CANSO Guide to Seamless Airspace
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1 Background

CANSO, the Civil Air Navigation Services Organisation, is the global voice of Air Traffic Management (ATM) and seeks to proactively improve the provision of air navigation services through working with all stakeholders in the aviation industry. Through established Workgroups, CANSO facilitates information exchange between Air Navigation Service Providers (ANSPs) and stakeholders to promote best practices in the ATM industry.

CANSO’s Global Vision on the future of Air Navigation Services is focused on a collective industry approach towards achieving seamless air navigation service provision.

CANSO’s goal is to help ANSPs provide services that are technically interoperable, procedurally harmonised, universally safe, and affordable. We seek an operational environment in which everyone is performance-oriented, and in which the flying customer does not notice the transition between Flight Information Regions (FIRs).

Global harmonisation of operational standards and procedures is key to improving the safety and efficiency of air navigation service provision. Today, there are a growing number of initiatives destined to revolutionise the way air traffic management will be conducted – programmes such as Single European Sky ATM Research (SESAR) in Europe and the Next Generation Air Transportation System (NextGen) in the United States will set the stage for operations and system development for the coming decades, and will influence ANSPs around the globe. In addition, many other service providers outside of Europe and the United States are modernising their ATM systems. It is ever more critical today, with these projects leading the way, that the community come together to achieve global harmonisation and seamlessness. ANSPs and associated stakeholders must take a leading role in the development of Seamless Airspace and seamless service provision.

While “Global Harmonisation” and “Seamless Airspace” are noble concepts, the subject matter is expansive and difficult to achieve as an end-state. The purpose of this document is to highlight critical areas for improvement, as well as to recognise initiatives and services that are working well. Reaching a full seamless set of global services is an evolutionary process. In order to maximise the impact of ANSP changes, our objective is to identify areas where investment funds will bring the best operational improvements. In other words, we will attempt to pinpoint the specific areas where the next steps on the seamless airspace evolution should take place.

We value your feedback as an important part of improving our future outcomes. We encourage you to send your comments to info@canso.org.

2 Executive Summary

The first section of this document sets the foundation for achieving seamless airspace and ANS service provision. To advance the ANSP community, as well as all stakeholders, we must reach consensus on seamless airspace definitions and terms.

CANSO’s Seamless Airspace Workgroup (SAWG) proposes the following definition for Seamless Airspace:

Seamless airspace is contiguous airspace that is technically and procedurally interoperable, universally safe, and in which all categories of airspace users transition between Flight Information Regions, or other vertical or horizontal boundaries, without requiring a considered action to facilitate that transition and without any noticeable change in: 1) Type or quality of service received, 2) Air navigation and communications performance standards, and 3) Standard practices to be followed.
This guidance document also explains the differences between “standardised”, “harmonised”, and “interoperable”. It is important to develop a common understanding of terms, not only to prevent confusion, but also to help avoid the tendency to encourage service providers to build identical systems in order to harmonise services. Identical systems are usually not necessary and may drive up risk and cost.

It is particularly beneficial to describe a minimum set of seamless airspace requirements. Globally, there is a wide variation among CANSO members with regard to levels of traffic density, traffic complexity, and ATM infrastructure. A single global solution should not be imposed on all service providers. Therefore, the SAWG developed a minimum set of requirements for those with lesser needs. This minimum set of seamless airspace requirements is important because seamless airspace can only be realised if all parties adopt a standardised minimum level of interaction.

The SAWG describes seamless airspace services using four functional areas:

- Infrastructure
- Procedures
- Information Management
- Regulation

The SAWG also describes a gradual vertical and horizontal integration process leading to seamless airspace services. The vertical approach means taking a “stepping-stone process”, starting with a neighbour-to-neighbour dialogue and working upward. Once neighbour relationships are in place, a regional approach to seamless services is possible and leads, in turn, to a global endeavour. The horizontal approach refers to several mechanisms, such as formal ICAO groups, informal work groups, government bodies, etc. (see diagram below).

Finally, information gathered from our surveys and case studies highlighted specific high-priority areas for improving seamless airspace. In the near term, efforts should be concentrated on phraseology, consistency in procedures, and common measurement units (i.e. metric system). Longer term efforts must be focused on automation alignment. In particular, information exchange/data transfer and avionics standards, so that one avionics works across FIRs.
3 Definition and Characteristics of Seamless Airspace

Necessary first steps for making progress in seamless services include development of a common understanding of the problem, a description of critical improvement areas, and agreement on salient characteristics for the solution. This section fosters common understanding of seamless airspace, breaks the description down into functional areas, and describes a range of service levels based on traffic density across the world.

3.1 Proposed Definition and Characteristics of Seamless Airspace

The term seamless airspace is one that is often used but seldom defined. CANSO has developed a definition for seamless airspace as well as a summary of the desired characteristics of seamless airspace. Seamless airspace is defined as:

Contiguous airspace that is technically and procedurally interoperable, universally safe, and in which all categories of airspace users transition between Flight Information Regions, or other vertical or horizontal boundaries, without requiring a considered action to facilitate that transition and without any noticeable change in:

- Type or quality of service received
- Air navigation and communications performance standards
- Standard practices to be followed

Before we continue our discussion of seamless airspace characteristics, the following definitions are offered to provide general understanding of the terms used in the remainder of this Report.

