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GLOBOIDS for a Seamless Cross Border Mobility Experience

Ajay Mutreja
University of Auckland, ajay_mutreja@yahoo.com

Gabrielle Peko
University of Auckland, g.peko@auckland.ac.nz

Johnny Chan
University of Auckland, jh.chan@auckland.ac.nz

David Sundaram
University of Auckland, d.sundaram@auckland.ac.nz

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Completed Research

Ajay Mutreja
University of Auckland
ajay.mutreja@gmail.com

Gabrielle Peko
University of Auckland
g.peko@auckland.ac.nz

Johnny Chan
University of Auckland
jh.chan@auckland.ac.nz

David Sundaram
University of Auckland
d.sundaram@auckland.ac.nz

Abstract

The Covid-19 pandemic has brought the global border management issue to the surface. Policymakers are deliberating on mitigating the situation by employing measures for immediate resolution and are working on future sustainability. The purpose of this research is to address the scale, scope, and complexity of border governance that not only entails minimal human intervention but also global collaborative action. A design science research methodology was utilized to design the proposed artefacts, to enable a high-level understanding of the global border affairs, and to introduce a potential solution for deliberation, discussion, and future digital. A global border management intelligent distributed system has been conceptualized to be contactless and concerted. It also envisions improving efficiency, performance, and seamless and secure cross-border mobility in the post-pandemic new normal.

Keywords

Collaborative Global Border Management, Distributed Information System, Seamless Mobility Experience.

Introduction

Before the pandemic, the international air travel and tourism industry catered to over 8 million people per day allowing safe travel across borders (WEF 2017). With security and safety as their prime focus, the border management agencies played the role of gatekeepers to manage this volume of mobility. (Doyle 2010). These agencies mostly operated in silos to secure the borders with variety of physical and digital systems and processes. These physical deployments required human contact and intervention that resulted in slow processes consequently leading to long ques and delays for travelers at the border checkpoints such as airports. With the evolution of technology, "digital borders were co-produced by the interaction and interplay of human actors and various technological systems at various border sites (Trauttmansdorff 2017)".

In 2020, the Covid-19 was declared a pandemic. Most countries sealed their borders. However, during the lockdown the world underwent a digital transformation at an accelerated rate among individuals, organizations and communities alike. And now the production, delivery, payment, and consumption are all being digitally realized, a whole new post pandemic experience is born (Singer 2020). One realization from the global lockdown is that globalization is deeply ingrained in the economic development of the 21st century world. Meaning borders is not a long-term solution for prosperity (Singer 2020) and thus the travel and tourism industry won't stay at bay for too long. Nevertheless, the tourism industry may not be the same in the post pandemic new normal. Contactless digital systems, vaccine passports, antigen tests, and quarantine requirements could become an integral part of cross-border travel (Douglas 2021). In the new normal, digitally advanced world the border agencies will have to face all the past issues together with new ones and find solutions that are contactless, concerted, efficient, safe, secure, and seamless. To address our research question, how can we create an efficient, secure, and seamless global cross border mobility experience? An intelligent system is proposed that can coordinate activities, among all the stakeholders

with minimum human intervention. This proposed system enables a seamless experience for travelers and global collaboration among agencies without compromising on efficiency and performance while upholding security of the participating nations.

This paper utilizes the insights of an industry insider, addresses contemporary border management issues and requirements from the perspectives of a traveler and the stakeholders including the practitioners. It draws upon the literature to investigate various border aspects, establishes the context of the global border management intelligent distributed system (GLOBOIDS), and outlines its design. In conclusion, the impending issues are discussed to further the efforts of industry and academia towards improving the system design for the management of digital borders.

