FOURTEENTH AIR NAVIGATION CONFERENCE

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3.3: Eighth Edition of the Global Air Navigation Plan (GANP)

GLOBAL STRATEGIC LEVEL OF THE GANP: THE CONCEPTUAL ROADMAP AND THE MAPPING TO THE TECHNICAL LEVEL

(Presented by the Secretariat)

1. INTRODUCTION

1.1 As part of the Global Air Navigation Plan Study Group's (GANP-SG) review of the conceptual roadmap, a gap in terms of operations in the conceptual roadmap was identified (e.g. how is air traffic flow management evolving).

1.2 The gap showed that the evolution of the operations was not in the conceptual roadmap but found to be addressed within the Aviation System Block Upgrade (ASBU) framework as part of the evolution of the concepts of operations within each ASBU thread (ASBU Threads - ICAO GANP Portal). However, when reviewing these concepts of operations (CONOPS), it was realized that a CONOPS should not be linked to a timeframe (i.e. an ASBU Block) since the ASBU elements are not sedentary. In addition, depending on the availability, the group of elements from a specific thread in an ASBU Block sometimes did not realize a CONOPS.

1.3 The GANP-SG concluded the need to:

a) move the CONOPS of the threads to the strategic level and review them in line with the conceptual roadmap;

b) map the ASBU elements to the new CONOPS linked to the conceptual roadmap, mapping the strategic and technical levels;

c) make this information available in the strategic level of the GANP; and

d) summarize the operational evolution of the threads linked to each evolutionary step and ensure this information is reflected in the conceptual roadmap.

2. UPDATE OF THE CONCEPTUAL ROADMAP

Note.— The proposed changes is arranged to show deleted text with a line through it and new text highlighted with grey shading.

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THE CONCEPTUAL ROADMAP[1]

The global air navigation system is becoming more complex as it supports new demand. To manage this complexity, meet the global performance ambitions and realize the GANP vision, the air navigation system must transform and build upon the use of emerging technologies, information and concepts of operations, many of which are not specifically designed for aviation purposes.

The evolution of the air navigation system is built on the notion of management by trajectory, empowered by access to timely and accurate shared information, which should improve overall ~~mission and business trajectory executions~~ safety and efficiency of the airspace.

~~Information exchanges between airspace users, ATM systems and aerodrome operations.~~ The aviation community will increasingly depend on the provision of accurate, secure and timely data that is quality-assured and situationally relevant to ensure that timely and consistent decisions are made on a network-focused and flight-centric basis. ~~New entrants such as spaceport operators, c~~Commercial space operators and new users of higher~~-altitude~~ airspace as well as advanced air mobility operators and other users in the middle levels and the lowest airspace will all contribute to the dynamic decision-making process ~~in this business of businesses~~.

This evolution will be enabled by a progressive increase in automation, powered in some cases by artificial intelligence, advancements in technology and the use of ~~standardized~~ harmonized, interoperable ground and air systems in an integrated infrastructure. This aviation infrastructure, based on the ubiquitous sharing of information, will interface with non-aviation transportation systems to achieve an efficient, multimodal transport system.

The conceptual roadmap presented hereafter is aimed at transforming the air navigation system based on its strengths and opportunities, rather than simply improving it, by providing a more holistic approach to its evolution. This evolution is described through four steps, which address the transformation of the air navigation system through digitalization (Step 1), enhancing time-based operations (Step 2), moving to trajectory-based operations (Step 3) and a total performance management system (Step 4).

On the Cusp of Transformational Change

The next 20 years will be a period of transformational change for the aviation sector, especially for the business of ATM and flight operations. While this will be an evolutionary change, even evolution has its disruptors that mark new eras. New types of aircraft, vehicles and airspace users are introducing a next generation of operating models to aviation through the application of advanced technologies and sophisticated operational decision-making processes in an integrated manner. This will expand traditional business models and accelerate the transition towards a total performance management system in which airspace users and other aviation stakeholders will be able to make orchestrated and/or choreographed collaborative decisions based on their business and mission objectives. In order for the last ~~stage~~ step to be

[1] https://www4.icao.int/ganpportal/GanpDocument#/lessons/-gbUn70LSAM5CNEGkjrFLcGjwTnB9aaM

reached, the conceptual roadmap brings together the opportunities that rising digital technologies of the information age and full connectivity are bringing to the aviation community.

