] and is expected to publish a proposal on the matter in 2023.

Recent debates in cross-border travel indicate **a shift from physical documents to the digital traveller identity** concept.

International Civil Aviation Organisation (ICAO) – Digital Travel Credential (DTC)

In 2017, the ICAO's New Technologies Working Group (NTWG)[77] established a specialised sub-group to standardise the issuance of travel credentials in a digital format, i.e., digital travel credentials. The concept of **digital travel credentials (DTC)** is related to the current standardised framework for the use of electronic machine-readable travel documents (eMRTD). The security of the eMRTD is based on the ability to verify the consistency of the data written in the passport and the data contained on the chip. The ICAO has presented the DTC approach as a '*hybrid concept, in which the DTC will consist of a **virtual component** (DTC-VC) containing the digital representation of the holder's identity, and one **physical component** (DTC-PC) that is cryptographically linked to the virtual component*.[78]

[75] International Civil Aviation Organisation (ICAO) **Document Series 9303 – Machine Readable Travel Documents**, 2021.
[76] European Commission (2021) **Travel – digitalising travel documents to make travelling easier**, 2021.
[77] **ICAO New Technologies Working Group (NTWG)** develops strategy, policy, specifications and guidance material in relation to the manufacture, security, testing, issuance, deployment and globally interoperable use of MRTDs in both physical and electronic form and global data sharing/exchange for the purpose of holder identification, document validation and secure border control.
[78] ICAO (2020) **Guiding Core Principles for the Development of Digital Travel Credential (DTC)**, Version 4.4, ICAO Technical Advisory Group on the Traveller Identification Programme (TAG/TRIP), Subgroup of the New Technologies Working Group (NTWG), October 2020.

The ICAO has proposed the following three types for the implementation of DTCs, as outlined below.

	DTC TYPE 1 Self-derived	DTC TYPE 2 Authority-derived	DTC TYPE 3 Authority-issued
			
Issuance procedure	Generated by the holder by scanning a passport	Generated by the authority. Holder presents a passport in person	Generated by the authority either remotely or in-person. No passport required.
Physical component	eMRTD	Mobile device and eMRTD	Mobile device (temporary emergency document)
Virtual component	Mobile device /cloud	Mobile device /cloud	Mobile device /cloud
Usage for identification at BCPs	Passport is required	Passport is for reference purposes only	Smartphone only
DTC uses	Part of the border crossing procedure can be performed using a mobile device and biometrics; however, passport needs to be shown at least once, for example, at border control.	Only mobile device or biometrics are used by the traveller to prove their identity at all touchpoints.	Can be used only for emergency documents, in which case the traveller may present only their smartphone or biometrics to prove their identity.

Figure 8. Three types digital travel credentials as proposed by the ICAO. [79]

In 2020, ICAO endorsed the specifications for Type 1 DTC, and published the 'Guiding core principles for the development of digital travel credentials',[80] in conjunction with the technical report on DTC virtual component data structure and public key infrastructure (PKI) mechanisms[81]. The initial implementations of the DTC are expected to follow the Type 1 approach. However, as all three types of DTC are based on the same core implementation principles, the implementations of Type 1 will be compatible with Type 2 and Type 3.

One of the main expected benefits of the DTC is the **reduction in traveller processing time at border crossing points** – to a few seconds per traveller – as remote reading and DTC validation would be significantly faster than reading a biometric passport.[82]

[79] Figure adopted from '**The Digital Travel Credential: Taking seamless travel one step further**', Idemia Position Paper, July 2021
[80] ICAO (2020) **Guiding Core Principles for the Development of Digital Travel Credential (DTC)**, Version 4.4, ICAO Technical Advisory Group on the Traveller Identification Programme (TAG/TRIP), Subgroup of the New Technologies Working Group (NTWG), October 2020.
[81] ICAO (2020) '**Digital Travel Credentials – Virtual Component Data Structure and PKI Mechanisms**', Technical Report version 1.2, October 2020.
[82] R. Rajeshkumar (2021) **Digital Travel Credentials**, 2021 ICAO TRIP Virtual Symposium, Montreal 25-28 May 2021.

The ICAO report 'Guiding Core Principles for the Development of Digital Travel Credential'[83] outlines four use cases to demonstrate how digital travel credentials could facilitate travel:

- DTC as an **enabler of seamless travel**, used in combination with the travel passport;
- DTC to **improve the advance travel authorisation process**. Some countries have implemented digital travel authorisation regimes that rely on the biographic and biometric information provided by the traveller – usually a photocopy of the passport data page. By using the DTC instead would ensure data authentication, while also eliminating data entry errors;
- DTC to **streamline border management**. An increasing number of countries are initiating programs to start the traveller processing stage of the border management process well before the traveller actually arrives in their destination country. By sending their DTC to the authorities in advance of departure, the travellers can expedite the work of border authorities;
- DTC as an **emergency travel document**. Additionally, DTCs could potentially simplify the issuance of travel documents in emergency situations (e.g., in case they have lost their travel document), enabling travellers to continue their journey or return home to get a replacement.

Digital travel documents in the EU

The most recent **Schengen strategy**[84] put forward by the European Commission's, outlines the EU's ambition to continue with the digitalisation of border management at the external borders of the Schengen Area. To complement the **digitalisation of the Schengen visa procedure**,[85] the Commission is also preparing a proposal for a regulation on the digitalisation of travel documents to facilitate international travel, with a view to making the EU one of the first adopters of the digital travel credentials for international travel.[86]

The Commission's proposal for a regulation on digital travel credentials is expected in 2023. To support the legislative proposal, the Commission launched a pilot project on the use of digital travel credentials to facilitate travel (for a more detailed overview, see box below). The project is based on the ICAO DTC Type 1 specification, which is important to ensure the global compatibility of solutions adopted by the EU. The project's objective was to test:

- the creation, submission and inspection of digital travel credentials,
- the verification of identity at the border,
- the effectiveness, efficiency and security of using digital travel credentials for entering the Schengen Area.

