

LEADING THE GLOBAL AVIATION SYSTEM TO THE NEXT LEVEL OF SAFETY AND RESILIENCE

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Aviation is the backbone of the global economy. A safe and resilient aviation system is essential to stability and growth in the United States and around the world. The groundwork for safety and resilience in the aviation system was laid on December 7, 1944, when 52 nations came together in Chicago to establish a new and growing form of transportation: commercial aviation.

Just over two years later, the International Civil Aviation Organization (ICAO), a specialized agency of the United Nations dedicated to ensuring safety and the orderly growth of the aviation industry, was created. ICAO has played an important role for the past 73 years in setting global technical standards and recommended practices, as well as ensuring the harmonization and interoperability of technologies, policies, and procedures.

In recent years, ICAO and the aviation community have demonstrated their ability to quickly respond to new threats and opportunities facing the global aviation system. After the attacks on September 11, 2001, ICAO instituted a new set of security standards, including a requirement that passenger-carrying aircraft be equipped with a flight crew compartment door designed to resist forcible intrusions by unauthorized persons. After Malaysia Airlines flight 370 disappeared in March 2014, ICAO implemented new guidelines requiring aircraft to carry tracking devices to autonomously transmit location information in situations of distress.

As we celebrate the Chicago Convention's 76th anniversary and ICAO's long history of success, new and growing challenges, from cyber risks to global pandemics, pose significant threats to aviation. There is a vital need for the global system to work better and for the ICAO to again lead the world in achieving new levels of safety and resilience. By leveraging data, building strong partnerships, and utilizing common frameworks, the global aviation community can address quickly evolving challenges. Together we can enhance passenger safety by closing the safety gap between countries and ensuring a resilient, robust system that can rapidly recover from accelerating cybersecurity threats.

Enhancing Safety for Passenger Confidence

Safety has always been the cornerstone of the aviation industry, and ICAO and its member states have led the way on standards and technology to make aviation one of the safest modes of transportation in the world. But achieving the next level of safety will require addressing three key issues: (a) closing the safety gap between countries, (b) developing a framework that includes global health standards to protect passengers and facilitate recovery from the current and future pandemics, and (c) to improve safety as our commercial fleet grows in diversity and numbers.

Closing the Safety Gap

The extraordinary safety record of passenger air transportation is illustrated in a recent study of global aviation safety by Arnold Barnett of MIT, an authority on the statistical analysis of aviation safety data.¹ Barnett focused on passenger fatalities during scheduled commercial air transportation and estimated a fatality rate per boarding, which equates to “passenger fatalities per passengers carried.”

Barnett calculated that, over the last 50 years, the worldwide fatality rate per boarding dropped by a remarkable 96 percent, going from 1 in 350,000 in the decade 1968-1977 to 1 in 7.9 million in the decade 2008-2017.

Barnett also grouped the data by country using a statistical method for partitioning the countries into three groups: lower risk, intermediate risk, and higher risk. In the most recent decade (2008-2017), the fatality rate ranged from 1 in 33.1 million in lower-risk countries, to 1 in 7.4 million in intermediate-risk countries, and to 1 in 1.2 million in higher-risk countries.

Again, the analysis shows consistent improvements over time, with each group reducing risk by at least a factor of six between 1988-1997 and 2008-2017. Even in the higher-risk areas of the world, scheduled passenger air transportation is extremely safe. As Barnett explains, if a randomly chosen passenger is subject to a fatality rate of 1 in 1.2 million whenever they fly, they could on average take one flight per day for 3,300 years before becoming an aviation fatality.

However, the persistence of the safety gap over time across the groups is disappointing. By Barnett’s estimations, other than the shift of some countries into the lower-risk category for 2008-2017, there is surprisingly little convergence in risk across the groups over the last three decades.