Standardised: Conforming to an ICAO or other internationally recognised standard or recommended practice.

Harmonised: Implementation of ATM systems and services in accordance with Regional and National plans and consistent with the ICAO Global ATM Concept.

Interoperable: The ability of ATM systems to accept and use services from and between component systems to enable seamless, effective, and efficient operations.

3.2 Airspace Functional Areas

To begin a discussion of the characteristics of seamless airspace, we first provide some thoughts on what functional areas, in general, would need to be addressed to achieve real seamlessness. Four functional areas make up the essential building blocks of airspace and associated ATM services, they are: infrastructure, procedures, information management, and regulation.

![Airspace Functional Areas](image)
3.2.1_Infrastructure

Air navigation services are enabled by the technology employed both on the ground and in the air. So, for our purposes, infrastructure includes the CNS/ATM systems the air navigation service provider operates throughout a flight, as well as the avionics in the aircraft that interoperate with them. Infrastructure is a key functional area because it dictates the level of performance that can be achieved by the air traffic management system in a given airspace. In order for that level of performance to be consistent in all airspace, the infrastructure in the airspace must be interoperable.

3.2.2_Procedures

Seamless performance of the air traffic management system requires that the procedures used by the participants in the system are harmonised and standardised. In this context, procedures refers not only to the standard operating practices of the various air traffic control specialists and aircraft operators, but also the instrument flight procedures that exist in a performance-based system. Standard air traffic control operating practices would include a common vocabulary and phraseology, as well as adherence to common operating manuals. Likewise, aircraft operators must recognise and respond to control instructions in a common and consistent manner. Finally, seamless airspace will require that performance-based procedures of the future (e.g. reduced separation procedures, continuous descent approaches, etc) be defined, developed and employed in a consistent and standard way. In as much as procedures in the airspace are derived from the concept of operations, it is important that the various concepts of operations in the airspace be harmonised.

3.2.3_Information Management

The future performance-based air traffic management system will require a complete and common understanding of the capability of the system. This understanding will be based on the exchange of vast amounts of information. This information will include aeronautical information, traffic flow management information, flight plan information, radar/surveillance information, etc. In order for this information transfer to be reliable and efficient, the manner in which this information is defined, formatted and exchanged must be, if not standardised, at least well understood and agreed upon. Further, the capability must exist to efficiently transfer that information from its source to its user. This capability will require the management of the information so that its existence can be discovered by a user, its integrity validated by the system, and its delivery ensured by the system’s infrastructure.

3.2.4_Regulation

Hand-in-hand with a discussion on air navigation service provision must be a consideration of how that service provision is regulated. It is well established that the service provision and regulatory oversight functions must be seen as independent and transparent. Consistency and standardisation of regulation, although perhaps not as well established, is important to the efficient and effective attainment of seamless airspace. In our context, regulation refers not only to the regulation and certification of aircraft and operating procedures (both aircrew and service provider), but also to the regulation of air navigation service provision and the evaluation of safety cases. Consistent and standardised (seamless) regulation throughout the global airspace leads to efficiencies in both cost and performance.

3.3_Characteristics of Seamless Airspace

Operations in a seamless airspace must be performance-driven. These operations are characterised by the following set of attributes:

1. Standardised:
   - Terms/definitions
   - ATM and pilot procedures (for normal, contingency and emergency operations)
   - Application of aircraft separation in like
airspace and traffic demand
- Airborne equipment requirements
- Navigation performance requirements
- Communications performance requirements
- Surveillance performance requirements
- Airspace organisation, regulation, and structure (ensures equivalent levels of safety and service)
- Air/Ground (A/G) phraseology
- Flight plan format
- Data message sets and protocols (Ground/Ground, Air/Air, and Air/Ground)
- Aeronautical information format

2. Harmonised:
- Flight level allocation schemes appropriate to ATM requirements and to direction of flight for bidirectional routes
- ATS route structure across FIR boundaries based on the traffic flow and fleet capability

3. Interoperable ATM automation systems

3.4 Minimum Seamless Airspace Requirements

The global demands on ANSPs and ATM systems are not uniform. A single, standard solution cannot, and should not, be imposed on regions that do not have the current, or forecast, traffic demands of a region requiring a comprehensive next generation system solution, such as SESAR or NextGen.

Furthermore, each ANSP and ATM system does not operate in isolation and the future overall effectiveness and seamlessness of an evolving, integrated global ATM framework is dependent on ensuring that adjacent ANSPs and their ATM systems are able to interoperate successfully. Consequently, for any collaborative global ATM system to be truly effective it is essential that all regions adopt and operate to an agreed and well-defined enabling set of standards and procedures.

The individual levels of ATM sophistication provided will be different throughout the world as each instance will be determined by the performance requirements of ANSPs and all airspace users at every boundary and system interface. However the strategic aim of achieving a harmonised seamless airspace can only be realised if all parties adopt a standardised minimum level of interaction supported by a set of clearly defined requirements. The minimum seamless airspace requirements are:

- Standardised:
  - Airspace organisation, regulation, and structure (ensures equivalent levels of safety and service)
  - Flight plan format
  - Application of aircraft separation in like airspace and traffic demand
  - ATM rules and procedures
  - Air Ground (A/G) phraseology.