[83] ICAO (2020) **Guiding Core Principles for the Development of Digital Travel Credential (DTC)**, Version 4.4, ICAO Technical Advisory Group on the Traveller Identification Programme (TAG/TRIP), Subgroup of the New Technologies Working Group (NTWG), October 2020.
[84] European Commission (2021) **A strategy towards a fully functioning and resilient Schengen area**, COM(2021) 277 final, June 2021
[85] European Commission (2020) **Entering the EU - online visa application process and digital visa**, 2020.
[86] European Commission (2021) **Travel – digitalising travel documents to make travelling easier**, 2021.

Digital Travel Credential (DTC) for boarding and border-crossing processes: A pilot project in The Netherlands*

The project was launched to measure the benefits of using **digital travel credentials (DTC)** to facilitate travel processes, while maintaining high security standards and respect for fundamental rights, including data protection. Ultimately, the aim is to improve the traveller experience, offer a remedy for staff shortages of border authorities, and provide enhanced security by advance checks.

The project comprises the creation of a **self-derived DTC (Type 1)** using a mobile application, and testing it in the context of boarding an aircraft. The processes covered include biometric enrolment prior to departure, pre-assessment, and border crossing at Schiphol airport using *tap & go.*

The pilot is expected to generate advanced knowledge on the usability of DTCs for aircraft boarding and border-crossing. It will also provide valuable insights on using DTCs for pre-checking information and risk levels of passengers.

* Presentation by Jeroen de Graaf (Ministry of Justice and Security, The Netherlands) 'Digital Travel Credential (DTC) for boarding and border crossing processes: A pilot project in The Netherlands', delivered at the eu-LISA Industry Roundtable in October 2022.[87]

The Commission is planning to use the results of this pilot project in its impact assessment accompanying the proposal for a regulation on digital travel documents, particularly concerning legal, economic and security aspects.

In line with the EU Charter of Fundamental Rights, the Commission has also set **privacy and data protection** as key requirements for the digitalisation of travel documents.[88] This is of particular importance in the use of **biometrics and facial recognition**, as they are considered special categories of personal data pursuant to the General Data Protection Regulation (GDPR).[89] Therefore, the pilot project will use biometrics and facial recognition in a proportionate manner, e.g., keeping the data for a minimum amount of time, using end-to-end encryption for data communication, applying security measures to counter identity fraud and theft.

Figure 9 depicts the traveller flow, demonstrating how the self-derived Type 1 digital travel credential (i.e., generated by the holder by scanning a passport) can be used in practice by travellers and authorities to make the travel experience faster and more efficient.

[87] Presentation by Jeroen de Graaf (Ministry of Justice and Security, The Netherlands) '**Digital Travel Credential (DTC) for boarding and border crossing processes: A pilot project in The Netherlands**', eu-LISA Industry Roundtable, October 2022.
[88] **Charter of Fundamental Rights of the European Union**, OJ C 326, 26.10.2012, p. 391–407.
[89] **Regulation (EU) 2016/679** of the European Parliament and of the Council of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC (**General Data Protection Regulatio**n), OJ L 119 4.5.2016, p. 1.

First, the traveller submits their application for the DTC, together with their biometric data, using a mobile application. Subsequently, the DTC is validated against a valid eMRTD (typically a passport), which is then associated to the virtual component of the DTC (DTC-VC) stored in the traveller's app. Next, the carrier verifies the DTC-VC with electronic travel authorisation to support pre-border risk management, laying the foundation for a seamless traveller flow at the airport.

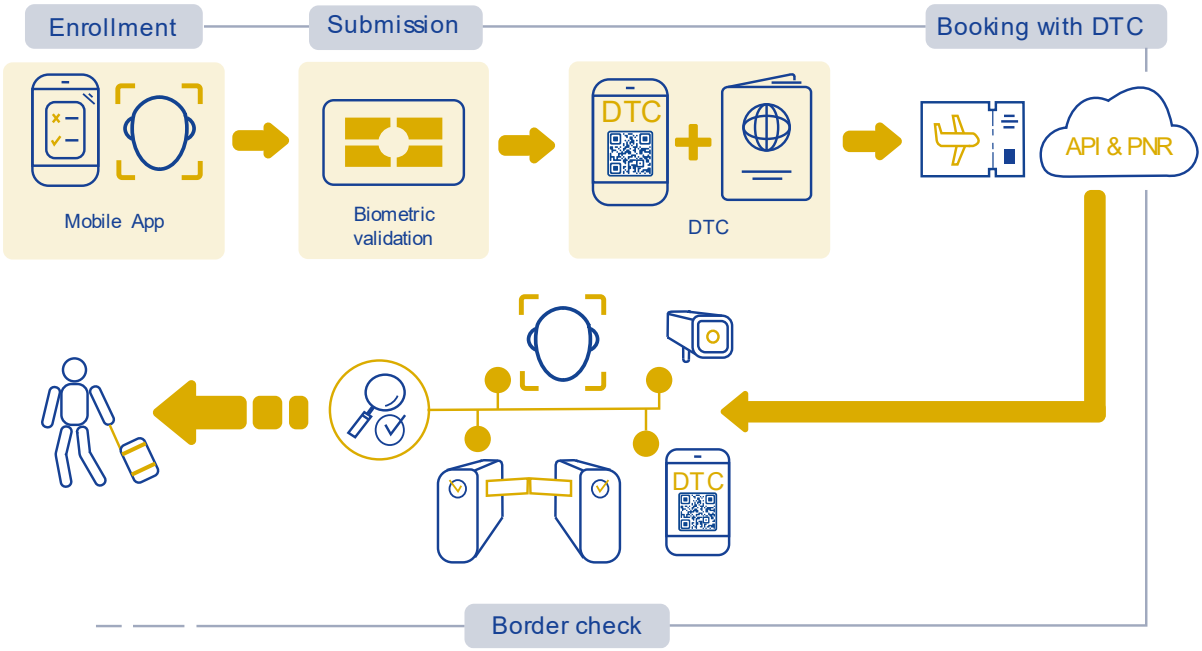


Figure 9. Process overview of the pilot project on digitalisation of travel documents and facilitation of travel.[90]

In the process of travel, the DTC-VC can be used to facilitate the passenger journey through the travel continuum by successful matching to the biometric information included in the validated DTC-VC (using passive authentication). If necessary, the eMRTD associated to the DTC-VC can be presented upon request to provide additional assurance of the link to the identity contained in the DTC, especially immediately before boarding.