Aviation is and will continue to be a safety-focused business. ATM has always been about safely and efficiently managing air traffic flow, flight operations and access to air navigation resources in a way that agreed levels of safety are always met. Given the forecasted increased volumes of traffic with ~~multiple~~ increasingly diverse business and mission objectives, the tactical management of flight operations based on static, individual and unique management of air navigation resources will no longer be sufficient.

A new paradigm based on the ability to manage, describe and communicate constraints at increasingly finer levels of resolution, as well as the capability to accept and react to inputs and data not only internal (e.g. flight plans with service provider needs and desired capabilities) but also external (e.g. weather) to the system is key to ATM. Such paradigm is also essential to leverage the availability of air navigation resources and maximize the system's inherent performance.

Evolution in technology, digitalization and data goes hand-in-hand. A data-driven network is only possible if technological and digital advancements happen in parallel. With data comes opportunity but also responsibility. Therefore, cyber security and cyber resilience will become system-wide priorities, with global quality standards to which the aviation community will comply.

EVOLUTIONARY STEP 1: FLIGHT OPERATIONS IN A DIGITALLY RICH ENVIRONMENT

Air navigation resources are limited. In a safety-critical environment, the capacity of the system relies on the ability to exploit air navigation resources. To unlock the inherent capacity of the system and ~~by~~ allow~~ing more scheduled flights~~ increasing volumes and density of traffic, a move towards a more ~~tactical~~ data-driven environment is required. In an information-poor system, the acceptable number of flights (i.e. declared capacity) is restricted to eliminate the possibility of excessive holding, sector overloads or diversions, which results from the lack of sufficient information to provide even tactical levels of planning.

Limited airspace and runway capacity results in delays, passengers not being served, goods not being delivered and loss of potential opportunities to accommodate demand. Therefore, industry and government leaders must embrace the opportunities that digital technologies are creating in order to unlock substantial benefits for the aviation community.

Opportunities

The first step of the conceptual roadmap focuses on improving the system's capacity. Constraints have an allocated volume with an associated time and position. The volume, time and position are based on the quality of the underlying information that defines the constraint. The introduction of digital technologies in aviation improves the quality of the information and removes or minimizes constraints to access to and use of air navigation resources, thereby increasing the capacity of the system while maintaining and enhancing safety.

The emergence of digital technologies not only improves the quality of data and information, but also increases data storage and enhances processing capabilities while allowing a wider distribution of information, which, as a result, is no longer limited to the front-line actor. Thus, digital technologies make it possible for more stakeholders to participate in the decision-making process and enable the design of specific decision-support~~ing~~ tools and automation for more focused decision-making processes in ATM.

Challenges

Improving the quality of data and information based on dedicated aviation applications, sensors and automation implies large investment by aviation stakeholders. Moreover, this information, when available, is often limited to front-line actors either by dedicated ground connections or by air-ground data communications. This reflects the poor state of data and information exchange and the cost of point-to-point communications, in comparison with other technologies used in society at large. Although capacity improves locally due to richer information on constraints, the lack of data and information-sharing beyond the local setting means that the system operates in an isolated manner. This fragmentation results in multiple views and disjointed operations caused by isolated automation and fit-for-purpose systems supporting only a loose network approach.

Although operations are generally improved by automation, the benefits that arise at airspace boundaries – both geographic and time boundaries – may result in conflicting approaches, leaving many potential benefits unachieved. For instance, the airport schedule of a time-based arrival tool may be disrupted by a more strategic initiative which balances demand and capacity and involves aircraft that have multiple destinations but are all in the same flow. Although automation is necessary as a first step in the system's evolution, the return on investment in digital technologies is subject to the comprehensive and full utilization of the generated digital information.