By themselves, Barnett’s results support a global call to action to reduce the persistent safety gap in risk across the groups. However, one aspect that Barnett’s analysis does not reveal is the increasing share of

global passengers accounted for by intermediate- and higher-risk countries over time. Based on data from the World Bank, the share of global passenger boardings accounted for by intermediate- and higher-risk countries has been consistently increasing over the past 30 years and, along with it, global aviation’s relative exposure to the safety gap. In terms of relative exposure, the significance of the safety gap between the lower-risk countries and the intermediate- and higher-risk countries doubled between 1970-1977 and 2008-2017, as the intermediate- and higher-risk countries’ share of global passenger boardings increased from 17 to 34 percent.

Looking to the future, the exposure to the safety gap is forecast to increase if current trends persist. Based on a forecast from Airbus of trips per capita by country, combined with a population forecast from the World Bank, the share of global passenger boardings accounted for by intermediate- and higher-risk countries is expected to increase by nine percentage points over the next 20 years, increasing from 36 to 45 percent.² In terms of relative exposure, the significance of the safety gap is forecasted to increase by a factor of 1.25 from 2018 to 2038, assuming no change in country-group assignments.

The impact of the COVID-19 pandemic on this forecast is unclear. The forecast is of the global share of passenger boardings across country groups, so it is the relative change that matters, not the change to the total number of global passengers. Also, the forecast is for 2038, so assuming a return to long-run patterns is reasonable.

While the aviation community should be commended for the steady improvements in safety, the call to action due to the persistence of the safety gap across country groups, as illustrated by Barnett, is amplified by the forecasted growth in the share of global passengers from intermediate- and higher-risk countries.

ICAO, by promoting improved standards, regulations, equipment, and infrastructure, has played a significant role in the dramatic improvement in aviation safety over

¹ Arnold Barnett (2020) *Aviation Safety: A Whole New World?* Transportation Science 54(1):84-96. <https://doi.org/10.1287/trsc.2019.0937>

² Airbus (2019) Global Market Forecast: Cities, Airports & Aircraft, 2019-2038. See supporting data spreadsheet from <https://www.airbus.com/aircraft/market/global-market-forecast.html>; The World Bank Data Catalog: Population Estimates and Projections, <https://datacatalog.worldbank.org/dataset/population-estimates-and-projections>

the past three decades. To close the safety gap and reach the next level of safety, ICAO and global safety leaders will need to further expand their efforts. Key focus areas that need to be pursued together include continued promotion of “just culture” approaches, wherein the broader aviation stakeholder community can be leveraged to reach deeper understanding of “what went wrong?” as opposed to “who do we blame?”; enabling an environment that leverages information and technological advances to incorporate global aviation data into collaborative non-punitive research environments and to allow for increased sharing of sensitive information; and the application of artificial intelligence and machine learning to provide faster insights into safety issues on a global scale. The trajectory of future safety takes us to a place where sharing “what went right” is equally, if not more, important as understanding what went wrong; a strong information sharing bridge needs to be defined.

Safety and Public Health – Facilitating Pandemic Recovery

Enhancing passenger confidence in the aviation system from a public health perspective will also be a key element of taking safety to the next level. Transportation networks have been a principal vector for disease transmission throughout human history. Outbreaks of Zika, Ebola, influenza A (H1N1), and COVID-19 demonstrate that the global aviation network creates an extensive diffusion route for communicable disease. In the past, governments and aviation authorities around the globe applied varying degrees of rigor in the enforcement of and compliance with public health measures, including special procedures related to infectious diseases.

To address these challenges, in 2006 ICAO launched the Collaborative Arrangement for the Prevention and Management of Public Health Events in Civil Aviation (CAPSCA) program. CAPSCA is a voluntary cross-sectorial, multi-organizational collaboration program managed by ICAO in partnership with the World Health Organization (WHO) to improve preparedness planning and response to public health events that affect the aviation sector. CAPSCA has issued several important guidance documents since the start of the COVID-19

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pandemic, including the “Testing and Cross-border Risk Management Measures Manual,” for those nation states that choose to include testing as an element of their overall COVID-19 risk management strategy.