4.2. Automated border control

The European Border and Coast Guard Agency – Frontex defines **automated border control (ABC) systems** as an automated system which:

- authenticates the electronic machine-readable travel document (eMRTD) or token,
- establishes that the passenger is the rightful holder of the document or token,

[90] Figure adapted from a presentation by Mikko Hakkarainen (DG HOME) '**Digitalisation of Travel Documents and Travel Facilitation**', delivered at the eu-LISA Industry Roundtable in June 2022.

- queries border control records,
- determines the eligibility of border crossing according to the pre-defined rules.[91]

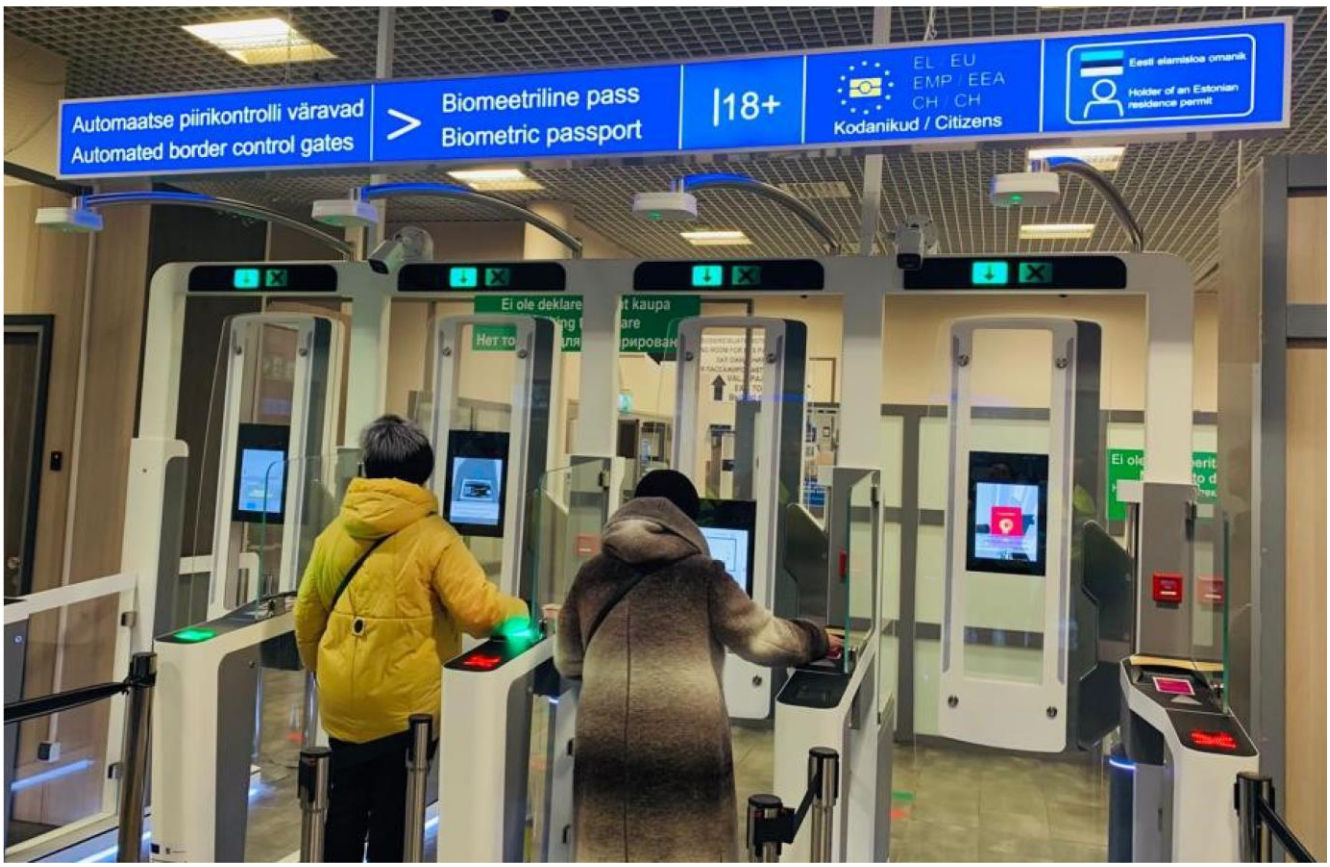
In addition, Frontex also specifies that the main objective of ABC systems is to support the facilitation of international travel, while guaranteeing the **compliance with security requirements**, making it an integral element in the pursuit to ensure a seamless travelling experience. The first ABC systems were deployed in the 2000s, following the introduction of biometric passports, which enabled automated biometric identification. Airports were the first to deploy automated border controls that were usually also connected to pre-enrolment in a registered traveller programme. With their gradual introduction in airports across Europe, ABC systems have been extended for use to all citizens benefiting from the freedom of travel in the Schengen Area.

Over the years, ABC systems have proven to be the best alternative for enhancing the convenience for travellers (i.e., travel facilitation), as well as increasing the throughput of border control points (BCPs) without affecting the overall security of the controls. As a result, ABC systems have been adopted as the main trend in this domain, mainly because the automation of the border control process for low-risk travellers frees up border control resources, allowing them to focus on higher-risk travellers.

Requirements related to visa verification and stamping on entry and exit have thus far prevented extending the use of ABC systems to all third-country nationals visiting the Schengen Area. After the adoption of the EES Regulation in 2017, the Schengen Borders Code was amended to include the potential use of ABC systems also for third-country nationals. Thus, this restriction will be lifted with the entry into operation of EES, planned for 2023, allowing border agencies and operators of border crossing points (e.g., airports, sea ports) to extend access to automated border gates also to third-country nationals, further streamlining the flow of travellers.