Research Motivation and Methodology

To begin, an advanced search with the keyword 'border' from the title of articles delivered more than 100,000 results in Google Scholar. Refining the search string with the exact phrase 'border management system' in the title, fetched 10 results which were shortlisted for study. Then, expanding the search of this phrase to occur 'anywhere in the article' produced 910 results, out of which 115 articles, from the time of the onset of the pandemic i.e. since Jan 2020 till May 2021, were selected. The analysis of the titles, keywords and abstracts from the total of 125 articles identified the following research gaps: 1) most studies are engrossed in the context of adjacent borders among the countries in the European Union (EU), 2) most articles are presented from the standpoint of policy, security, mobility, surveillance and mistrust but not much has been studied from the perspective of traveler experience, 3) the integrated system solutions addressed the aspects of integration and collaboration for cooperative border efficiency, but few addressed them from a global perspective, and 4) there appears to be a lack of a comprehensive model for a global border management information system. This study utilizes a design science research methodology (Hevner et al. 2004), follows its design cycle; ideate, acquaint, abduct, analyze, abstract, architect, and evaluate, conceptualizes a comprehensive global information system design for seamless border management, and contributes to addressing some of the gaps identified.

Digital Borders

Borders and Ports of Entry: A border is an imaginary line (Cambridge Dictionary, 2021), that divides one country from another. It is an implied understanding that a border defines sovereignty of a country; the citizenship of the people belonging to that sovereign territory; the legal, political, and economic rules; and the resources (natural or manmade) as well as the environment within a territory. None of the means, employed to demarcate the borders, have been able to effectively bar people from crossing them in either direction (Nail 2016). On their POEs the managing country exercises their controls necessary to prevent and punish infringements of its customs and regulations through immigration control systems, custom control systems, policing and patrolling systems, and other assets housing these systems such as airports and seaports (Andreas 2019).

Border Management Systems: Border management has to deal with legal and/or illegal movement of people and goods positing Political, Economic, Socio-cultural, Technical, Environmental, Ethical, Legal, and Security challenges associated with them. Humans crossing the border could be legitimate non-threatening (travelers with entry-exit permissions) or illegal non-threatening (slaves, immigrants crossing without permission) or illegal/legal but threatening (e.g. terrorists). The commodities including currencies crossing the border carried by humans or not, could also be legal (allowed/moving with permission) or illegal such as contraband, counterfeit, weapons, explosives, illegal plant or animal species or their parts. And now in light of Covid-19, viruses may also be included in this category (Papademetriou 2011).

Border Information Systems: Border Information Systems (BIS) are a category of all technology mediated information systems used at the border for border management (Koslowski 2003). Some of the key BIS are discussed below.

Visa Information System: A visa (Merriam-Webster, 2021), is a permission endorsed on a travel document of the applicant by the issuing authorities that denotes that the conditions of applicant have been examined and it is safe to legally allow the bearer of the permit to enter the sovereign territory of the issuing country for a specified period of time. The information system that manages the issuance of this permit by capturing all the information required to issue this permit is generally known as Visa Information System (VIS). For

seamless data synchronization, VIS may have an opportunity to connect with Passport/ID issuance information systems, now commonly known as Identity Management Systems (Hill et al. 2020).

Identity Management System: As of now a passport is still the main Identity document accepted for international cross border movement. It is a standardized document accepted globally by all the countries of the world since 1980 under supervision of ICAO (International Civil Aviation Organization). Passport (Merriam-Webster, 2021), is defined as 'a formal document issued by an authorized official of a country to one of its citizens that is usually necessary for exit from and re-entry into the country, that allows the citizen to travel in a foreign country in accordance with visa requirements, and that requests protection for the citizen while abroad'. Passports are evolving, the latest passport standard require passports to embed a microchip in them to make them, machine readable and counterfeit resistant (Kundra et al. 2014). Digital transformation across the globe is expected to transform the passport from booklet to a simple microchip enabled card that will carry all the digital information about the traveler's personal identification, citizenship, visa permissions and time stamps (Sparke 2004).

Exit and Entry System: Immigration and Emigration Exit Entry systems (EES) are deployed on the border as stamping systems, they collect the traveler's information from the chips and/or magnetic data strips on the traveler's passports. They may connect with visa system to confirm validity of the permissions, they may connect with transport systems of airlines and cruises to confirm the authenticity of the travel and duration of stay and formally stamp the validity of their stay digitally on the information system and manually on the passports. These systems may also be used for audit purposes (Singh and Jotheeswaran 2018).