- Harmonised flight level allocation schemes appropriate to ATM requirements and to direction of flight for bidirectional routes

- Interoperable ATM automation systems.

The services described for global seamless operations and for minimum harmonisation across regions are captured in the table on page 8. It is recognised that there are many service levels that can be captured between the two levels shown in the table. The table is designed to show the minimal service level necessary, and to show the end state to which CANSO is striving for the industry. When looking at the table, one can see that for an FIR with minimal traffic and complexity, the service provider should concentrate infrastructure harmonisation efforts on a standardised flight plan format and toward cross-system interoperability. However, as traffic levels increase, the need to harmonise globally also increases. For infrastructure systems, the service provider must look to more than standardised
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<tr>
<th>Target - Global Application</th>
<th>Regulation</th>
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<tr>
<td>Standardised Terms and Definitions</td>
<td>Standardised Airborne equipment requirements</td>
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<td>Standardised application of aircraft separation in like airspace and traffic demand</td>
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<td>Standardised Navigation Performance Requirements</td>
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<td>Standardised Application of Aircraft Separation in Like Airspace and Traffic Demand</td>
<td>Standardised Flight Plan format</td>
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<td>Harmonised flight level allocation schemes appropriate to ATM requirements to direction of flight for bidirectional routes</td>
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<td>Harmonised flight level allocation schemes appropriate to ATM requirements to direction of flight for bidirectional routes</td>
<td>Interoperable ATM Automation Systems</td>
<td>Harmonised ATS route structure across FIR boundaries based on the traffic flow and fleet capacity</td>
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<td>Harmonised ATS route structure across FIR boundaries based on the traffic flow and fleet capacity</td>
<td>Standardised Surveillance Performance Requirements</td>
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<td>Harmonised flight level allocation schemes appropriate to ATM requirements and to direction of flight for bidirectional routes</td>
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<td>Standardised Application of Aircraft Separation in Like Airspace and Traffic Demand</td>
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<tr>
<td>Minimal Level - ANSP/FIR Application</td>
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<td>Standardised Airspace Regulation, Organisation, and Structure</td>
<td>Standardised Flight Plan format</td>
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<td>Standardised application of aircraft separation in like airspace and traffic demand</td>
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flight plan formats and interoperable ATM systems. The service provider should also comply with standardised data message sets, meet communication performance requirements, meet navigation performance requirements, and deliver services for standardised airborne equipment.

The table is a tool that CANSO ANSPs can use by assessing their current service level ("minimal level" or "global application") and their desired level in the future. Next, the service provider can check to see if they are currently providing the necessary core services, and look to see what additional services are needed in order to fit into the desired future state. The table is not intended as a final solution, but as one input to help determine which services to add to improve harmonisation.

4 Role of ICAO

As previously mentioned, four functional areas make up the essential building blocks of seamless airspace and the associated ATM services: infrastructure, procedures, information management and regulation. Infrastructure in the airspace must be interoperable; procedures must be harmonised; the manner in which information is defined, formatted, and exchanged, must be standardised; and regulations must be consistent and standardised throughout the global airspace. Operations in a seamless airspace must be standardised, harmonised and based on interoperable ATM systems. This would not be possible without the existence of an organisation that can establish globally accepted standards and recommended practices that are agreed by States. ICAO is this organisation.

ICAO is a specialised agency of the United Nations whose mandate is to ensure the safe, efficient and orderly evolution of international civil aviation. It provides the forum whereby requirements and procedures in need of standardisation may be introduced, studied and resolved. It is in the Council of ICAO that Standards and Recommended Practices (SARPs) are adopted and incorporated as Annexes to the Convention on International Civil Aviation. The Council is composed of members from 36 States.

The principal body concerned with the development of technical Standards and other provisions is the Air Navigation Commission. Its primary role is to advise the Council of ICAO on air navigation issues, and is composed of nineteen experts with appropriate qualifications and experience in various fields of aviation. Its members are nominated by Contracting States and are appointed by the Council. They are expected to function as independent experts and not as representatives of their States. The Air Navigation Commission is assisted in its work by the technical personnel of the Air Navigation Bureau, which is a part of the Secretariat.

The Global ATM Operational Concept, endorsed by the 11th Air Navigation Conference held at ICAO in 2003, calls for and presents the ICAO vision of an integrated, harmonised and globally interoperable ATM system, and requires greater cooperation and collaboration within the

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1 A Standard is defined as any specification for physical characteristics, configuration, material, performance, personnel or procedure, the uniform application of which is recognised as necessary for the safety or regularity of international air navigation and to which Contracting States will conform in accordance with the Convention. In the event of impossibility of compliance, notification to the Council is compulsory under Article 38 of the Convention.

A Recommended Practice is any specification for physical characteristics, configuration, material, performance, personnel or procedure, the uniform application of which is recognized as desirable in the interest of safety, regularity or efficiency of international air navigation, and to which Contracting States will endeavour to conform in accordance with the Convention. States are invited to inform the Council of non-compliance.