In order to use ABC systems, third-country nationals must hold a **biometric travel document** that contains their facial image on a chip. Additionally, they must also be enrolled or pre-enrolled in EES. For example, the Prague airport, in the Czech Republic, has installed 17 ABC gates, 55 self-service kiosks and 34 assisted counters for third-country nationals, and Estonia has installed 16 ABC gates at Tallinn Airport and Narva border crossing point, the two main gateways for entry into Estonia[92].

[91] Frontex (2016) **Best Practice Operational Guidelines for Automated Border Control (ABC) Systems**, April 2016.
[92] Tallinn Airport (2021) **The first automated border control gates in Estonia are operating**; press release, 11 February 2021.



Automated border control at the external borders of the Schengen Area:
Narva entry point at the land border crossing point between Estonia and Russia.
Photo by A. Carri, eu-LISA.

Preventing vulnerabilities of automated border control systems

Given their continuous development and widespread use, ABC systems have become under scrutiny to improve their robustness against external attacks and potential vulnerabilities that could be exploited to gain access or bypass such systems. Within the studied vulnerabilities, **presentation attacks and morphing attacks** have received the most attention by industry and academia (see box on p. 33).

Presentation attacks and presentation attack detection (PAD) methods are currently outlined in the ISO standard on biometric PAD[93], providing specific metrics for evaluating the risk posed by these threats and to objectively assess potential system vulnerability. This standard is currently under review in order to incorporate also **morphing attacks** and morphing attacks detection (MAD) methods, together with the respective metrics to conduct evaluations of these threats, as well as countermeasures.

Currently, there are no available statistics on the incidence of direct attacks on ABC systems, and only some isolated cases have been reported in the news. However, in the current state of play, it is almost unanimously agreed that the implementation of PAD methods is the key measure for guaranteeing the security of border control operations performed by ABC gates or e-gates. The guidelines developed by Frontex for deploying ABC systems illustrate the importance of these controls and recommend the implementation of such checks for face and fingerprint recognition[94].

Although the literature describes various approaches for addressing presentation attacks, this area of research is still an ongoing effort. In particular, PAD methods tend to have a limited validity period because the attacks continue to be perfected. To address this pressing issue, industry and academia have joined efforts, e.g., **project TABULA RASA – Trusted Biometrics under Spoofing Attacks**[95], funded by European framework programme for research (FP7). The project aims to define standard procedures for assessing the vulnerability of biometric systems to presentation attacks, as well as innovative PAD methods that included the use of alternative biometric modalities (e.g., thermal face print, touchless 3D fingerprints), and the adoption of multibiometric systems (i.e., combination of information from two or more biometric modalities, such as facial images and fingerprints).

As part of this joint effort by all stakeholders to increase the robustness of biometric technology to both presentation attacks and morphing attacks, different international competitions have been organised to evaluate the effectiveness of current protection methods against these threats, e.g., by the National Institute of Standards and Technology (NIST) in the U.S.[96]

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[93] International Standard ISO/IEC JTC 1/SC 37 – **ISO/IEC 30137:2016 – Information Technology – Biometric presentation attack detection**, International Organization for Standardization, 2016.
[94] Frontex (2015) **Best practice technical guidelines for Automated Border Control (ABC) Systems**, Technical Report by the Frontex Research and Development Unit, September 2015.
[95] Trusted Biometrics under Spoofing Attacks (TABULA RASA) project **http://www.tabularasa-euproject.org**.
[96] M. Micheletto, *et. al.* (2022) **Review of the Fingerprint Liveness Detection (LivDet) competition series: 2009 to 2021**, Chapter of the Handbook of Biometric Anti-Spoofing (Third Edition), 2022; M. Ngan, *et. al.* (2022) **Face Recognition Vendor Test (FRVT) – Part 4: MORPH Performance of automated face morph detection**", NIST Technical Report NISTIR 8292, National Institute of Standards and Technology (NIST), U.S. Department of Commerce, 2022.

New concepts in automated border control

In addition to extending the use of ABC systems to more categories of travellers, governments and industry are working on new concepts that could further enhance the use of automated border control, making it contactless and even faster to avoid queues that can still form around e-gates.

Over the last decade, the funding provided by the European Commission through the EU research framework programmes, has supported multiple large projects in the area of automated border control.

The concept of 'contactless corridors' or 'biometric corridors' is based on the ability to **verify the identity of travellers using biometric capture 'on-the-move'**.

Quality of biometric samples. Considering that the quality of automated border control depends to a large extent on the quality of biometric acquisition, research has mainly focused on the quality of biometric samples. In general, the collection of good quality biometric samples is directly related to the level of control that can be exerted over the external physical conditions in the acquisition scenario.[97] The higher the constraint and repeatability of the conditions, the better the quality, and this applies also the other way around, the higher the variability of the conditions, the poorer the quality. Thus, in most cases, the physical conditions at the border crossing points (BCP) represent an extremely challenging scenario for the acquisition of high-quality biometric samples. This is particularly valid for land BCPs where there is little to no control over atmospheric conditions, light, background, position of the subject, etc. However, it is also applicable to sea borders (and even to airports) that still have, despite more stable environmental conditions, a long way to go from the almost fully controlled scenario of a law enforcement facility.

Biometric corridors. The concept of 'contactless corridors' or 'biometric corridors' is based on the ability to perform biometric capture upon arrival and verify the identities of travellers *'on-the-move'*, e.g., after disembarkation at the airport. Although the concept of biometric corridors was first proposed a long time ago, the technology remains at complete research inception phase. The main rationale behind these corridors is to enable the capturing the biometrics (e.g., face, iris, gait) of people on the move, while passengers simply stroll through these corridors. However, this ambitious goal is not yet attainable due to the *'garbage-in-garbage-out'* principle, where the quality of output is determined by the quality of the input. For the time being, existing biometric scanners are not able to capture fingerprint or face samples of sufficient quality without significant cooperation from the subject, at least not in the quality that could guarantee reliable and accurate results in the identity recognition process.