Customs Control System: Customs (Merriam-Webster n.d.), is 'duties, tolls or imposts imposed by the sovereign law of the country on imports and exports.' Like VIS Customs Control Systems (CCS) govern and control the movement of goods, they capture information of consigner from the alien countries, the type of goods and the information of people importing the goods inside the country and vice versa (Arnold 2012). Since travelers often carry luggage and baggage with them and customs have to ensure that illegal goods are not imported or exported in those baggage (Zhang et al. 2008).

Security and Surveillance System: Security and Surveillance System (SSS) may be qualified as systems devised to manage security and surveillance of the borders or POE facilities, these systems connect with various devices such as CCTV cameras, and may use various advance detection technologies such as facial recognition, body X-Ray scanning, baggage scanning, IoT beacons for fire, temperature, wind and humidity check, heat scanners for crowd control, smoke detectors for fume controls etc. These security systems may independently operate on their own underlying databases collection, management and control (Georgi 2008).

Travel Management Systems and Logistics Management System: Various airlines, hotels, cruises, rental companies and logistic companies operating in the host country as well as the guest country. They manage their own systems with their own independent databases, or work together to distribute their services (reservation and booking) through central reservation systems or global distribution system. They may have to share information with international bodies such as IATA, Interpol, Immigration, security and VIS as on need basis and this information may be presented by the traveler when demanded at any of these touchpoints (Dogac et al. 2004).

Verification and Validation System: As stated earlier, visas are no more necessarily endorsed on the passport they can be electronic as well, but to apply for these online or offline, manual or electronic visas/ permits, the travelers have to submit applications manually (paper applications) at the embassies or consulates of the destination country while at the home country or through online web-based application systems directly to the destination country from the home country. The most important point here is that there is a huge digital divide between the countries on this middleware, either due to technology divide or policy divide and because of these divides the systems may not talk to each other and there is still a lot on manual work undertaken to manage these processes (Galbally et al. 2019).

Cross Border Mobility

In the context of European Union, millions of migrants cross its borders to make their way to safe spaces. The refugees rely on physical and digital bequests for movement. These bequests can be leveraged for generating information for surveillance, control and policy draft (Latonero and Kift 2018). The three flows identified in cross border mobility are;

People Mobility: Travel and tourism may be defined differently in different context by different scholars. From one of the perspectives, international travel and tourism are activities, which are politically agreed upon, economically rewarding and legally permitted arrangements for cross border mobility of people and the goods that those people are allowed to carry for their personal use for the duration of the stay at their destination country.

DIKW Mobility: When people move, they come across several checkpoints infused with several technologies, share their information at these touchpoints and in this whole process a lot of data, information, intelligence, communication, economic values, permissions, consensus, and agreements transact. These transactions take place in between the actors, the actors and the agencies, and in between the agencies (travelers, airport, government, airlines etc.); these transactions may be explicit or implicit or latent. And there are a lot of systems that orchestrate to facilitate this activity of mobility. This movement of data (D), information (I), knowledge (K), and wisdom (W) across the borders is referred to as DIKW mobility.

Objects Mobility: Mobility of goods, commodities and objects of personal use may be permitted as carry-on baggage or shipped goods or not permitted depends on the laws, rules and regulations of both the home country and the destination country. The travelers have to comply with the rules of both the countries and may have to pay necessary fee, duties, taxes to carry on or ship permitted goods and may be subject to penalty in case the rules are not followed or are disobeyed (a fundamental topic for free markets and free trade). It is the responsibility of border management, BMS, and BIS to safeguard its sovereign territories from border activities by permitting the legal ones and obstructing the others while maintaining the highest state of security of their respective sovereign states without compromise.