As the global aviation community looks to the future and develops a recovery strategy for COVID-19 and future pandemics, key questions need to be addressed. Even with the eventual widespread availability of a vaccine, how can passenger confidence in the safety of the air transport system from a health perspective be assured? How can nation states be assured that arriving passengers do not pose a threat for disease transmission? Among many cooperative interventions that will be needed, a key element will be expanding the speed and volume of information sharing across the stakeholder community. Participation will extend beyond traditional aviation stakeholders (regulators, airlines, airports, security) to reflect the diverse community required to address global pandemics, including public health officials, hospital systems, commercial laboratories, and medical professionals. The goal is to establish a trust framework to enable all participants to have confidence that each actor is fulfilling its obligations for health safety.

ICAO is uniquely positioned to build that trust framework across the community. One example would be around the health passport concept—an electronic record of a passenger’s test results or proof of vaccination. Several aviation stakeholders, including the Commons Project Foundation and the World Economic Forum, the International Air Transport Association, and several private companies have announced pilot programs for a health passport prototype. Outstanding issues associated with a health passport that the community must come together to address include:

- Developing a common open-source, verifiable credential standard for validation and authenticity that facilitates global interoperability³
- Ensuring the privacy and cybersecurity of sensitive health data
- Building and promoting trust in the health passport solution among passengers so they will voluntarily share this data with airlines and other aviation stakeholders
- Promoting rapid adoption by supporting common workflows (e.g., airline check-in, security screening)
- Creating a coordinated trust framework for international travel that recognizes both shared and unique data elements

Industry and governments need to come together to provide valuable leadership in shaping international standards for the development of a trustworthy, traceable, verifiable, and universally recognized digital record of immunization status. Working through a global public-private partnership of governments, industry, and non-profit organizations, we can accelerate the return of a robust international aviation industry.

Resilience Is Essential to Countering Accelerating Threats

As is the case with passenger safety, it is vital that the aviation system and diverse commercial fleet be able to withstand security threats that jeopardize service. ICAO has played an essential role in responding to threats and ensuring the aviation system can quickly rebound. With the number and severity of malicious

cyber threats increasing at an accelerating pace, the focus must be on building more resilience into the system. Rapidly emerging threats from cyber-attacks are important to consider as we work to achieve the next level of safety and resilience.

Like other industries, aviation is being transformed by an information technology and communication revolution. Air traffic control (ATC) and flight operations centers (FOCs) are now exchanging large volumes of information with one another and with aircraft. Modern commercial aircraft (e.g., B787 and A350) generate up to 10 terabytes of data on each flight, which is exchanged with ATC, FOCs, and airframe/engine manufacturers—in addition to passengers accessing video streaming and other services. New entrants, such as Unmanned Aircraft Systems (UAS), are also dependent on robust links between the ground and the aircraft. These types of operations will account for an increasing share of air traffic and drive even faster growth in data exchange.

To meet its current and prospective needs for ubiquitous connectivity affordably, aviation is moving to adopt commercial information technologies and communication services. In doing so, the global aviation system is increasingly exposed to the cybersecurity risks that confront other industries. As a result, the safety and efficiency risks to the entire system, due to an interruption to this information flow, are increasing.

To focus on one example, global aviation is increasingly reliant on radio frequency (RF) spectrum and thus is increasingly vulnerable to degraded use caused by malevolent actors. As aircraft systems and ATC move away from traditional land-based navigation and surveillance systems to rely on space-based technologies such as GPS, the aviation ecosystem may become more vulnerable to purposeful interference. Given the centrality of the RF spectrum to aviation operations, the global aviation community must take steps to safeguard its use, including physical security measures as well as technical measures to prevent jamming and spoofing, to enable authentication, and to address other cybersecurity needs.