[97] S. Bharadwaj, *et. al.* (2014) **Biometric quality: a review of fingerprint, iris, and face**, EURASIP Journal on Image and Video Processing, Vol. 1(34), 2014.

Several research projects and industry stakeholders are currently developing and evaluating technological solutions for biometric corridors and **capturing biometrics on the move**. In Europe, the D4FLY project developed a working prototype for seamless biometric verification of travellers on the move.[98] Another EU-funded project PROTECT, completed in 2020, focused on the development, demonstration and evaluation of a system for identifying travellers with biometrics captured on the move.[99] Both projects concluded that on-the-move biometric recognition had the potential to generate significant benefits by reducing queues and investment in costly e-gate equipment, while providing additional flexibility for the staffing of border agencies.

EU funded research projects on ABC systems:

ABC4EU: harmonised design and operational features for ABC gates, compatible with second-generation EU passports and other travel documents. For more, visit **https://cordis.europa.eu/project/id/312797**

FastPass: harmonised modular approach for ABC gates. For more, visit **https://fastpass-project.eu**

FLYSEC: end-to-end integrated airport security process for passengers, enabling a guided and streamlined procedure from landside to airside and into the boarding gates. For more, visit **https://www.fly-sec.eu**

D4FLY: upgraded capabilities and capacities for border authorities in countering emerging threats in document and identity verification (e.g., forged documents, impostors, morphed faces) at manual and highly automated border control points and in the issuance process of genuine documents. For more, visit **https://d4fly.eu**

TRESSPASS: modernising the security checks process at BCPs. For more, visit **https://www.tresspass.eu**

With the knowledge gained over the years on the different factors affecting biometric quality, the stakeholders are currently engaged in improving scanners, and the overall biometrics acquisition processes in order to increase accuracy to, perhaps someday, achieve the goal of 'seamless biometric corridors'.

In the ABC context, where fingerprints and facial images constitute the vast majority of biometric characteristics being acquired, the main quality factors are:

Factors influencing fingerprint image quality. Low-quality fingerprint samples can result from physical aspects, such as poor skin conditions (e.g., skin being too dry or moist), dirty fingers, or latent fingerprints remaining on the sensor surface.

Behavioural aspects can also influence the quality if the user is not familiar with the technology, e.g., too low or too high pressure on touch-based optical scanners, used in the vast majority of current fingerprint acquisition devices, will result in lower quality fingerprints.

Additionally, ergonomic aspects can also influence quality, e.g., if the sensor is placed at an uncomfortable height and inclination. Other aspects that are more specific to ABC environments include, for example, the presence of dust or grease on the fingertip.

[98] **Detecting Document frauD and iDentity on the fly – D4FLY** is a research and innovation project funded by the EU Horizon 2020 programme "Secure societies – Protecting freedom and security of Europe and its citizens". For more, visit **https://d4fly.eu**

[99] **Pervasive and UseR Focused BiomeTrics BordEr ProjeCT – PROTECT** is a research project funded by the EU Horizon 2020 programme "Secure societies – Exploring new modalities in biometric-based border checks". For more, visit **http://projectprotect.eu**

Factors influencing face image quality. In the ABC context, the main factors that result in low quality facial images are related to personal behaviour such as: pose, facial expression, hairstyle, makeup, small wounds, and motion blur. For this reason, it is important that ABC gates instruct the traveller to look straight into the camera, while also maintaining the correct distance.

Other contextual factors that can have a big impact on the quality of facial images being acquired are illumination conditions and device specifications (e.g., camera resolution, photo size, and image file format). As for other types of degradation in face images, they are more specific to files that are digitally acquired from the image stored in the machine-readable travel document (MRTD).

Demographic bias in automated border control

In the context of decision-making, "***fairness*** *is the absence of any prejudice or favouritism toward an individual or group based on their inherent or acquired characteristics. Thus, an unfair algorithm is one whose decisions are skewed toward a particular group of people*".[100]

In recent years, **algorithmic bias and fairness** have emerged as noteworthy challenges for automated biometric systems. As per the definition above, a biometric system or algorithm is considered to be biased if significant differences in its operation can be observed for different demographic groups of individuals, e.g., based on age, gender or ethnicity.[101] With growing adoption of various biometric applications, the non-equitable performance of such technology across demographic groups has led to serious debates among regulators, vendors and academia.[102] Different institutions have conducted demographic bias evaluations of popular biometric applications, including face recognition solutions developed by commercial vendors.[103] On the academic front as well, the research in understanding, estimating, and mitigating demographic bias is gaining significant traction.[104]

In the case of automated border control, demographic bias of biometric applications could lead to situations of discrimination or even exclusion of certain segments of the population. As mentioned before, such cases of disparity in treatment have raised serious concerns regarding their societal impact, raising questions about the applicability of biometric technology in private and public domains. Therefore, for biometrics to reach their full potential, such potentially discriminatory results should be avoided to the largest extent possible. To reach this objective, a quantitative evaluation of demographic fairness is an important step towards understanding, assessment, and mitigation of demographic bias in biometric applications.[105]

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[100] N Mehrabi, et al (2022) **A Survey on Bias and Fairness in Machine Learning,** ACM Computing Surveys Volume 54 (6), pp 1–35**.**

[101] P. Drozdowski, *et.al*. (2020) **Demographic bias in biometrics: A survey on an emerging challenge**, IEEE Transactions on Technology and Society, Vol. 1(2), pp. 89–103, 2020.

[102] European Agency of Fundamental Rights – FRA (2019) **Data quality and artificial intelligence: mitigating bias and error to protect fundamental rights**, and **Facial recognition technology: fundamental rights considerations in the context of law enforcement**, both Publications Office of the EU, 2019.

[103] P. Grother, *et.al.* (2019) **Face Recognition Vendor Test - Part 3: Demographic effects**, NIST Technical Report 8280, 2019.