SARPs are formulated in broad terms and restricted to essential requirements. For complex systems such as communications equipment, SARPs material is constructed in two sections: core SARPs - material of a fundamental regulatory nature contained within the main body of the Annexes, and detailed technical specifications placed either in Appendices to Annexes or in manuals.

Procedures for Air Navigation Services (or PANS) comprise operating practices and material too detailed for Standards or Recommended Practices - they often amplify the basic principles in the corresponding Standards and Recommended Practices. To qualify for PANS status, the material should be suitable for application on a worldwide basis. The Council invites Contracting States to publish any differences in their Aeronautical Information Publications when knowledge of the differences is important to the safety of air navigation.
ATM Community. While the Operational Concept provides the ‘vision’, the Global Air Navigation Plan (GANP) provides the strategic, high-level plan for bringing the Concept to realisation.

Various ICAO CNS/ATM panels have since been doing standards work, and the regional planning and implementation groups (PIRGs) are doing the regional coordination work among States, ensuring alignment with the GANP. However, the industry is still lacking a roadmap or plan of action that will bring these various activities together and set out a course toward implementation.

This is where CANSO can add value as the interface to the operational environment. CANSO can help identify the operational and system/technology performance requirements that are in need of global standardisation. CANSO can also help determine the priorities and recommend activity time-lines.

ANSPs have historically participated in ICAO meetings and engaged its work programmes as State nominees, serving as advisors to the State delegation, and did not have an independent industry voice. However, ever more stringent separation between the regulatory function and service provision will increasingly reduce the ANSP ability to contribute to ICAO through government channels. Further, the realisation of a globally interoperable ATM system will require greater convergence of views and positions among ANSPs.

One of CANSO’s primary goals is to be the legitimate consolidated voice of ANSPs. This includes having a direct voice and influence at ICAO through its Observer status. A coordinated and consolidated ANSP voice in ICAO proceedings will strengthen the influence ANSPs have on ICAO policy development and SARPs work programmes. Several CANSO Member ANSPs also realise that their national authorities may be slow to respond to new ANS developments and that national regulations are often not fully aware of current operational practices and requirements. A more effective dialogue with ICAO may ensure improved timeliness and appropriateness of regulations.

ICAO is actively seeking consolidated industry views and guidance, especially in view of the substantial standards-setting work that needs to be done in support of ATM modernisation programmes. Accordingly, it has initiated a series of Standards Roundtable (RTCA, SAE, Eurocontrol, EUROCAE, European Commission, and FAA) meetings to identify the basic standardisation needs over the next 5 year period, especially as a result of the NextGen/SESAR programmes, and has invited CANSO to contribute to this effort. The GANP is to be updated to include a framework to ensure harmonisation of air navigation modernisation programmes.

Additionally, CANSO can be expected to contribute to the development of a global aeronautical communications roadmap as an aid to investment decisions. These decisions are critical as the advanced capabilities defined in the GANP will depend on advanced aeronautical communications. Today, there are many communication technologies available with very different capabilities and operational benefits.

As a follow-up to the 11th Air Navigation Conference, ICAO is planning its 12th Air Navigation Conference for November 2012, and CANSO can be expected to make a significant contribution to this event, especially in determining the steps and initiatives required to realising an integrated, harmonised and globally interoperable ATM system.

Well-coordinated work between ICAO and CANSO on ATM programmes should provide a win-win benefit for both the regulatory and ANSP communities.

5 Survey Results & Indications

In order to assess next steps in the seamless airspace evolution, it is necessary to first determine the position of the ANSP industry.
We must assess the current services provided by CANSO members and learn their intent of near-term implementation plans.

To gather this information the SAWG led an initiative to develop, distribute, and assess a survey on ANSP services. The survey questioned members on current services in each domain: Communications, Navigation, Surveillance, and Airspace. In addition, we asked the members to project the services that they will provide in 2015. The objective was to learn where services are inconsistent today, and to gain insight into whether those gaps will increase or decrease over the next 5 years.

We released the survey to CANSO members in June 2009 and received responses from the following members:

- Airservices Australia
- Airways New Zealand
- ANA Luxembourg
- ATNS South Africa
- BULATSA Bulgaria
- EANS Estonia
- FAA-ATO
- GACA Saudi Arabia
- MATS Malta
- NANSC Egypt
- NAV CANADA
- NAVIAIR Denmark
- NAV Portugal
- PIA J.S.C.Kosovo
- PANSA Poland
- SENEAM Mexico
- STATE ATM Corporation Russia
- UK NATS

Survey results were limited, but did indicate several good trends, along with gap areas to watch in the future. Positive trends include the commitment expressed by many members toward the ICAO flight plan format. In addition, there is good compliance with ICAO separation standards. Furthermore, consistent approaches are used for graphic products for weather and aeronautical information.

A few areas of concern were highlighted by the survey. One example is that there is still a mix of systems using metric and imperial units of measurement. Also, there is a lack of consistency in RVSM applications for oceanic and remote areas. Even though Continuous Descent Approaches are receiving significant interest, only 25% of the members responded with an indication that they would incorporate such procedures during the reporting period. Likewise for User-Preferred Trajectories (UPT), which also only garnered a 25% response from members who indicated that UPT was in their plans.

