

# *Trends in Biometrics for Travel, Transportation, and Immigration*

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## Introduction

Biometrics is a rapidly growing capability within the Travel and Transportation market. This growth is attributed to the need to appropriately verify travelers and streamline the processes between travel screening and immigration. This paper:

- Reviews biometric system requirements based on increased security interests
- Provides examples of international applications that have started to incorporate biometrics
- Compares the levels of use of different biometric modalities based on international markets
- Analyzes the benefits of implementing biometrically enabled systems for travel and transportation domains
- Projects the natural evolution towards an uninterrupted and paperless travel procedures

## 1. Biometrics Background

According to the National Science and Technology Council (NSTC), *biometrics* is a general term used alternatively to describe a characteristic or a process. As a characteristic [the term biometrics refers to] a measurable biological (anatomical and physiological) and behavioral characteristic that can be used for automated recognition. As a process [biometrics refers to] automated methods of recognizing an individual based on measurable biological (anatomical and physiological) and behavioral characteristics [1]. Biometrics is an enabling technology used in the service of identity management projects in lieu of issued credentials (e.g. passwords, cards, etc.) [2]. Biometric recognition takes two general forms:

- Verification: uses a biometric system to determine that an individual is who they claim to be. Usually this is accomplished through one-to-one (1:1) authentication.
- Identification: is the familiar use of a biometric to aid in the search for a person of unknown identity. Usually this is accomplished through one-to-many (1:N) search within a database. One particular case of identification system is the watchlist system, where there exists a list of select persons and given an input record the system must decide if that record matches with an individual on the watchlist.

Biometric modalities refer to the type or class of biometric system. Any measurable biological or behavioral characteristic can be a biometric modality. Some of these include: face, iris, fingerprint, hand geometry [1].

Biometrics has been recognized across the United States and around the world as a vital component in providing identity management services and has increasingly been recognized as an “essential security measure” [3]. In her testimony before the House Appropriations Committee, Department of Homeland Security Deputy Assistant Secretary for Policy Kathleen Kraninger stated that, *“Biometrics are enabling people to have greater confidence that their identities are protected, and in turn decision-makers are more certain that the people they encounter are who they say they are”* [4].

Inclusion of biometric technology provides an increased level of security through identification and verification of individuals. Integration of biometric technology can increase security and help the transportation sector achieve their needed safety levels.

## 2. Requirements and Metrics

Since 9/11 tightened immigration policy and more rigorous transportation security standards have resulted in the need for identity management solutions that ensure people are vetted and verified

before traveling and crossing national borders. This tightening of policy and update in security standards is coupled with the desire for simpler, stream-lined, efficient travel [5] [6] [7]. Many travelers have expressed the desire to provide more personal information in return for travel benefits, expedited processes, and safer systems [5] [6]. Expressing these concepts as system objectives, Travel and Transportation systems can be categorized as needing to provide:

- Passenger protection, screening, property linkage, and identity verification
- Transportation hub employee identity verification (e.g. airport employees, airline staff, airport cleaning and maintenance staff, luggage transporters, tarmac workers, etc.)
- Protection of public areas
- Government identity verification and access authorization (e.g. inspector general, law enforcement, etc.)
- Balance between passenger throughput and screening procedures

Taking these objectives and expanding them into functional specifications provides the following system requirements:

- **Streamlined Processes-** Manual individual security screening (e.g. identity document checking, boarding pass confirmation, x-ray screening) needs to be replaced by faster and more efficient automated identity management systems resulting in higher confidence. The various organizations and security systems that a passenger traverses should be perceived as uninterrupted, where data flows from one application to the next.
- **Intuitive Application/User Interface-** In order to meet the high throughput demands of travel and immigration industries, the user interfaces of the systems needs to accommodate users of different backgrounds, different technology usage skill level, and users with special needs (e.g. blindness, color blindness, hearing impairment, physically challenged). The user interfaces should be intuitive and easy to use; ideally being seamlessly directing the traveler to provide biometrics for screening.
- **Non-contact Biometric Collection-** Implementation of non-invasive sensors capable of rapid biometric collection from cooperative individuals without requiring physical contact offer several advantages including:
  - Reducing risk of transfer of microorganisms and communicable diseases
  - Eliminating costs associated with cleaning of conventional scanners between uses
  - Providing identity information to officers ahead of personal interaction to save time during screening procedures
  - Image acquisition regardless of skin conditions (in case of fingerprints, hand geometry, or similar modes)
- **System Security Management-** The system must deploy security measures such as, protecting physical tempering with the equipment and data protection.
- **Implementations of Data Privacy-** There are several concerns are associated with the use and storage of biometric data. Misusage of biometric data by travel and immigration-governmental bodies becomes of particular concern by privacy groups. Personal data should be secured by means of encryption and other safeguards.
- **Assure System Interoperability** –Interoperability refers to how the data conforms to standards and can be utilized by other systems; this allows for the sharing of data and ability to exchange components. Data should be able to be shared with many government organizations, with unambiguous, shared meaning. System peripherals utilized should be easily exchanged for others as needs dictate.

- **Assure Backwards Capability-** Data collected should be compatible (or at least, convertible) with legacy conventional security databases.

It is highly recommended that these requirements are tested and validated at the traveling and immigration ports through operational pilots. These pilots will help evaluate data sharing and interoperability with other governmental databases as needed. Metrics should be established at the start of each pilot to properly measure the implementation and define criteria of success. Any biometric system should implement traditional system-level performance evaluation metrics such as the failure-to-acquire (FTA) rate, the failure-to-enroll (FTE) rate, the false-accept rate (FAR), and the false-reject rate (FRR). Some suggested additional metrics, for implementation within this market, are:

- **Officer to passenger ratio-** This ratio compares the number of passengers to the total number of officials overseeing the process. By implementing an automated screening system the number of officials administrating the travel screening should be reduced.
- **Cost per match-** The cost for verification with traditional credentials can be measured against the new procedures.
- **Throughput-** The number of individuals being screened can be counted, including the quantity of passengers who go through a secondary screening. With the new technologically enhanced processes the number of individuals screened in a given time should increase.

### 3. Examples of International Implementations

To meet the aforementioned requirements the international community is trending toward the use of biometric technology within the identity management systems of their corresponding travel and transportation security [8].

**Table 1: International Examples of Biometric Travel Programs** provides select examples of how biometrics is being used to enhance transportation systems internationally; this table shows that biometrics is increasingly becoming a mainstream technology.

International Examples of Biometric Travel Programs	
•	Within the United States the Department of Homeland Security US-VISIT program has individuals use their fingerprints to authenticate their travel visa upon arrival within the United States [9]
•	Germany's Frankfurt Airport (FRA) has implemented voluntary, automated, biometric passenger systems to expedite border controls and enhance security [10]. The system leverages facial recognition technology within an automated e-gate process that can perform authentication within 18 seconds. [11]
•	Canada uses face, fingerprint and iris modalities for workforce and passenger screening [12]
•	India incorporates fingerprint verification with breathalyzers to ensure railway crew suitability [13]
•	The UK uses "Iris on the Move" for automatic queue management at checkpoints, instant visibility into how key functions are performing, and perimeter screening [14].
•	Within the United Arab Emirates the iris patterns of all arriving passengers (via seven international airports, three land ports, and seven sea ports) are compared in real-time against an enrolled central database [15]
•	The Israel Airports Authority issues passengers, who volunteer, a smartcard allowing them to automatically check-in and register luggage. The system uses fingerprint and facial imaging. [16]
•	Taiwan's National Immigration Agency (NIA) is deploying e-gates that use facial recognition cameras and passport readers, to verify the biometric data of passengers passing through them [17]

Table 1: International Examples of Biometric Travel Programs

## 4. Analysis of Biometric Implementations

**Table 2: Biometric Modalities in Travel and Immigration** compares the use of different biometric modalities based on international markets. Each of the columns represents a different mission for biometric implementation as follows:

- **International Border Control** – verification for travelers between countries; primarily used at destination arrival
- **Passenger Screening** – provides some form of verification of the general population base to confirm their presented identities; no particular group is distinguished from another ahead of travel
- **Registered Traveler** - passenger security assessment system, usually on a voluntary basis, whereby passengers provide biometrics in exchange for expedited screening procedures and other benefits
- **Employee Access Control** – restrict access to secured areas to select employees

	International Border Control	Passenger Screening	Registered Traveler	Travel & Transit Employee Access Control
<b>North America</b>	3 - Face 2 - Iris 4 - Finger	1 - Face 1 - Iris 2 - Finger	3 - Finger 3 - Iris	2 - Face 2 - Iris 3 - Finger
<b>Middle East</b>	4 - Iris 3 - Finger	4 - Iris	4 - Iris	4 - Iris 3 - Finger
<b>Central and South America</b>	3 - Finger	3 - Finger	N/A	2 - Hand
<b>Europe</b>	4 - Iris 3 - Face 4 - Finger	3 - Iris	4 - Iris	4 - Iris 3 - Soft
<b>Africa</b>	2 - Finger	N/A	N/A	2 - Finger
<b>Asia/Pacific Rim</b>	3 - Face 4 - Finger	3 - Face 4 - Finger	4 - Finger	4 - Finger
<b>Key</b> <b>Levels of use:</b> <b>4</b> – Leading technology; widespread use <b>3</b> – Mainstream technology; moderate use <b>2</b> – Limited market presence; niche use <b>1</b> – Research and or conceptual phase <b>N/A</b> – No presence identified <b>Modality:</b> <b>Face</b> – Facial recognition <b>Finger</b> – Fingerprint <b>Hand</b> – Hand Geometry <b>Iris</b> – Iris matching <b>Soft</b> – Soft Biometrics (e.g. height, weight, etc.)				

**Table 2: Biometric Modalities in Travel and Immigration**

Extrapolating the data presented in **Table 2: Biometric Modalities in Travel and Immigration** the following can be deduced:

- Biometrics are a key component for increasingly complex national border policies and are being integrated within ePassport (electronically enhanced passport) initiatives
- The technology initially has been used for permanent residents and visa purposes, and has slowly been expanding to include citizens on a typically voluntary basis
- The historic use of Hand Geometry and Fingerprint are giving way to contactless biometric modalities such as Face and Iris
- Verification is not limited to international passenger travel

## 5. Benefits

There have been many benefits realized from the international implementations of biometrics within travel and transportation systems. **Table 3: Benefits of Biometrics for Transportation Systems** provides a summary of the gains that have been achieved. The long term benefits do provide significant return on investment across several key stakeholders. Specific program expenditures, costs, and potential revenues are beyond the scope of this paper.

Benefits of Biometrics for Transportation	
<b>Benefits to travel hubs:</b> <ul style="list-style-type: none"> <li>• Less space required for mandatory processes</li> <li>• Passengers have more time during departure/arrival to purchase goods and services</li> <li>• More commercial space available in existing facilities</li> <li>• Ability to deploy common use self-boarding gates and generate revenue from airlines</li> </ul>	<b>Benefits to airlines:</b> <ul style="list-style-type: none"> <li>• Reduced number of personnel at boarding gate thus reducing costs</li> <li>• Fewer late passengers detained elsewhere (e.g., security lanes, check-in queue)</li> <li>• Can recognize frequent travelers without additional procedures</li> <li>• Paperless environment reduces equipment costs</li> </ul>
<b>Benefits to passengers:</b> <ul style="list-style-type: none"> <li>• More pleasant travel experience</li> <li>• Less time required for security and screening procedures</li> <li>• Greater assurance against identity and property theft</li> <li>• Removes risk caused by lost documents</li> </ul>	<b>Benefits to government:</b> <ul style="list-style-type: none"> <li>• Increased public safety and comfort</li> <li>• Improved insight into traveler activities</li> <li>• Less personnel required to facilitate passenger screening thus reducing costs</li> <li>• More flexible in adapting to passenger traffic growth</li> </ul>