[104] Y. Sun, *et. al.* (2018) **Demographic analysis from biometric data: Achievements, challenges, and new frontiers**, IEEE Transactions on Pattern Analysis and Machine Intelligence, Vol. 40(2), pp. 332–351, 2018.

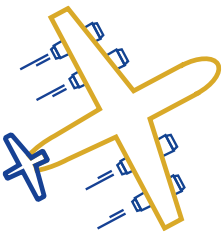
[105] If an algorithm is biased, it can negatively affect a certain segment of the population compared to others. For instance, if a facial recognition algorithm makes more mistakes recognising male senior citizens above 70 years of age, these subjects will be stopped more often to carry out other checks. As a result, they will spend more time at the border and their travel experience will be less seamless, compared to other segments of the population.

4.3. Outlook on the seamless travel experience

Digital identity for travellers, interoperability of the EU's JHA information systems, and advance biometric enrolment, presented in this report, all contribute to achieving a seamless and contactless traveller experience.

International travel covers a broad range of scenarios, depending on the type of transport and border crossing point. In practice, border control agencies and international travel industry have proposed a wide range of technological innovations to facilitate the seamless travel experience. Overall, it appears that the most advanced systems are currently deployed at major international airports, especially in compared to seaports or land border crossing points.

Air travel



The air travel industry and its partners have already worked on advancing the integration and testing of all these elements, to offer some categories of travellers a completely seamless and contactless journey.

For example, the **One ID concept**, proposed by the **International Air Transport Association (IATA)** in 2018, aims to ensure air travellers a fully seamless and contactless experience throughout the different stages of their journey, including check-in, bag drop, security scanning and boarding.[106] According to IATA's One ID concept, passengers would create a trusted digital identity prior to arrival at the airport and share it in advance, coupled with the enrolment of an authenticated biometric to allow for biometric recognition. Upon submission, passenger data would be securely transmitted to authorised stakeholders to facilitate biometric processing at the airport, using local or collaborative identity management systems. This approach is supported by the implementation of **privacy by design**, where passengers retain the ownership of the data they provide. The passenger's digital identity would be temporarily stored on their mobile phone or on a cloud-based digital platform. This solution is expected to facilitate and speed up the authentication and identity verification process at the airports, improving the overall passenger experience.

Trusted digital identity. In June 2021, the European Commission proposed a framework for a European digital identity that would be available to all EU citizens, residents and businesses, via a European digital identity wallet.[107] The proposed regulation aims to ensure universal access for people and businesses to secure and trustworthy electronic identification and authentication by means of a personal digital wallet on a mobile phone. In December 2022, the Council adopted its common position on the proposed legislation, and the process will proceed with negotiations between the Council and European Parliament.[108]

[106] International Air Transport Association – IATA (2022) **One ID Fact Sheet**, November 2022.
[107] **Proposal for a Regulation** of the European Parliament and of the Council Amending Regulation (Eu) No 910/2014 as regards **establishing a framework for a European Digital Identity**, COM(2021)281 final, June 2021.
[108] Council of the EU (2022) **European digital identity (eID): Council makes headway towards EU digital wallet, a paradigm shift for digital identity in Europe**; press release, 6 December 2022.

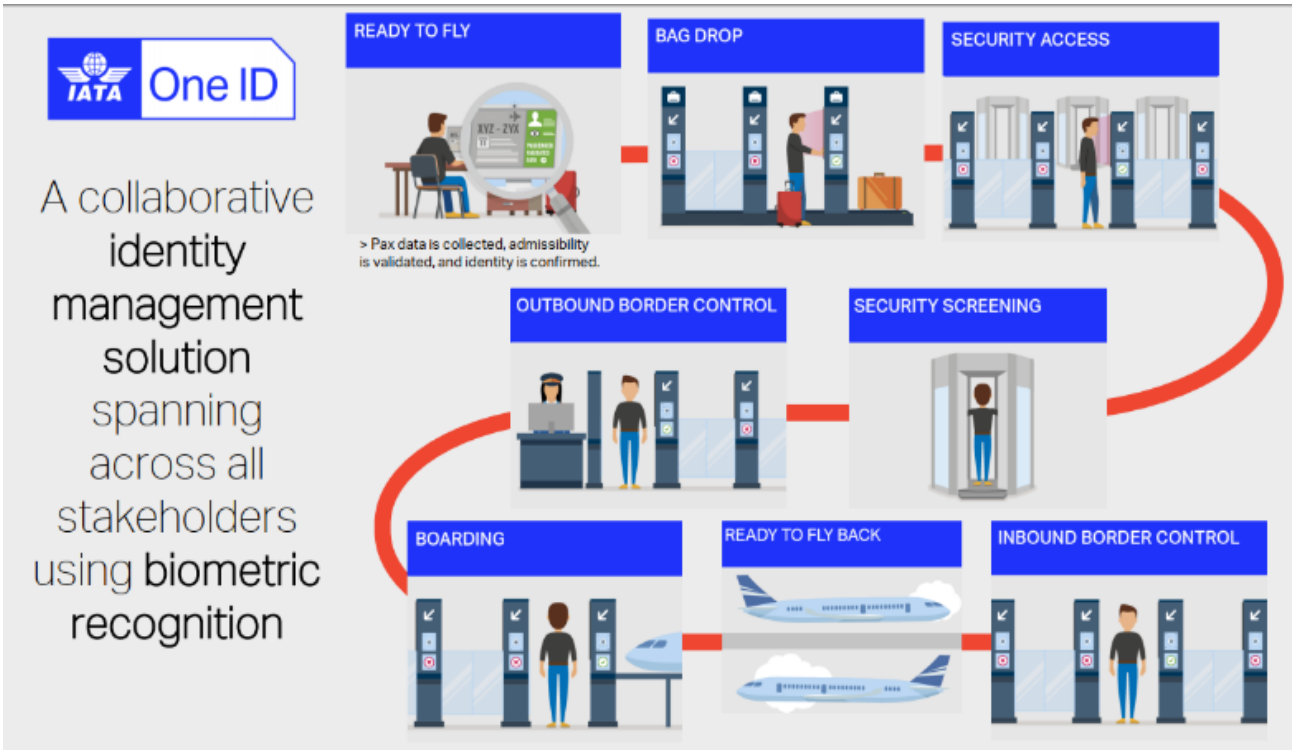


Figure 10. One ID concept proposed by the International Air Transport Association (IATA).[109]

[109] Presentation '**A Vision for an end-to-end Biometric Passenger Journey'**, delivered by IATA at the 12th eu-LISA Industry Roundtable 'Data Quality and Interoperability: Addressing the Capability Gaps through Standardisation' in November 2020.