EVOLUTIONARY STEP 2: TIME-BASED OPERATIONS ENABLED BY AN INFORMATION REVOLUTION

Aviation is a global business of businesses where customer satisfaction depends on the aviation system's predictability. Customer satisfaction varies from the passengers arriving at their destination on time, to the airlines maintaining daily schedules. Although the digital transformation has increased the capacity of the air navigation system, ~~the~~ isolated ~~(~~local~~)~~ ~~nature of~~ decisions can result in unforeseen delays to schedules and customer dissatisfaction, along with additional costs and inefficiencies. As a first step, a regional approach to flight operations based on the timely integration of information and seamless cross-border services is required.

Opportunities

The second evolutionary step focuses on improving efficiency, predictability and cost-effectiveness by moving from isolated data pockets and automation to a single, shared view/coordinated system involving the use of non-aviation specific and dedicated resources.

What has been uniquely developed in aviation in the past has become an opportunity for other industry segments, given the inherent capabilities of automation, navigation and communications used in social and commercial interactions. However, in the last decade, other industries have taken the lead in providing high-level performance thanks to cutting-edge technology that is superior to existing aviation technologies. Other industries and society at large benefit from the robust distribution of information and have moved from a point-to-point to network approach where information is available to all interested parties. To ensure that aviation stays up to date with global best practices and reduce costs, air navigation services will be increasingly provided by facilities and services outside of current air navigation systems and beyond the traditional aviation industry.

Data that are digitally available and referenced to common systems (time and position data) are shared through globally accepted exchange models. Increased access to commonly available data sources, enabled by data cloud storage capabilities, together with big data analysis and machine learning applications, make it easier to process vast amounts of information that could not be processed by humans. This is leading to a more accurate and precise definition of constraints, including common projections of aircraft position and intent, enabling time-based operations. With greater precision comes earlier and more accurate predictability, which in turn is reducing system uncertainties and their associated operational buffers. As a result, the overall network efficiency is improved. This, together with the sharing of information in a system-wide environment, will further improve the predictability of the air navigation system, leaving room for improved, independent and collaborative decision-making, and seamless cross-border services. The increased availability and greater accuracy of data and information will also make it possible to apply big data analysis methodologies and take an improved, proactive approach to safety and efficiency of operations.

The expanded information pool will enable the introduction of, or enhancements to, network management functions supporting a resilient and robust regional network approach. This increased ~~regional network~~ capability, coupled with greater availability of accurate data and information, will support synchronization across local tactical decision~~-making~~ support~~ing~~ tools.

Challenges

In this information revolution, ~~the synchronization of different decision-making supporting tools will be made possible~~ capabilities are enhanced by the sharing of actionable information across the network enhancing decision-support tools. However, there are limitations as to the quality of the information provided, as some data and information inputs are estimated, derived and possibly not obtained directly from the source, since not all systems are connected to the network. There are still aircraft that can only provide limited data sets based on legacy protocols and data communication systems, airline tools that may provide estimated versus actual flight status information, and weather tools that are yet to benefit from the increased pool of observations from aircraft. Decision support tools ~~support for decision-making tools~~ continue~~s~~ to suffer from ~~have~~ inaccuracy ~~margins on recommended actions so that the accuracy of mixed~~ in the information ~~can be taken into account~~ on which they rely~~, although margins are smaller~~. In addition, the level of automation is only beginning to evolve from manual or human-controlled and has not reached the levels required to support trajectory-based operations.