Global Border Management System Requirement

An intelligent system is required that can coordinate all activities, among all actors and agencies with minimum human intervention, enabling seamless experience to the travelers and global collaboration among agencies, with improvement to efficiency and performance while upholding the security of the nations and security of its citizens. While people and objects are physical, the deployment of such system will enable all the actors and agencies to produce, consume, interact with and create data. In layperson terms this contextual handling of the data that is collected through system collaboration, inter-agency cooperation, shared as on need basis, and presented in a way that makes sense to actors and agency in the home country, destination country, and to the international neutral organizations, would make the global border management information system intelligent. It would enable the system to operate in compliance with complex rules, regulations, laws, and policies of multiple countries; promote governance and security for each of them; support their efficient use of resources; make best use of collective infrastructure; is easy to use by personal of all cognitive levels in all languages, and can aid in new information creation, generating intelligence, and enhancing communication.

But the problem is that now-a-days countries consider data as a new economic force. They believe, the one who controls the data controls the world, therefore, everyone wants to control the data and no one wants to give up their ownership of the same, hence, everyone wants their own system to create such data (The Economist 2017). Therefore, only a system that could be everyone's, can keep the sacrosanctity of data for everyone, yet manage to cooperate and deliver the desired results, would be able to garner the acceptance of the agencies, and can hope to see the light of the day.

Ludwig Von Bertalanffy, (1975), prescribes that a system is an entity that is made up of various connecting parts or elements. According to Van Steen and Tanenbaum, (2016) 'A Distributed system (DS) is a collection of autonomous computing elements that appear to its users as a single coherent system'. Here each system (node) may behave independent of one another, although interconnected yet appear to be single to the users. A node may range from high performing super computer to small IoT sensor or beacon. With conditional closed group membership only settings, the member nodes of the group can communicate with each other privately and securely. With structured overlay arrangement each node is logically organized such that it can be exactly defined whom it can communicate with and what can be communicated with clear path and information settings, leading to high relevancy and reliability. The transaction, computing and data management may be distributed according to distribution transparency but a unifying file system may be used as an interface to access the resources. Thus, the requirement, an Intelligent Distributed System for Global Border Management, GLOBOIDS.

GLOBOIDS

The current state of affairs of the industry is that the industry actors and agencies across the globe are at some state of the digitalization continuum. According to the UTAUT2 theory (Venkatesh et al. 2003) for the technology to be accepted by these multiple actors and agencies in the multiple countries, the solution must be easy to use, easy to implement, valuable, and must not be costly. According to Cognitive Dissonance theory (De Vos and Singleton 2020) the solution should not bring any radical change. As also supported by conservation of resources theory (Hobfoll and Ford 2007) the actors and agency may look to protect, conserve, and use the systems they own and acquire new ones they value. GLOBOIDS shall position itself among the currently deployed systems as shown in Figure 1.

GLOBOIDS System Prerequisites

To be able to cooperate and integrate diverse systems without creating commotion, to benefit all the actors and the agencies, GLOBOIDS has to fulfil certain requirements, make some commitments, and uphold certain oaths for its commissioned life as shown in Figure 1. It should operate in compliance with the rules regulation, laws, and policies of all the countries it would serve; administer automated governance and control; make judicious use of all the resources human, technical, and financial; first make use of all existing infrastructure (equipment, facilities, and telecom) and then prescribe minimum requirement for upscaling; serve all actors, users and personnel deputed to its use for security or other purpose with permissioned access management and optimum levels of transparency; promote the sharing of the information, but the ownership of the data shall remain with the producer system; enhance inter agency communication, and; build cooperation, trust and collective intelligence.

GLOBOIDS Design Consideration

GLOBOIDS permits collaboration among diverse BIS, this collaboration unifies diverse system owner to collaborate towards a common goal promoting mutualism and optimization. Collaboration promotes sharing of data, resources and infrastructure. Sharing enables aggregation and cutting down of duplicate transactions and generation of shared intelligence that improves vigilance and security. All actors equitably get the data that they need. Workflows shall be manageable (administrable & configurable) but automated. The system shall generate traffic analytics for wise decision making. Users do not have to enter their information again and again as required by all the systems, they may just use their mobile phones and/or IDs to transact at the border e-gates that would facilitate digital stamping and relevant database update for all the actors and agencies.