Maritime travel

The international transport of persons by sea is of very heterogenous nature. While globally, the vast majority of vessels are transporting cargo with a rather limited number of seafarers, international passenger ferries regularly transport hundreds of persons, e.g., between the EU and the UK. On the other side of the scale, cruise ships, although in smaller numbers, regularly transport thousands of passengers and crew members from country to country, including embarkation and disembarkation for day trips.

In the context of EES, the cruise industry has raised concerns with regard to the operational and technical **readiness of port infrastructure** for processing the flows of embarking and disembarking passengers, and the possible impact on the traffic fluidity of vessels. For example, at the moment it is not clear what resources are required at ports (including small ports) to deal with the large numbers of passengers on vessels, amounting to ten times the size of an Airbus A380.

According to the **European Community Shipowners' Associations (ECSA)**,[110] the implementation of EES requirements may be especially challenging for smaller ports that cannot expand their infrastructure for additional equipment, such as EES enrolment kiosks and booths. Another challenge is for ferry ships, especially when disembarking passengers with their vehicles, leading to long queues starting inside the ferries, delaying the ship's departure to the next destination, and increasing operational costs for operators. Those costs will probably be covered by the increased ticket prices for travellers, and may hurt the competitiveness of the maritime industry, especially vis-à-vis the rail industry. To address these issues, ECSA suggested conducting a pilot project to identify risks of congestion and draw lessons on how to ensure traffic fluidity at seaports.

The implementation of EES requirements may be **especially challenging for smaller ports** that cannot expand their infrastructure for additional equipment.

In the Netherlands, the authorities conducted a simulation with ferry disembarkation at Europoort in Rotterdam, to better understand the impact EES might have on infrastructure and human resources. The simulation demonstrated that with EES, the disembarkation time for passengers (and cars) is expected to increase from about the current one-hour process to almost two hours and more. One of their main conclusions that will enable a smoother entry into operation for EES is the need for more innovation in technologies and business processes to avoid longer queues. One example of such innovative solutions is the biometric enrolment using mobile devices developed by the Dutch Police as presented in 3.3.

[110] Presentation delivered by the **European Community Shipowners' Associations (ECSA)** at the eu-LISA Industry Roundtable '**EES, ETIAS and Carriers getting ready for the entry into operation**', October 2022.

Land border crossing points

The EES working group report on ICT solutions for external borders (sea/land) outlined a number of requirements and challenges at land border crossing points as relates to the implementation of EES, including:

- strong **wireless network** to allow connectivity between the border control infrastructure and the border guard on the move,
- difficult **climatic conditions** at some border crossing points, especially in the summer and winter months,
- **lighting conditions** need for ensuring high-quality biometric capture, especially for facial images[111].

In recent years, several seamless solutions have already been introduced at land border crossing points, such as automated border control (ABC) gates or e-gates for pedestrians. In addition, ABC systems using in-vehicle identification of passengers have been tested in several pilot projects, both by national authorities,[112] and also by industry stakeholders.[113] Also, many land border crossing points use dedicated lanes for pre-registered, low-risk travellers, e.g., Nexus at the U.S.-Canada border[114].

To better prepare land border guards for registering the entries and exits of third-country nationals, the EU has been testing new digital solutions for optimising traveller flows at its external borders. These pilot projects have focused on addressing potential suspicious activity, while avoiding congestion and ensuring a steady flow of traffic, especially for low-risk travellers.

For optimising the flow of **passengers traveling in vehicles**, IN Groupe conducted a proof-of-concept project at the land border crossing point between France and the UK, with an average daily throughput of 1,300 trucks. The project tested the usability of a tablet that enables biometric enrolment of drivers without exiting the truck. A supervising agent was present to ensure that all passengers in the truck enrol their data in the tablet, which is automatically disinfected after each use. The project demonstrated that this solution has the potential to significantly reduce traffic congestion at land border crossing points. Next, IN Groupe is planning to conduct a similar proof-of-concept project with passenger cars to test if biometric enrolment without the need to exit a car will improve the flow of traffic at land border crossing points.[115]

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[111] **Report by the eu-LISA EES Working Group on ICT Solutions for External Borders (sea/land)**, 26 March 2019.
[112] U.S. Customs and Border Protection pilot project '**Facial Biometric Pilot for Inbound Vehicle Travelers at Anzalduas International Bridge Port-of-Entry (POE) in Texas for travellers arriving in the United States**'; U.S. CBP press release, September 2021.
[113] Pilot project '**Intelligent Vehicle Occupant Detection (IVOD)®**' by Gatekeeper Intelligent Security.
[114] Trusted traveller and expedited border control program operated jointly by the Canada Border Services Agency and U.S. Customs and Border Protection, allowing expedited processing for pre-screened travellers when entering the United States and Canada, using dedicated processing lanes and kiosks at designated border ports of entry. For more information, visit the dedicates webpage of the Canada Border Services Agency **https://www.cbsa-asfc.gc.ca/prog/nexus/menu-eng.html**.
[115] Presentation '**Innovative Land/Sea Border Technologies to Optimize Passenger Flow in Vehicles**', delivered by Pascal Janer from IN Groupe at the eu-LISA Industry Roundtable in October 2022.