EVOLUTIONARY STEP 3: TRAJECTORY-BASED OPERATIONS ENABLED BY FULL CONNECTIVITY THROUGH THE INTERNET OF AVIATION

One of the barriers to improving ~~the~~ regional air navigation system is the lack of full participation due to the high cost of aviation-specific technologies. The need to accommodate all stakeholders can therefore result in s~~S~~uboptimal decisions ~~are therefore made to accommodate all stakeholders. The lack of information on current wind, turbulence and weather conditions, resulting in a less accurate definition of constraints, is also part of the issue~~. In addition, without full connectivity and the real-time availability of aircraft derived information, the optimization of the flight remains subject to substantial constraints. ~~Finally, t~~The inability to connect cross-regional information sources and synchronize trajectory information is affecting global flights and the ability of ~~ANSPs and airspace users~~ the aviation community to ~~further plan~~ optimize the planning of their operations. A move toward the global internet of aviation will reduce such costs and inefficiencies.

Opportunities

As access to broadband Internet becomes more widely available ~~with faster and better value for money~~, and as more devices with built-in connection capabilities and sensors enter the market, a perfect environment for the Internet of Things will be created in the aviation industry. The third evolutionary step envisages a scenario in which everything in aviation that can be connected, is connected. This evolution in aviation is already occurring in some areas including remotely piloted aircraft systems, where the Internet and wealth of possible communications networks are providing direct links between aircraft/vehicles and their stations, and aircraft/vehicles and ANSPs.

In this step, each actor will be seen as a system node, source of and user of information. Constraints~~, very accurate in time and position,~~ will be minimized due to ~~the increased~~ near instantaneous processing ~~capability~~ of richer information and opportunities to continuously recalculate and review the scenario based on the ongoing supply of accurate data and information.

The aircraft's intent will be readily available ~~to ANSPs~~, and atmospheric conditions surrounding each aircraft will be available owing to enhanced grid data sets and forecasts. The automation tools of airspace users employ the state of the network and arrival management, surface management and departure management schedules in real time. As a result, network management will become a globally shared endeavour, free of the boundary inefficiencies caused by limitations in cross-regional boundary information.

Trajectory-based operations are the natural step forward in this environment of rich information-sharing and advanced automation levels. Pre-flight trajectory deconfliction, augmented by advanced onboard technologies, will enable self-separation in normal operations in certain environments. I~~n implementing trajectory-based operations, it will be necessary to take advantage of the i~~ncreased precision in the position, intent and time of constraints will enable all stakeholders to more fully benefit from the ~~larger number~~ increased availability of air navigation resources ~~available~~.

Challenges

The emergence of aircraft, airspace users and ANSPs as nodes in the global network will support flow management and time-based management that extend across flight information region (FIR) boundaries to efficiently support the increasing demand and complexity of ground and air operations. As a result, it will be essential to move towards a global approach to information security. More common approaches to information exchange must also be considered since operational improvements now need to be either regional, as a minimum, or in many cases, global.

To fully accommodate airspace users with different operational capabilities and needs and take advantage of innovation and rising digital technologies, a shift from aviation-specific to performance-based system solutions and architecture will be necessary. A performance-based system will enable the safe use of infrastructure and capabilities not specifically designed for aviation, resulting in cost-effective operations enabled by high-quality services.

Even within this enhanced environment of information, the principles of decision-making will still be held at the ANSP level, despite the improved collaborative decision-making process as a result of better data and information received from users and the upgraded tools for the collaborative modelling of constraints.

EVOLUTIONARY STEP 4: TOTAL PERFORMANCE MANAGEMENT SYSTEM FOCUSED ON BUSINESS/MISSION NEEDS

~~Moving passengers and cargo worldwide is not the sole purpose of aviation. The emergence of multiple airspace users and different vehicles and business models has added significant complexity to decision-making among ANSPs. Without flexibility in the decision-making process, ultimate customer satisfaction~~

~~will not be met. ANSPs will only meet these various new demands by managing the process that enables their direct customers and other stakeholders to make their own decisions based on predefined system performance requirements.~~

The aviation industry is experiencing significant changes in airspace usage, aircraft and business models leading to increased complexity in the air navigation system. This has created a need for greater flexibility in managing air traffic, and shifts in the roles and responsibilities of the various stakeholders involved. The redistribution of responsibilities will focus on managing a process that enables airspace users to make their own decisions based on predefined system performance requirements. By embracing a more flexible and collaborative approach to air traffic management, the aviation industry can better accommodate the growing diversity of airspace users and vehicles, while improving safety, efficiency and sustainability in the air navigation system.