6 Real-world Issues; Two Case Studies

When reviewing the survey results discussed in section 4 above, the SAWG concluded that more in-depth study was required. Therefore, we decided to conduct two case studies analysing all critical services along two major traffic flow streams. The city pairs for the case studies were selected based on several factors, including:

- CANSO membership of service providers along the route (giving us the ability to interview the operational staff)
- Previous responses in the Seamless Services Survey
- Traffic volume along the route
- Known issues along the seams.

With the above criteria in mind, the team down-selected the traffic flow streams to two flows: One flow covering NAV CANADA, FAA, and SENEAM; and another flow covering UK NATS, Irish Aviation Authority (IAA), NAV CANADA, and the FAA.

SAWG team members interviewed ANSP operational staff and airspace users who were experienced with flight operations along these traffic flow corridors. The interviews were designed as an open discussion in regard to systems, procedures, and operational issues based on practical experience.
ANSPs provided information on a number of topics which included issues ranging from local concerns to global ANSP matters. In some cases, the local issues had a regional impact that affected traffic into and out of neighbouring FIRs. In other cases, the local issues were truly local and therefore did not fall under the purview of the SAWG. For this report, we edited the information to cover issues that are most relevant to cross-FIR operations.

6.1 Case One: SENEAM, FAA, NAV CANADA

The city pair for this case study was Cancun-Toronto. However, the subjects interviewed had free range to cover any issues impacting the boundaries between the service providers. Best practices and areas of concern were both openly discussed.

In regard to best practices, several subjects emerged as the primary drivers for seamless operations. First was to have a Traffic Flow Management (TFM) practice sharing information on flights between the ANSPs. In this case study, all three parties (SENEAM, FAA, and NAV CANADA) have a centralised traffic flow facility. Even more important for seamless services is the ability to coordinate between central flow facilities.

The SENEAM staff members surveyed were quick to point out that they have a scheduled dialogue between their central flow facility and the FAA Command Center at least once per day. Likewise, the NAV CANADA TFM personnel participate in a regularly-scheduled teleconference call with the FAA Command Center, also on a daily basis. The TFM discussion between central flow facilities is used to identify any traffic flow issues for the day (e.g. weather problems, temporary flight restricts) and to work together to manage the operation in the best possible manner. Beyond the regularly-scheduled teleconference calls, traffic flow personnel in each organisation will pro-actively contact each other when situations require coordination between service providers. For SENEAM and the FAA, during peak traffic season, two teleconference calls per day typically take place involving representatives from Mexico City, Mérida, Monterrey, Houston, and Albuquerque ATC centres. Discussions relate to expected
weather events affecting traffic flows between the U.S. and Mexico, and any resulting traffic flow strategies. In addition, the number of arrival slots per hour for various airports in Mexico, including Cancún, is coordinated.

Likewise, NAV CANADA and the FAA work closely together to manage traffic flow along the U.S.–Canadian border. NAV CANADA frequently provides routes to relieve congestion (normally during severe weather) along the northeast border of the U.S.

In addition to the regular coordination between central flow facilities, the next important step cited to improve seamless services was the basic ability to establish “camaraderie” between operational personnel who work in boundary sectors. When forming the case studies, the SAWG emphasised a technical dialogue; and indeed technology was verified as a key seamless services enabler. However, when it comes to smoothly handling traffic from one FIR to another, the most important characteristic of a seamless boundary is that the ATCOs on each side “know each other”, view themselves as part of a team, and develop a desire to work together. The staff members interviewed said that such camaraderie developed slowly over time as they talked to each other during traffic flow discussions or called each other to handle a specific difficult situation. As they overcame exceptional situations, the staff developed a rapport and began working together more often.

During the case study investigation, the surveillance difficulties over the Gulf of Mexico were highlighted. There is a wide mix of surveillance capabilities and therefore a significant variance in separation standards when flying across the Gulf of Mexico. For example, according to FAA Order 7110.65 dated 2/10/2010, there are several separation rules in the ZHU Gulf Of Mexico. Crossing traffic is 15 minutes but it is rare for a pure crossing scenario to occur. In trail separation is 10 minutes at same MACH. Time can be reduced based on MACH speed. The FAA is implementing ADS-B in most of the Gulf, which can eventually allow a reduction in separation in covered areas to 5 nm. However, there will still be areas in the middle of the Gulf without surveillance coverage; in which 100 NM lateral separation must be applied. The variance in surveillance coverage is not considered a boundary issue because the variation results from a geographical situation. Nevertheless, mixes of surveillance coverage and changes in separation standards create a non-harmonious flow of traffic. For flights crossing the Gulf of Mexico, the situation was exacerbated by an overly complex route structure with numerous crossing flights. In this case, SENEAM, the FAA, U.S. DoD, IATA, ICAO and the users worked together to change the Gulf of Mexico routes in order to simplify traffic flow. The resulting route structure will improve FIR border operations, increase predictability and efficiency and reduce controller workload along the SENEAM-FAA FIR boundary.