The system is scalable vertically and horizontally to integrate the new actors and agencies and new activities such as digital vaccine passport information systems connected with the national ID management system or medical insurance contract with the insurance company that might be needed in case of emergency in the foreign country. In case of subsequent travel, the system may facilitate data reuse, time stamping, profile updating, versioning and change archiving. With such facility all the travel history and traveler ID related updates will be available to all security agencies at all checkpoints, the amount of information to be revealed can be layered in the hierarchy of transparency from 100% transparent to 100% opaque and permissioned according to the specifics of the role of the agency actors. Although the transactions may be geographically dispersed in time and space, it would be chained together for usage. The storage of data is managed by multiple owners and may be physically distributed across the globe but shall appear to be centralized. The processes such as relocation, migration, replication and failure handling of the databases by sundry agencies shall be transparent. GLOBOIDS system would be scalable (in size, geography, and administration) and open to be actor wise component bases that can easily integrate and interoperate. Storage, sharing, refreshing, and exemption policies abstraction is paramount for trust fabric as well as protecting itself from the malicious attacks from outside and inside. The sundry cooperating systems needs to be pervasive as they will cooperate with systems in diverse geographies and time. It would facilitate asynchronous and synchronous transactions across temporal-spatial distribution, suggesting that the interaction and transaction of the system is dynamic on-the-move. The maintenance and the ownership of the data shall remain with the principal agent however metadata or concocted data hashes is stored on the central platform, data shall be available instantaneously and provided on request/ demand as and when required for deeper probing.

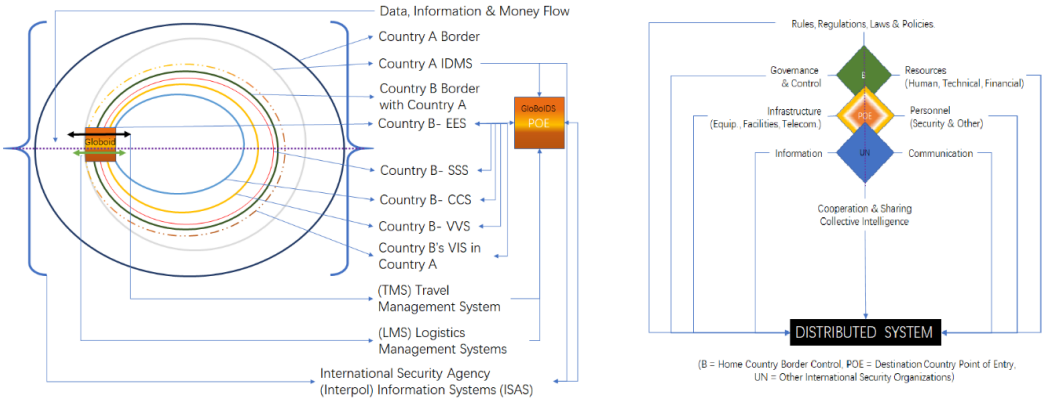

Figure 1 – Positioning GLOBOIDS and System Prerequisite

GLOBOIDS Architecture

A system architecture is its structure, a representation of its features, and a model of its separately and specifically behaving components and their interrelationships. To comprehend the architecture of GLOBOIDS it is essential to consider four key questions to frame its structure: 1) what entities are communicating, 2) how do they communicate, 3) what are their roles and responsibilities, and 4) what is their placement on the physical distributed infrastructure? GLOBOIDS architecture presented in Figure 2 considers the above questions and provides for the means for inter application and intra component communication through the hard and soft interfaces such as sensors and APIs respectively.

