TWELFTH AIR NAVIGATION CONFERENCE

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Agenda Item 1: Strategic issues that address the challenge of integration, interoperability and harmonization of systems in support of the concept of "One Sky" for international civil aviation
1.1: Global Air Navigation Plan (GANP) – framework for global planning
e) Avionics roadmap

AVIONICS ROADMAP

(Presented by the Secretariat)

SUMMARY

The *Global Air Traffic Management Operational Concept* (Doc 9854) presents the ICAO vision of an integrated, harmonized and globally interoperable air traffic management (ATM) system. The ultimate goal of this system is to support airspace users' requirements to follow preferred trajectories on each flight, resulting in fuel savings and reduced emissions. This requires the ATM system to manage each flight in four dimensions (4D), the fourth being time.

The avionics roadmap describes the avionics that will be needed and their availability to achieve the goal of the Global ATM Concept and many other operational improvements. The roadmap timeline is shown against the aviation system block upgrades (ASBUs).

The ASBU process defines timelines for the operational use of various ATM capabilities. Some of the ASBUs depend on the implementation of various avionics, as described in this document.

1. INTRODUCTION

1.1 The 37th Session of the ICAO Assembly requested that the ICAO Secretariat produce communications, navigation, and surveillance (CNS) technology roadmaps. These roadmaps were proposed to assist States and other stakeholders with their implementation decisions.

1.2 The existence of many CNS technologies with similar names yet with very different capabilities causes confusion. In addition to this, the operational benefits that can be achieved with the various technologies are not clear. This makes it difficult for States and aircraft operators to make long-term investment decisions. These decisions are critical as the advanced capabilities defined in the Global Air Navigation Plan (GANP) will depend on advanced CNS technologies.

1.3 Since the 37th Session of the ICAO Assembly, the aviation system block upgrade (ASBU) initiative was developed by ICAO. The block upgrades and the roadmaps have been developed as complementary tools to assist with air traffic management (ATM) planning and implementation. In the course of development of the block upgrades, the need for information management and avionics roadmaps was also identified.

1.4 This paper provides important background, enabling readers to gain a better understanding of the avionics roadmaps provided in the GANP and an awareness of future issues for which solutions must be found.

2. ROADMAP DOMAINS

2.1 The reader is referred to the new draft GANP for the avionics roadmaps. Three avionics roadmaps are provided:

a) communications and surveillance;

b) navigation; and

c) airborne safety nets.

2.2 Although every effort was made to replicate the format of the other general technology roadmaps, the avionics roadmaps do not distinguish between enablers and services/capabilities. The reasons for this are explained below.

2.3 As this is an avionics roadmap, the nomenclature used by the avionics industry has been adopted; however, this paper will provide linkages to the generic terms used in other roadmaps.

3. KEY THEMES

3.1 A number of key themes emerge from the avionics roadmaps:

a) integration will be the key to the implementation of many future concepts, i.e.; trajectory-based operations (TBO), self-separation, etc.;

b) robust navigation will be required through a multi-frequency/multi-constellation global navigation satellite system (GNSS) capability;

c) many technologies will have an extended lifetime; and

d) the cockpit will see numerous additions to the complement of equipment.

3.2 Integration

3.2.1 A number of the future concepts depend on the integration of various avionics functions. For example:

a) performance-based navigation (PBN) will depend on the integration of the navigation capability with the flight management system;

b) progressing from PBN to TBO will depend on the integration of the communication capability with the flight management system; and

c) self-separation will depend on the integration of the surveillance capability with the flight management system.

3.2.2 The roadmaps show that some of this integration is available today; however, Block 1 will see the introduction of all of the necessary integration needed to implement the final concepts. An important point to remember is that some of the underlying technologies may change without affecting the overall utility; this will be addressed in a later section.

3.2.3 This integration is both an enabler and a service/capability; however, as the avionics are essential to many operational improvements, they are recorded on the roadmaps as “enablers”. As the avionics often offer a bundle of integrated capabilities and that these “bundles” have their own nomenclature, the roadmaps are based on the nomenclature used to described these avionics by industry. Again, as these specific avionics are essential to many operational improvements, they are shown as “enablers”.

3.3 Robust Navigation

3.3.1 The reader is referred to the navigation roadmap and supporting discussion. One of the promises of GNSS was the opportunity to reduce the number of terrestrial navigational aids and thus achieve significant savings. Although there are multiple GNSS constellations available, the avionics to exploit these are not available today. Hence a GNSS outage can only be mitigated through reversion to terrestrial navigational aids. There are two disadvantages to this:

a) a network of terrestrial navigational aids must be maintained; and

b) in many cases, a less optimum trajectory must be chosen if the same level of PBN cannot be maintained.

3.3.2 The roadmap shows that avionics capable of supporting multi-constellation GNSS will be available during the Block 1 timeframe. Although this will not be a clear requirement until Block 3, this capability will be available to support more robust PBN operations and thus allow the achievement of operational benefits in the Block 1 timeframe.

3.4 Technology Lifetime

3.4.1 Avionics retrofit is generally a costly exercise. The opportunity to obtain new avionics capability typically occurs with the acquisition of new aircraft. Given the general cost of avionics and the difficulty of their retrofit, especially when spread across a broad fleet, aircraft operators will pursue those technologies/capabilities which promise a long operational life.