Technology harmonisation and compliance with ICAO standards is necessary for seamless handing of information between ANSPs. The FAA, NAV CANADA, and SENEAM operate modern ATC systems. Their systems have automated Flight Data Processing Systems (FDPS) and Radar Data Processing Systems (RDPS) that exchange flight plan and radar derived information. Flight plans received from the U.S. are automatically processed and input into the Mexican FDPS for Mexico City and Mérida Area Control Centres (ACCs). Flight plans received from Mexico are automatically processed and input into the FAA FDPS for Houston Center. Similarly, NAV CANADA and the FAA exchange flight plans between systems as well as radar handoffs.

Several “blockers” to seamless operations were highlighted during the interviews for the Toronto–Cancun city pair. Within the three ANSPs, there is a mix of metric and imperial units in use for the ATC systems. Similarly, nations tend to default to their native language when talking to domestic aircraft which has a cascading impact on situational awareness and also creates difference in service offerings based on language comprehension (or perceived language comprehension). Differences in language and
phraseology were mentioned several times during the interviews as an impediment to harmonised operations. The comments were not limited to voice communications with ATC. For example, the U.S. AIP is only published in English, whereas the AIP of Mexico is only published in Spanish. Even in the limited number of ANSPs surveyed for this case study, there were many exceptions in place to ICAO regulations. Most of the discussions during the case studies were focused on cross-border operations. However, the traffic flow was identified to a specific city pair (i.e. Toronto-Cancun), and ATC personnel frequently brought up local issues. For Cancun Airport, one of the local issues was found to have impact stretching back to U.S. airspace. Cancun has a very limited number of gates and off-gate parking for aircraft. During tourist season, the lack of places to position aircraft limits the acceptance rate at the terminal and affects traffic flow coming from the southern border of the U.S. The traffic flow situation is handled by the air traffic controllers, but still has an impact on traffic flow and controller workload across the boundary.

6.1 Case Two: FAA, NAV CANADA, IAA, UK NATS

The city pair for this case study was Chicago-London. As with the previous case study, the staff members interviewed were not restricted to just discussing flights only on the specific city pair route. Rather, the city pair was used as a mechanism to start the dialogue.

This case study highlighted several best practice examples. The ANSPs involved had collaborated closely together for many years and worked to provide a seamless suite of services to their customers. In particular, UK NATS and NAV CANADA jointly designed and developed an oceanic ATC display system, greatly enhancing their ability to exchange information; as well as enabling common infrastructure, procedures and regulation. In addition, UK NATS and NAV CANADA (along with the FAA) were early adopters of ADS and CPDLC in oceanic airspace, permitting flights to go from one FIR to another seamlessly.

As reported in the first case study, the importance of good camaraderie between operational staff was emphasised as a critical component in handling flights across boundaries. The camaraderie aids communication and coordination because the controllers want to work with their colleagues in the other ANSPs to collectively handle the traffic in the best way possible.

Coordinated traffic flow is handled in a number of different ways. UK NATS and IAA are members of Eurocontrol. The Eurocontrol Central Flow Management Unit (CFMU) exchanges flight information with the FAA Air Traffic Control System Command Center (ATCSCC) and engages in a regularly-scheduled dialogue to review the daily traffic flow situation. In addition, UK NATS electronically exchanges traffic flow information with the FAA.

Airfields close to the UK boundary have a flight level allocation scheme that aids transition. Flights from Chicago have a flight level offered by Shannon (or Prestwick) approximately 10 minutes before entry to their airspace. If the electronic offer is not accepted then a telephone call takes place. Despite the regular discussions to handle traffic flow information, there were still some border issues identified during the case study. On a regular basis, the volume of North Atlantic traffic is so high that it causes “bunching” at Moncton Centre, which distributes traffic down the Eastern Sea board. In a similar fashion, overseas traffic arriving at Boston Center in the U.S. is not distributed in a way that is suited for domestic airspace, resulting in considerable manoeuvring to realign the flows. Clearances that are efficient for the North Atlantic are not necessarily efficient for domestic airspace. There still exists “compartmentalisation” and lack of full harmonisation between oceanic and domestic operations.

Interviewed personnel reported that some service providers still use systems with non-standardised FDP message sets, reducing the
ability to exchange information and impacting service across boundaries.

UK NATS and IAA use Flight Level Allocations (FLAs) with neighbouring service providers to aid the hand-off of flights. However, staff members reported that FLAs are not always standardised and resulting traffic coordination with neighbours is not harmonious. Interviewed staff also pointed out that there are some boundaries that connect to non-standard separation airspace, creating a mix of separation distances when crossing the FIR.

It was noted that there is some inconsistency in pilots’ adherence to individual ANSP requirements to reduce speed to 250 knots below 10,000 feet. This restriction is a requirement in the United States but is not generally required in Europe. Also noted was a general comment from multiple ANSP personnel that lack of English language proficiency in some pilots created a situation in which they may simplify clearances in such a way that may constrain operational efficiency.

7 Seamless Airspace Challenges and Opportunities

ANSPs and their customers and users face multiple challenges as they work toward a seamless global airspace. The case studies presented above highlight different challenges to seamless airspace operations between contiguous FIRs. In the Toronto-Cancun city pair case, for example, differences in language and phraseology present a barrier to standardised procedures, while exceptions to ICAO regulations prevent a harmonised regulatory environment. In the Chicago-London city pair case, lack of harmonisation between oceanic and domestic operations, and service providers still using systems with non-standardised Flight Data Processing (FDP) messages, are additional examples of procedural and information management barriers to providing seamless airspace services.