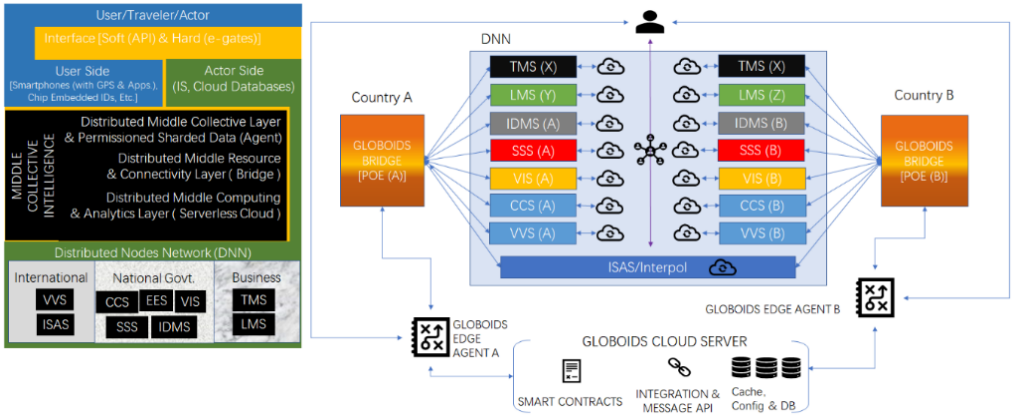

Figure 2 – GLOBOIDS Architecture

The Distributed middle layer provides several services such as security services, failure management and recovery services, accounting services, and resource management of peripherals, storage space, data files, etc. It offers its networked applications to efficiently deploy their resources, share them across the network, and guarantee inter application communication through remote procedure calls (RPC). This is done to invoke functions that are implemented and executed on remote computers and to manage multiple services distributed among several remote actors through atomic transaction management. Resource sharing may be enabled through P2P file sharing.

GLOBOIDS System Design

Globoid creates a distributed node network (DNN) of the participating BIS, Each BIS has its own independent function and data management scheme, either on cloud or privately managed servers. The GLOBOIDS cloud application may have multi-language front end application for the traveler's PC as well as Mobile use, it ought to have the multi-language back-end application interfaces for the agency users. A distributed cloud infrastructure will be created for managing the data inflow from the distributed systems spread across the geographies and managing permissioned shared data operation. This would consist of

centralized cloud server which would manage inter agency smart contracting, API, and RPC definitions and various databases for memory, storage, and configuration of hash chained traveler's profile. The regional cloud bridges would connect to respective region BIS and get the hashes of grouped data and the edge agent that will perform regional hash computing for the regional bridges and corresponds with the central cloud server. The traveler's profiles may be managed and stored in the regional bridges. Depending on traffic, latency and data requirements there could be multiple bridges, agents and servers interconnected to deliver seamless service, also different computing edges may also be responsible for natural language processing computing operations as shown in Figure 2. The design makes no assumptions about the similarity of hardware, operating systems, networks, domains, computational capacity, storage capacity, backend architecture, I/O transfer rates and cache duration among the actors DNN.

GLOBOIDS Process Flow

Travelers shall continue to use the applications they use to travel internationally. They may use the IDMS application system to get passport, then they may use a travel management systems to book hotel or flight, use centralized VIS to obtain visas, all these systems will feed information to GLOBOIDS and GLOBOIDS middleware will generate the QR code and push them to frontend application for scanning at the airport personnel check-ins, baggage check-ins, e-gates of the home country on departure, the e-gates system relays exit time stamp information to GLOBOIDS, before the traveler arrives at the destination the information on the QR code is updated and applicant can scan seamlessly on the e-gates of the destination country on arrival, the updated entry time stamp information is relayed to GLOBOIDS. The process is reflected in Figure 3 and remains the same for the return. The next time the traveler is bound to travel, this timestamp information will already be available in the archived profile of the traveler, any changes to the ID would also be registered, and the number of IDs issued to the traveler shall be registered. All the traveler information shall be available at POEs, to all international security agencies such as Europol and Interpol, as on need basis.