³ <https://healthwallet.cards/>

Working through ICAO, all aviation stakeholders must establish a trust bridge giving all participants confidence that each actor is fulfilling its cybersecurity obligations. Maturing standards and recommended practices can mitigate damage and expedite recovery from an attack. Security measures must be balanced with the safe and efficient movement of cargo and people, economic and market-based factors, and protection of individuals' privacy and civil liberties. Maintaining transparency in the planning effort and promoting public-private partnerships and common frameworks will increase the effectiveness of risk mitigation actions and reduce burdens on aircraft operators and manufacturers. When attacks on the aviation community do occur, prior coordination on response strategies using a set of common frameworks is needed to mitigate damage and expedite recovery. The community must be prepared to implement contingency procedures to ensure continuity of operations, essential aviation services, and the resumption or redirection of civil aviation activities.

One example of such an approach is the Adversarial Tactics, Techniques & Common Knowledge (ATT&CK™) framework, a globally accessible knowledge base of adversary tactics and techniques based on real-world observations. The ATT&CK knowledge base is used as a foundation for the development of specific threat models and methodologies in the private sector, in government, and in the cybersecurity product and service community. ATT&CK helps cyber defenders develop analytics that detect the techniques used by an adversary and provides analysts a common language to structure, compare, and analyze threat intelligence. In these ways, ATT&CK can be a crucial contributor to adaptive security operations.

In order to maintain a safe, secure, efficient, and prosperous aviation system, ICAO and the global aviation community must maximize their awareness of current and emerging threats through rigorous data collection and sharing; identify gaps in existing threat management frameworks, and develop and



implement appropriate solutions to close them; and ensure resilience against expected and unexpected threats through dynamic and adaptive measures.

Leveraging the Community for Action

Addressing the challenges associated with achieving the next level of passenger safety and cyber resiliency will require the cooperation of the entire global aviation community. As it has over the last 70 years, ICAO can play a leading role in building the required trust across industry stakeholders and convening nation states to develop and implement standards and recommend practices. As a global leader in safety and resiliency, the United States can and should provide expertise as the world strives to take safety and resiliency to the next level.

Aviation stakeholders from across the public and private sectors, including airlines, aircraft manufacturers, airports, and air navigation service providers, will need to come forward, build strong partnerships, and share their expertise, data, and insights to successfully address these challenges. Specific actions are described in the following sections.

Promote Data Sharing

The future aviation system will be driven by data. A future rich with data provides the opportunity to leverage advanced analytics to improve passenger safety and system resiliency. However, to maximize this value,

data must be shared across companies and national boundaries. To achieve these benefits, issues related to data security, governance, trust, and standards will need to be addressed.

Build Strong Public-Private Partnerships

Aviation operates in a global environment, with both government and industry stakeholders playing key roles. By coming together in formal, structured public-private partnerships, the community has successfully addressed specific issues. Examples include regional safety information sharing partnerships and industry cybersecurity sharing and analysis centers. For sustained and scalable impact in the future, these partnerships must expand beyond national borders. Member states, working through ICAO, are uniquely positioned to champion the public-private partnerships required to build the technical infrastructure and orchestrate the policies and procedures needed to support a 24x365 service to protect the global aviation industry.

Develop and Implement Common Frameworks

To support expanded data sharing and strong public-private partnerships in the passenger safety and cyber resilience domains, a set of shared, common frameworks must be created and implemented. The broad adoption of interoperable solutions will accelerate the impact of these activities.

Leading the Way

Seventy-six years ago, the signers of the Chicago Convention could not have dreamed of the size, scope, and economic importance of global aviation. Over the ensuing decades, ICAO has proven to be a resilient organization that has effectively addressed new challenges as they arise.

Looking to the future, we are confident ICAO is the proper forum for U.S. leadership to address challenges such as taking safety and resilience to the next level. MITRE stands ready to assist the global aviation community, including government, industry, and academia, to identify solutions, facilitate collaboration, and define a path forward.

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