There are other types of challenges to seamless airspace operations. Neighbouring ANSPs, for example, may be at different stages in their internal risk management, business management, and people management structures, creating institutional challenges to the standardisation and synchronisation of recommended practices that lead to seamless operations.

However, there are also opportunities to apply best operational practices identified by the working group through the case studies and additional research conducted in the process of developing this guidance document. Consequently, the SAWG recommends that ANSPs develop an inventory of challenges to seamless airspace operations between and within their FIRs. To support this recommendation, the table on page 16 provides an assessment framework that ANSPs, based on their operational needs and resources, may apply to identify and categorise that inventory of challenges. The assessment framework provides the ANSP with a check-list of relevant factors that may impact seamless airspace operations including:

- The four seamless airspace functional areas (Infrastructure, Procedures, Information Management, and Regulation) introduced in this document;
- Several ICAO Global ATM Operational Concept elements relevant to seamless airspace such as Airspace Organisation and Management (AOM), Demand and Capacity Balancing (DCB), ATM Service Delivery Management (ATM SDM);
- Internal ANSP best practice management principles (risk management, business management, people management) suggested by ANSP representatives to the SAWG, and external factors such as the national, institutional (political), and legal environment in each country.
<table>
<thead>
<tr>
<th>Seamless Airspace Functional Area</th>
<th>Internal and External Factors that Impact Seamless Operations</th>
<th>Examples of Best Practices</th>
</tr>
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<td><strong>Infrastructure</strong></td>
<td>Communications</td>
<td>CANSO’s CNS/ATM workgroup cross-ANSP dialogue on communications standards and infrastructure development</td>
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<td></td>
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<td>Automation</td>
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<tr>
<td><strong>Procedures</strong></td>
<td>Airspace Organisation and Management (AOM)</td>
<td>FAA Command Center and Eurocontrol CFMU operational coordination and Traffic Flow work groups</td>
</tr>
<tr>
<td></td>
<td>Demand and Capacity Balancing (DCB)</td>
<td></td>
</tr>
<tr>
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<td>Aerodrome Operations (AO)</td>
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<td></td>
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<td></td>
<td>Airspace User Operations (AUO)</td>
<td></td>
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<td></td>
<td>ATM Service Delivery Management (ATM SDM)</td>
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<tr>
<td><strong>Information Management</strong></td>
<td>AIMNet – Aeronautical Information Management</td>
<td>CANSO AIM Work Group</td>
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<tr>
<td></td>
<td>Surveillance Data</td>
<td></td>
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<td></td>
<td>Flight Data</td>
<td>Flight Object work groups</td>
</tr>
<tr>
<td><strong>Regulation</strong></td>
<td>National Institutional Environment (political decision-making process)</td>
<td>Tailor the Single European Sky (SES) model to the ANSP’s regional conditions</td>
</tr>
<tr>
<td></td>
<td>Legal Environment</td>
<td>CANSO’s Middle East Regional workgroups for Airspace, CNS/ ATM, and safety</td>
</tr>
</tbody>
</table>

Table 1: Assessment Framework to Identify Seamless Airspace Challenges and Opportunities
Collaboration Framework Best Practices

The definition of seamless requires that airspace users be able to transit from one jurisdiction (FIR and/or sector) to another without noticeable changes (Refer Para 3.1.). In order to achieve this goal in areas of multiple jurisdictions, regional collaboration between ANSPs (and airspace users) is required. There exist today many examples of successful regional groups such as NAT SPG, ISPACG, FIT-BOB etc. that have implemented both airborne and ground technology and procedures harmoniously across the region. The SAWG reviewed collaboration successes via the case studies and by expert experience with multi-jurisdiction work groups. The SAWG recommends that collaboration begin locally as a neighbour-to-neighbour process. The neighbour-to-neighbour exchange of operational procedures, traffic information, and system development direction is applicable to all ANSPs worldwide. As traffic density and complexity grows, it becomes increasingly important to develop regional collaboration vehicles. It is only after neighbour-to-neighbour and regional collaboration is in place that one can reasonably expect to be successful with global collaboration.

With the above migration in mind, collaboration should be viewed as a multi-faceted activity. Because there are such a variety of mechanisms for collaboration, it is best to section the opportunities for harmonisation work into distinct categories. The table below lists the primary collaboration categories and gives some best practices examples for each area.