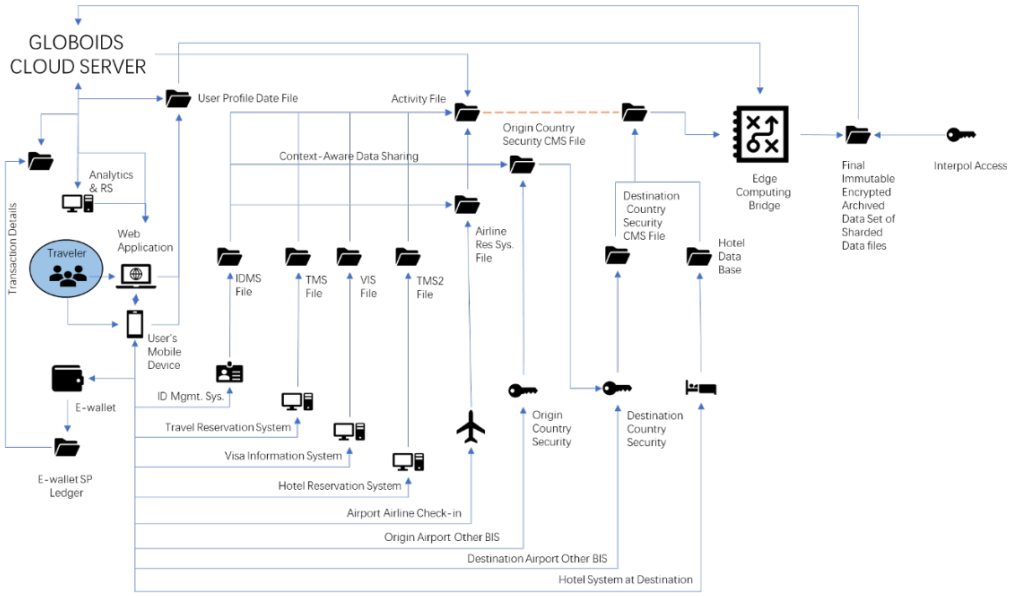

Figure 3 – GLOBOIDS Process Flow

GLOBOIDS System Design Evaluation

Descriptive, Scenario Based Evaluation (Venable et al. 2012): A user from New Zealand Mr. X is in Hungary and has to travel to Canada, but his passport has expired. He has to apply to renew his passport through New Zealand national ID management System (S1) which connects to New Zealand Passport department (S2). He waits a month for his renewed passport to be delivered to him in Budapest. After which he books a ticket to Toronto using a GDS (S3) and applies for a travel permit to Canada using the Canadian visa portal (S4). On the day of departure he goes to Budapest airport, an immigration officer enters the data on its entry exit system (S5) and stamps the exit date on his passport, the data is crosschecked with the black list

from Europol (S6). On arrival in Canada there is an exit entry system (S7) maintained by Canadian Immigration at Toronto airport, an officer checks the data, stamps entry date on his passport allowing entry to Mr. X into Canada. After finishing meetings in Toronto Mr. X returns and encounters systems S3, S7, and S5 on his way back. In this scenario, Mr X interacts with 7 systems (S1-S7) either once or twice. The systems are developed, implemented, operated and maintained (DIOM) independently. They may not be connected, may collect same information repeatedly (name passport number, dates, etc.), and may maintain self-governed databases.

GLOBOIDS system design conceptualizes to interconnects all these systems and make them talk to each other, share database, reduce repetitive data entry, increase automation, improve efficiency, eliminates the hassles of physical stamping of passports. On the ripple effect the passport as we know, may reduce from a book to a card that may never expire, data once entered in one system shall be shared by all and the concatenated data would generate collective intelligence to achieve discerning risk vectors for security and safety of the travelers. What if the Covid-19 vaccine status of Mr. X connected to his ID automatically gets associated to his international travel? How many hassles would such a seamless system save Mr. X and others involved in Mr. X's journey?

Discussion & Conclusion

The implementation of a comprehensive border management system is not a common approach and is a challenging effort on even the national and sub-regional levels (WEF 2017). On global scale, balancing good and bad, right and wrong, legal and illegal, political and economic, with respect to millions of crossing per day at a POE of people from more than 200 countries speaking more than 100 languages can be an extremely challenging tasks for the busiest border checkpoints of the world. Particularly, when the management of the BMS is a responsibility of more than one agency, interoperating more than one information system, the implementation of GLOBOIDS is a complex process. Firstly, regional cooperation systems like an EU system may be drafted such as NAFTA system, ASEAN system, etc. and all such regional systems may then be connected into a larger global system just like a Global Distribution system of an airline.