The **'free-flow system' for investigation and prevention**, developed by Adaptive Recognition, is intended to assist border guards in analysing large amounts of data, and provide indication of suspicious activities at border crossing points.[116] This technology can read licence plates, identify vehicle models and colours, while also counting the number of people in the vehicle. Artificial intelligence can analyse data and provide border guards with valuable information, for example, in cases where the same licence plate is used on different vehicles. In this case, the technology could alert border guards of potential suspicious activity and recommend conducting a check. In essence, the 'free-flow system' can assist border guards in focusing on high-value tasks of identifying suspicious activities, while ensuring a steady flow of traffic at the border crossing points. The 'free-flow system' is currently being tested in Denmark and Germany and is expected to be in operation in more than 100 lanes at land border crossing points. However, individual checks of passengers, including for biometric capture, still need to be conducted separately.

Horizon 2020 project '**SMILE – SMart moblity at the European Land Borders**'[117] provided a set of affordable and easy-to-install modules to support the needs of the EU's land border infrastructure without sacrificing security. From 2019 to 2020, two pilot projects were conducted at land border crossing points in Nadlac (Romanian-Hungarian border) and Ruse (Bulgarian-Romanian border), with 221 and 136 participants, respectively. The project workflow was based on the concept of 'pre-registration', where:

- similarly to air-travel check-in, travelers provide their information (i.e. documents, biometrics, travel plans, estimated time of arrival, etc.) prior to their arrival at the border crossing point,
- background checks are performed offline: the SMILE system collects information from national and international databases (e.g., EES, ETIAS, VIS, SIS, etc.) and runs a risk analysis on the travelers,
- if no alerts are given, the travelers are allowed to go through the fast lane, where they are required to provide final identification.

As reported by end-users, communication delays between various systems can significantly increase waiting times – the tested pre-registration application provides an improvement on this point. Similar approach was tested with lorries, and tourist buses. In the latter case, passengers are treated as group, instead of individuals, to improve traffic flow at the border. In addition to facilitating checks, the SMILE platform can also suggest the best arrival time period based on the expected traffic, thereby improving the traffic flow and reducing waiting times.

As presented in this chapter, the process of border-crossing in Europe is undergoing significant changes, and is set to become more seamless with the introduction of digital travel credentials, proliferation of ABC gates, and a wide variety of novel technological solutions being developed in collaboration with the industry and academia.

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[116] Presentation '**Vehicle and traveller management**', delivered by Csaba Nagy-Amigo from Adaptive Recognition at the eu-LISA Industry Roundtable '**EES, ETIAS and Carriers getting ready for the entry into operation**' in October 2022.

[117] Presentation '**SMILE H2020 project land BCP pilots experience and results**', delivered by Dr Georgios Stavropoulos from CERTH at the eu-LISA Industry Roundtable '**EES, ETIAS and Carriers getting ready for the entry into operation**' in October 2022. For more information about Horizon 2020 project '**SMILE – SMart mobILity at the European land borders**', please visit **https://smile-h2020.eu**.

Conclusions

The legislative, security and technological landscape of international travel has changed considerably in the past two decades, while the number of travellers has almost doubled. These changes have affected the experience of travelling. However, travel facilitation has been and remains an important goal for most countries.

This report provided an overview how the main developments in international travel can support a more **seamless and contactless** travel experience. EU regulations, travel industry practices, and new technological solutions can support the alignment of the travel facilitation and security objectives at all steps of the traveller journey, from the application for a visa or a travel authorisation up to the eventual border-crossing.

Travel authorisations are undergoing a major revision, particularly due to the EU's ambition to fully digitalise the **Schengen visa procedure**, which is expected to facilitate the process and reduce associated costs for all involved. The **European Travel Information and Authorisation System**, scheduled to enter into operation by November 2023, will also modify the experience for third-country travellers that were previously not required to apply for a travel authorisation when visiting the Schengen Area. However, ETIAS will include functionalities that will support seamless travel, in particular, reducing the risk of refusal at the border crossing points.

Automated border control continues to be an important technology supporting seamless travel, and the concepts of **digital identity and digital travel credentials** are expected to further accelerate identity verification at the borders.

In the past couple of years, pre-border checks have gradually become an integral part of international travel, allowing more time for **checking the backgrounds of inbound travellers**. The entry into operation of EES and ETIAS will have a significant impact on pre-border checks, as international passenger carriers will be granted formal access to the EU's JHA information systems to ensure that their passengers have the right of entry to the Schengen Area. In particular for EES, the pre-enrolment of information and of biometric data is expected to be a challenge at first, and the industry has been working closely with Member State border agencies to develop supporting systems and ICT solutions, such as self-service terminals or portable devices that will support the process and mitigate potential queues.

Novel concepts and technologies have also been under development to streamline the process of border checks. Automated border control continues to be an important technology supporting seamless travel, and the concepts of **digital identity and digital travel credentials** are expected to further accelerate identity verification at the borders.

In the EU, in conjunction with the deployment of EES, **automated border control gates** are expected to become widely used for processing all inbound travel from third countries, provided that TCN travellers are in possession of biometric passports, which has the potential to significantly improve their travel experience, especially by reducing queues at ports of entry.

In some use cases, the industry has shown that all these building blocks can be combined to offer a fully seamless and contactless experience to all travellers. However, it bears noting that the most advanced technologies and concepts are often prepared by the air travel industry for air travel use cases. While this industry has the necessary resources to contribute to the development of advanced technologies and robust standards, use cases for other modes of transport, such as trains, buses, or people crossing borders in their personal vehicles, remain less studied and researched.

On the other hand, some portable devices and new concepts can apply to all types of border-crossings, and the **regulatory frameworks are ready** to support their use. Going forward, these use cases must continue to be analysed and further researched in order to come up with novel solutions to cover all types of transport and border-crossings, to avoid the situation where the benefits of seamless and contactless travel are enjoyed only by a select category of international travellers, while others must still wait in long queues to cross a border.

Automated border control at Fiumicino Leonardo da Vinci International Airport Rome, Italy.

Photo by A. Carri, eu-LISA

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