<table>
<thead>
<tr>
<th>Collaboration Category</th>
<th>Best Practice Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICAO Regional Groups</td>
<td>– North Atlantic Systems Planning Group (NAT SPG)</td>
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<td></td>
<td>– Informal South Pacific ATS Coordinating Group (ISPACG)</td>
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<td></td>
<td>– FANS Implementation Team, Bay of Bengal (FIT-BOB)</td>
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<tr>
<td>ICAO Technical Panels and Study Teams</td>
<td>– Required Planning Performance (RPP)</td>
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<td>– Performance-Based Navigation</td>
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<td>CANSO facilitation</td>
<td>– CANSO Operations Standing Committee</td>
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<td></td>
<td>– Regional Work groups (Europe, Mid-East, Asia Pacific)</td>
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<td></td>
<td>– CANSO Europe Interoperability Group</td>
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<tr>
<td></td>
<td>– Middle-East work groups (Airspace, Safety, CNS/ATM)</td>
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<tr>
<td></td>
<td>– CANSO Regional meetings, conferences, programmes</td>
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<td></td>
<td>– CANSO Guidance Materials</td>
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<tr>
<td></td>
<td>– CANSO Training Cycle (possible facilitator support)</td>
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<tr>
<td>Multi-Government Regional Coordination</td>
<td>– Eurocontrol</td>
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<td></td>
<td>– Single European Sky Council</td>
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<td></td>
<td>– SESAR Joint Undertaking</td>
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<tr>
<td>Regional/multi-national Traffic Flow</td>
<td>– Eurocontrol Central Flow Management Unit (CFMU)</td>
</tr>
<tr>
<td>Management</td>
<td>– FAA Command Center coordination with CFMU, SENEAM Central Flow, and NAV CANADA Central Flow</td>
</tr>
<tr>
<td>Bilateral/multilateral Coordination and</td>
<td>– Atlantic Interoperability Initiative to Reduce Emissions (AIRE)</td>
</tr>
<tr>
<td>Planning</td>
<td>– Asia Pacific Interoperability Initiative to Reduce Emissions (ASPIRE)</td>
</tr>
<tr>
<td>Geopolitical alliances</td>
<td>– European Civil Aviation Conference (ECAC)</td>
</tr>
<tr>
<td></td>
<td>– Agence pour la Sécurité de la Navigation Aérienne (ASECNA)</td>
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<tr>
<td></td>
<td>– Corporación Centroamericana de Servicios de Navegación Aérea (COCESNA)</td>
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<tr>
<td></td>
<td>– Safe Skies for Africa</td>
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</tbody>
</table>
These groups should have three primary commonalities:

1. Agreed objective and timeline
2. All relevant stakeholders are involved, e.g., regulatory authorities, ANSPs, airlines, aircraft manufacturers and communication service providers
3. All stakeholders accept individual accountability for their organisation to meet agreed deliverables and time frame

It is suggested that existing groups accept or add the goal of achieving seamless airspace to their agendas, establishing a regional strategic plan that addresses technology interfaces and practices that inhibit seamless operations. Where such groups do not exist, regional ANSPs should take the lead in establishing these and perhaps could contact the Chairperson of an existing group for guidance and/or assistance.

Furthermore, the SAWG recommends extensive use of web-based information where possible. Insight and transparency are key factors for improving global seamless services and the most cost-effective means for relaying information is through well-designed and frequently-updated Internet pages. Examples of best practices for web-based information include:

- Posting of roadmaps and architecture information. In particular, avionics roadmaps with timelines
- AIP access from web
- NAM EUR traffic density analyser, available to ANSPs and customers
- Eurocontrol Network News, Eurocontrol One Sky site, OIS publication, Eurocontrol Network Operation Plan daily publication, AGORA site
- Airspace consultation

The United States and the European Union recently initiated large-scale ATM modernisation programmes for each region. The NextGen programme under the FAA, and SES ATM Research (SESAR) under the European Commission will fundamentally change the core concepts of ATM for years to come. With such large modernisation efforts underway, it is imperative to have a strong link between both efforts in order to harmonise future services for the airspace users. Because of the complexity and importance of harmonising the systems and procedures to be developed and implemented as result of NextGen and SESAR, the U.S. and EU decided to formalise the cooperation efforts by using a Memorandum of Cooperation. The need to sign Memoranda of Cooperation does not apply to all ANSPs and government bodies in order to develop seamless services but it is an option to consider when strong collaboration is necessary over an extended period of time.

9 Conclusion and Recommendations

From the perspective of the aviation customer, flight transition from one FIR to another is rarely seamless. The boundary transition frequently requires different communications protocols, additional pieces of equipment, and different operational procedures. Furthermore, non-boundary operations, procedures, and regulation vary more than necessary; requiring additional workload, resources, and expense.

One single initiative will not solve the problem. In order to make substantial progress towards seamless airspace, the gaps must be approached from many angles and several methods are necessary for affecting change. Although there is a tendency to call for global harmonisation, it is important to understand that regional improvements can be just as valuable as global initiatives. Both must be considered and global harmonisation is the final goal; but analysis conducted through the SAWG shows that many ANSP members should start with a regional focus (depending on traffic levels and patterns).

Our case studies indicated that basic challenges such as phraseology, language proficiency, and variation in procedures are a
significant issue and should be addressed in the near term. Furthermore, when attempting to improve seamless service in a regional or global environment, it is essential to begin by developing good camaraderie between ANSPs. The single biggest advancement in cross-ANSP seamless services is Traffic Flow Management coordination; ideally between traffic flow command centres.

From the perspective of our aviation users, the highest-value improvement can come from harmonising data exchange, communication standards, and anything directly impacting avionics or cockpit operations.

The SAWG does not recommend creating new work groups and panels to address these issues. Existing workgroups are adequate as long as they have the proper focus. Informal work groups and structures, and CANSO global and regional work groups can be invaluable. CANSO, ICAO, IATA and all aviation stakeholders must work together to improve seamless airspace as a common objective.
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  Republika)
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- Thales

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