Opportunities

The last step of the conceptual roadmap is to take full advantage of ~~this~~ the information-rich environment to fully optimize decision-making and satisfy the needs of airspace users. In the past, ATM decisions became centralized due to the limitations of information availability among airspace users on both the ground and flight deck. In each of the previous steps, improvements to information-gathering ~~are focused on~~ and sharing served to provid~~ing~~e the ANSPs with a larger amount of and more accurate information so that they ~~can~~ could make better decisions ~~on behalf of~~ in collaboration with airspace users.

With this improved total system performance in mind, the entire focus will shift to who is best positioned and able to make decisions. Even with shared information, there are aspects of each flight that may be unique to the operator. ~~Therefore, despite this pool of rich information, a situation in which only ANSPs make decisions based on inputs will be suboptimal.~~ Processes and procedures will be developed to ~~shift and~~ enable the operator to manage the flight trajectory, while ANSPs focus on managing constraints and air navigation resources. With the move towards the Internet of things, information will no longer be the limitation.~~, and the focus will shift to who can make the best decisions resulting in improvements to the total system performance. This will be possible because c~~ Constraints will be minimized owing to the increased accuracy and availability of data, considering all inputs to the system and the absence of coordination limitations with everyone connected to the network. Now, the organization and management of airspace is harmonized and increasingly automated.

Challenges

Achieving the optimum decision-making scenario requires new approaches for ensuring “access and equity” to air navigation resources. The simple rules of capacity-rationing, air traffic flow management and time-based scheduling, implemented in the past, need to be replaced through a gradual introduction of “market rules”. ~~with r~~Regulations must be adapted to the needs and possibilities of the market to self-regulate, as long as the performance of the overall network is not negatively impacted ~~and access and equity are preserved so as to accommodate all demand~~.

3. MAPPING OF THE TECHNICAL LEVEL

FROM CONCEPT TO OPERATIONS[2]

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A STRUCTURED APPROACH DRIVEN BY PERFORMANCE

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The GANP provides a path to the safe, orderly and efficient evolution through the BBB and ASBU frameworks. Obligations in terms of the provision of essential air navigation services have been reflected in the BBB framework to ensure a robust baseline for the evolution. The evolutionary transformation reflected in the different evolutionary steps of the conceptual roadmap is also reflected in the ASBU framework to ensure the interoperability of systems, harmonization of procedures and a harmonized approach to the modernization of the global air navigation system. New users, operations and roles, and all stakeholders are part of this structured transformation.

The way the evolutionary steps are reflected in the ASBU framework is through the description of conceptual steps for the ASBU threads aligned with the four evolutionary steps of the conceptual roadmap. These conceptual steps for the ASBU threads are available in https://www4.icao.int/ganpportal/document/MappingToThreads[3]. Within the ASBU threads, the ASBU elements represent the availability of operational improvements in time. To better show how these elements support the progression within the conceptual roadmap, each element is mapped to an appropriate conceptual step within their thread. This mapping, which is available at https://www4.icao.int/ganpportal/document/MappingToElements[4], serves to link the technical level (ASBU framework) to the conceptual roadmap (strategic level).

The ASBU framework is not a miscellany of all possible solutions, but a list of operational improvements structured in a way that highlights what is available and what is under development. Based on its demand, an implementer can therefore select with confidence an existing capability or decide to defer implementation until a new solution is available if the demand does not pose a constraint.

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[2] https://www4.icao.int/ganpportal/GanpDocument#/lessons/Q1IoXBUo-xrMe__1nZ9NcTmB6RKGWJnK
[3] The tables provided in this hyperlink are under the review of the GANP-SG and will be updated for the 42nd session of the ICAO Assembly.
[4] The tables provided in this hyperlink are under the review of the GANP-SG and will be updated for the 42nd session of the ICAO Assembly.