Table 3: Benefits of Biometrics for Transportation Systems

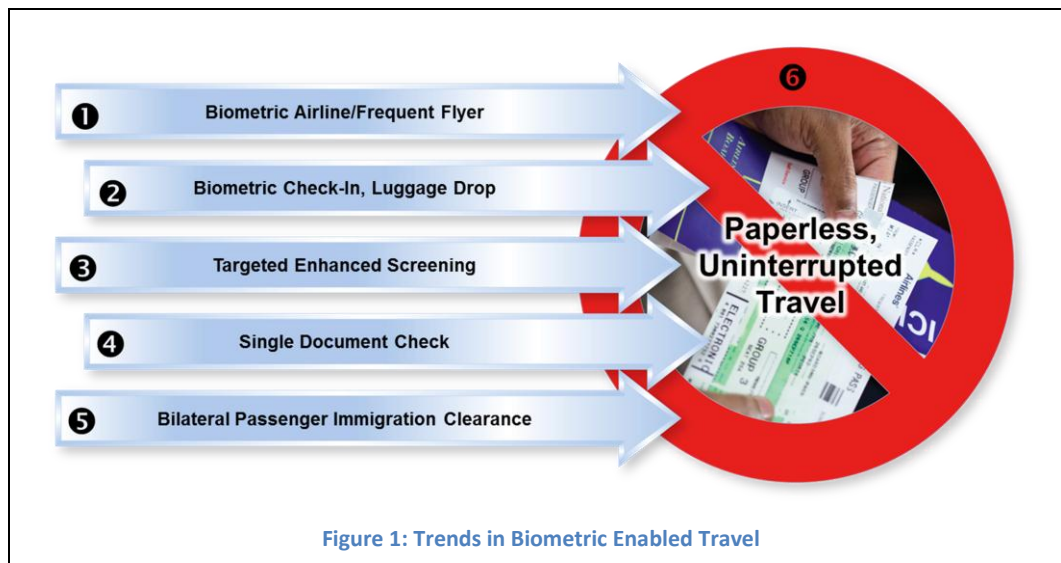
## 6. Future Trends

Recent advances in biometric technology have led to several capabilities that can be leveraged by Travel and Immigration systems. Most notably these advances relate to:

- Identity at a distance
- Binding a travel document to a pre-established identity

When used together and integrated appropriately these capabilities could eventually lead to uninterrupted, paperless travel. Technological innovations will reduce the need for paper-based travel documents (e.g. boarding passes, baggage receipts, etc.). Automated identification systems will use biometrics for check-in procedures and visa confirmation. Advanced sensors will perform screening without disturbing passengers. These innovations will be applied over time, successfully building on each other to reach the final state where use of paper-based credentials are eliminated and passengers can move unimpeded at travel locations while being thoroughly vetted.

A possible order of events is shown in **Figure 1: Trends in Biometric Enabled Travel**. Some of these technologies are already in limited production, while others are still in a concept state. Each step is expanded below.



- **Step 1 – Biometric Enablement:** In this phase biometrics are being used in limited capacity at some point in the travel or immigration process.
- **Step 2 – Biometric Check-in Procedures and Baggage Drop/Retrieval:** In this phase biometrics are more formally used in the initial steps for passenger travel, whereby the passenger uses their biometric to authenticate their identity and associate them to their belongings.
- **Step 3 – Targeted Enhanced Screening:** This is a conceptual phase whereby a travel profile is created for each traveler based on their individual risk level. Correspondingly, each traveler has a set of screening procedures assigned to them based on the defined risk profile [18].
- **Step 4 – Single Document Check:** This is a conceptual phase where, through identity binding the traveler need only biometrically verify their identity against one credential; any additional screening or travel information needed is logically retrieved through the identity management system.
- **Step 5 - Bilateral Passenger Immigration Clearance:** At this stage governments have come to agreements about data sharing for passengers, visitors, immigrants, and visa elements. Travelers between nations need only to verify who they are and their data is disclosed accordingly in a safe, secure manner.
- **Step 6 – Paperless Uninterrupted Travel:** Passengers are able to freely move through transportation hubs without the need for hardcopy credentials (e.g. all documentation, if exiting, is digitized) and without the need to stop and present their identities (e.g. identity is determined at a distance).