Although the strength of this paper is the conceptual model itself, the prime limitation of this paper rests in the practicality of the implementation of the conceptual model. Through literature review it appears that there is a lack of comprehensive model for a global border management information system, this is probably due to the lack of a central authority (CA) to overlook the system DIOM. The prime limitation may overturned by appropriately involving a CA like ICAO which has already been controlling all the global airports, airlines schedules, etc. and, have an extensive experience in handling inter-governmental policies, trust, and cooperation. All agencies may fund the CA for DIOM of GLOBOIDS based on the proration of the transaction data that each one may prosume. CA would organize consensus to integrate all BIS across the travelers' journey, from digital identification to visas to authentication through biometrics to immigration to airport transfer gates.

GLOBOIDS highlights the power of cooperation, it represents an ideology of one world, a global culture, and a state of collective consciousness that calibrates in trust. The policy makers may raise concerns about privacy and data sharing but this solution would generate information from the data that is pre-consented to be used by the travelers to the agencies they trust, would prove to be more legitimate and efficient way for agencies like Interpol and Europol. Data from the IOT enabled touch points and security systems would converge to form such neural networks that could help machine to deeply learn about the traveler's behavior and generate a risk vector, through which a few travelers on one side of the vector may be screened for deep probing while the majority clustered on the other side conveniently cross hassle-free and seamlessly (keeping the human bias constant).

This solution does not challenge the existing policies, which are anyways challenged by pandemic, in any new way; it is a right time to look at them and shape new digital border policies of tomorrow, in parallel to responding to the issues of today while improving the safety of the national borders and the citizens within those borders. Creating a secure, connected, and inclusive world is possible today. This solution may seem to be fictional but in this digital age, with data technology, digital ID and digital security advancements, as well as standardization of data policies, moving from physical borders to digital borders is not unimaginable. In effect, it is needed to integrate all BIS across the travelers' journey, from digital identification to visas to authentication through biometrics to immigration to airport transfer gates. Data

from the IOT enabled touch points and security systems would converge to form such neural networks that could help machine to deeply learn about the traveler's behavior and generate a risk vector, through which a few travelers on one side of the vector may be screened for deep probing while the majority clustered on the other side conveniently cross hassle-free and seamlessly (keeping the human bias constant).

There are several other issues that GLOBOIDS may face similar to other distributed systems such as; computational capacities, storage issues, change in topology, change in network performance, homogeneity, latency, bandwidth and most importantly the trust on the administrators. In our future studies we may look into usage of TOSCA data (Dehury et al. 2022) for modelling data pipeline as per the schema of data federation. GLOBOIDS would offer advance capabilities in data cooperation for seamless travel experience while crossing borders. And, it may solve data integration issues on local, national, regional, and global levels. The data integration, processing, computing and analytics would make the future AI systems more powerful and strengthen the overall big data driven global security. The designs proposed here contributes to the theory of BMS designs and would serve as a great reference point for future. With its comprehensive understanding, scholars may be able to look into other compelling aspects, such as block chain technology's smart contracts for equitable permission management.

GLOBOIDS is an acronym to support the representation of an intelligent system harnessing the power of a distributed systems with cooperation among the diverse nations of the world. This paper presents a unique solution from a traveler's perspective and inks the understanding with clarity for various industry stakeholders. It proposes an architecture that is an enhancement of the architecture suggested by Papademetriou, (2011) and furthers the body of knowledge for the academia to refer to, to improve the system design for efficient global border management.

The proposed GLOBOIDS solution may seem to be fictional, but in this digital age, with data technology, digital ID and digital security advancements, and standardization of data policies, moving from physical borders to phygital (Physical + digital) borders is not unimaginable. It may not solve all the current POE problems and issues, but it is a step to making them smarter and traveler's experience at those POEs seamless. It may also encourage policy makers to think about this as one of the ways in which various agencies can collaborate, cooperate, and control their border to secure their sovereign territories with trust rather than mistrust. The pandemic presented an opportunity to address the global border management issue and shape new "digital borders (WEF 2017)" of tomorrow, while caring about the safety and security of the citizens within those borders. With the advent of digital technologies, creating one, secure, connected, inclusive, and seamless world with phygital borders for a sustainable future is possible today.

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