3.4.2 The reader will see that some avionics technologies cover a span of three or more blocks. This is very positive for aircraft operators. However, as pointed out above, many of these technologies rely on the integration of various systems, some of which may change over time. The communications and surveillance domains are key examples.

3.4.3 Let us examine those technologies with a long lifetime and the possible effect of technological change:

a) FANS 1/A with Comm, Nav integration via ACARS;

b) FANS 2/B with Comm, Nav integration via ATN B1;

c) FANS 3/C with CNS integration (via ATN B2);

d) traffic computer;

e) ADS-B IN/OUT (ICAO v2);

f) surveillance integration (via ATN B2);

g) multi-sensor navigation management;

h) FMS supporting PBN;

i) ACAS v7.1;

j) airport moving map;

k) EVS;

l) CDTI; and

m) electronic flight bags.

3.4.4 FANS 1/A with Comm, Nav integration via ACARS

3.4.4.1 As more and more aircraft make use of datalink, those aircraft using standard ACARS will need to upgrade to VDL Mode 2, which can support both ACARS (protocols) and the ATN. This will make greater use of the radio spectrum and improve overall performance. VDL Mode-2 will have a useful lifetime until at least Block 3. The service supported by this package in the air-ground datalink roadmap is "CPDLC and ADS-C over FANS-1/A".

3.4.5 FANS 2/B with Comm/Nav integration via ATN B1.

3.4.5.1 This package was designed for use with VDL Mode-2, which will have a useful lifetime until at least Block 3. The service supported by this package in the air-ground datalink roadmap is "CPDLC over Baseline 1 (Link 2000+)".

3.4.6 FANS 3/C with CNS integration via ATN B2

3.4.6.1 This package was designed for use with VDL Mode-2, which will have a useful lifetime until at least Block 3. The service supported by this package in the air-ground datalink roadmap is

Advanced CPDLC and ADS-C over Baseline 2. Over the lifetime of this package, the available communications links will migrate from ATN/OSI to ATN/IPS. VDL Mode-2 as currently defined is intended for use over ATN/OSI whereas new media such as AeroMACS and later LDACS and planned satellite systems will use ATN/IPS. It is likely that some means of accommodation will therefore be required.

3.4.7 Traffic computer

3.4.7.1 This is a generic term for the package which hosts airborne collision avoidance system (ACAS), the new air traffic situational awareness applications and airborne separation assistance systems (ASAS). Each of these applications is expected to undergo refinement and evolution, over its lifetime.

3.4.8 ADS-B IN/OUT (ICAO v2)

3.4.8.1 The lifetime of this technology is expected to extend over Blocks 0 through 3. Although a future ADS-B system is expected during the Block 2 timeframe, the expectation is that the two versions will be interoperable.

3.4.9 Surveillance integration via ATN B2

3.4.9.1 This package supports the integration between the traffic computer and the datalink systems. This will allow the automatic loading into the traffic computer of ASAS manoeuvres transmitted via datalink. In order to meet the requirements of these operations, an upgrade of the communications from earlier ACARS-based or ATN B1 communications will be required. The former, to improve performance, the latter to improve capability through better integration and improvements to the message sets.

3.4.10 Multi-sensor navigation management

3.4.10.1 Today’s cockpit automation merges and manages navigation data from various sources. This capability is expected to be adequate for the future however challenging PBN manoeuvres may call for changes in the processing logic.

3.4.11 FMS supporting PBN

3.4.11.1 This is expected to have a long service life extending over many blocks, as PBN is only now beginning to be exploited. This does not however cover 4D operations, which will require an avionics upgrade.

3.4.12 ACAS v7.1

3.4.12.1 As with many technologies this is expected to have a lifetime extending over many blocks.

3.4.13 Airport moving map, EVS, CDTI and EFBs

3.4.13.1 The reader is referred to the next section dealing with new cockpit equipment.

3.5 New Cockpit Equipment

3.5.1 A number of on-board systems are envisaged, namely:

a) airport moving map;

b) enhanced vision systems;

c) cockpit display of traffic information (CDTI); and

d) electronic flight bags.

3.5.2 Many of these will be implementation specific and many of these technologies overlap. For example:

a) both airport moving map and CDTI can be hosted on an electronic flight bag;

b) airport moving maps and CDTIs could be hosted on the same platform; however, they do represent different functionality; and

c) it is expected that enhanced vision systems will make use of a heads-up display; however, where implemented in a head-down display, these systems may also display an airport moving map.

3.5.3 The final implementation will depend on numerous factors, i.e. ergonomics, economics and certifiability. Certification considerations are of special concern as certain operational benefits may be limited to particular implementations, i.e. a heads-up-display as opposed to a heads-down display.

3.5.4 The conclusion to this point is that the flexibility of the new on-board systems means that careful attention must be given to the operational improvements/benefits sought and the implementation choices available.

4. CONCLUSION

4.1 This paper describes four trends affecting future avionics. The degree of level of integration will affect functionality and utility and also the operational benefits achievable with the avionics. Future operations will require robust, reliable navigation which can be achieved. Many technologies will have long lifetimes, which is an advantage to aircraft operators however some of these will need successive upgrade in order to obtain the maximum benefits available. Aircraft operators should consider this when making equipment purchases in order to ensure that all required benefits will be forthcoming. Finally, the cockpit will see various new additions to the existing equipment complement.

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