## 6.1. Paperless Uninterrupted Travel

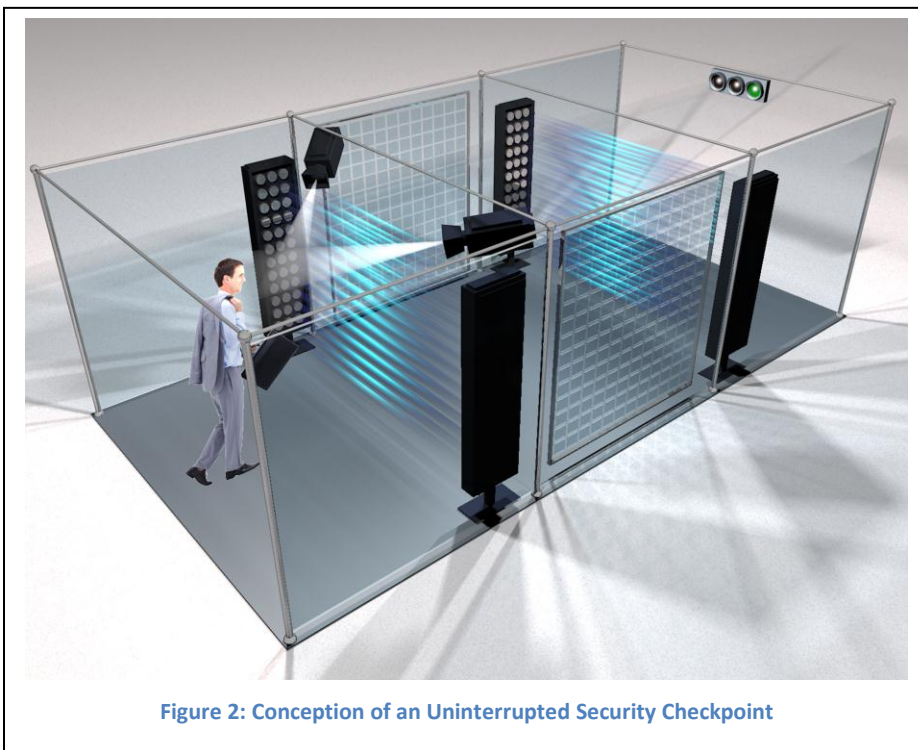
The final projected state of paperless, uninterrupted travel warrants special discussion. In this scenario, the airport security checkpoint is no longer a standalone line, but rather part of an integrated system that uses risk based analysis as well as advanced screening technology to improve security and the travel experience for the passenger.

With paperless uninterrupted travel the passenger move unimpeded through a series of gates. Each of these gates use specialized sensors that work in harmony to:

- Identify the traveler
- Validate that the traveler is authorized to cross into a secured zone based on established travel plans
- Screen the traveler for prohibited items
- Direct the traveler through each gate or to a Transportation Security Officer if an issue is encountered.

These concepts are illustrated in **Figure 2: Conception of an Uninterrupted Security Checkpoint**. This diagram illustrates how an individual can pass through several screening checkpoints, each with its own function. The first gate uses non-contact, identity-at-a-distance scanners, to recognize the traveler. Subsequent gates scan for prohibited materials. Finally a traffic light provides feedback information if the individual is free to move forward or needs to interface directly with a travel official.

Recently the International Air Transport Association (IATA) demonstrated a similar concept with its "Checkpoint of the Future" [19] which showed a series of neon-lit tunnels, each equipped with an array of eye-scanners, x-ray machines, and metal and liquid detectors.



## 7. Conclusion

Biometrics are a proven technology to enhance Identity Management. There is a critical, world-wide, recognition of the need to enhance identity management services at border crossing and during travel. In time, the traditionally separate government functions of travel and immigration will move closer together as they operate in the same space and increase the data shared. Eventually, due to efficiencies in using biometric services to enhance identity management services passengers can experience uninterrupted travel in both national and international settings, without the need to provide documentation. These changes cannot be made without strongly developed policy and processes to guide the growth and implementation of biometric technology.

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