Agenda Item 4: Assessment of the various voice and/or data communication systems and overview of their performance characteristics

Note.— As per parts a) and b) of AMCP/4 Recommendation 2/1.

4.1 INTRODUCTION

4.1.1 The meeting reviewed the work that was carried out in response to the need recognized by AMCP/4 for a comparison of the expected performance of the various mobile subnetworks against known operational requirements. AMCP/4 had developed Recommendation 2/1 on the future communications, navigation, and surveillance (CNS) systems evaluation as follows:

“Recommendation 2/1 – Future CNS systems evaluation

That an appropriate ICAO body be tasked to:

a) undertake, as a matter of urgency, an assessment of the various systems providing for voice and/or data communication against their operational requirements;

b) provide an overview of the performance characteristics of these systems;

c) outline a general policy of view on the introduction of the future systems considering the operational scenario in which they would be implemented; and

d) address the transition aspects for implementation of the future systems.”

AMCP was requested by the Air Navigation Commission to undertake the activities as per part of a) and b) of this recommendation with regard to air-ground digital links while taking due account of the work carried out by other ICAO bodies. Further work, as requested in parts c) and d) of this recommendation, was deferred until the results of the assessment and the overview of performance characteristics were available.

4.1.2 Working Group D developed the assessment of the various systems and produced an overview of their performance characteristics.

4.2 REVIEW OF THE REPORT ON THE ASSESSMENT OF CNS DIGITAL LINKS

4.2.1 In reviewing the report, the major outcome that “no single data link is capable of satisfying all requirements due to range and capacity limitations or single application specifics” was particularly noted by the meeting. The report considered eleven data link technologies and provided a short description and overview of their performance characteristics. Tables summarizing the operational requirements, characteristics and the potential of systems to support certain services were incorporated.

4.2.2 The meeting also noted the co-ordination activities that were carried out with the Automatic Dependent Surveillance Panel (ADSP), the Aeronautical Telecommunication Network Panel (ATNP), the
Global Navigation Satellite System Panel (GNSSP) and the Secondary Surveillance Radar Improvements and Collision Avoidance Systems Panel (SICASP), including the results from a SICASP working group meeting which was held in March 1998. The results of this co-ordination significantly assisted in completing the presented material.

4.2.3 The meeting noted that, in some cases, the report referred to systems which were not considered by ICAO for application in international civil aviation. However, it was felt that in order to inform ICAO of the ongoing developments, the presentation of this information was useful. In this context, the meeting was informed that the frequency band 960 - 1 215 MHz in a number of regions were used for aeronautical radio navigation services, such as distance measuring equipment (DME), tactical air navigation aid (TACAN) and other systems, while the band 1 350 - 1 400 MHz was used for radar systems and was shared with the non-aeronautical-fixed and mobile services in International Telecommunication Union (ITU) Region 1. The meeting was also informed that ITU was studying the extension of these allocations to Region 3. These bands may be potentially used for the universal access transceiver (UAT) and the range applications data link system (RADLS), respectively. In addition, the meeting noted that difficulties in acquiring spectrum for data links in the high frequency (HF) and very high frequency (VHF) bands was a matter already considered by the panel.

4.2.4 A full and comprehensive report on the assessment of CNS digital links was presented, and the meeting recognized, with appreciation, the large amount of work which was necessary to complete this material. It was noted that this rather voluminous and detailed material should be circulated, on an informal basis, to other ICAO panels (ATNP, ADSP, GNSSP and SICASP). The meeting developed an extensive summary which contained essential material which was extracted from the full report. This material is contained in the appendix to the report on this agenda item.

4.2.5 The meeting agreed that the report on the assessment of CNS digital links completed the work, as per Recommendation 2/1 items a) and b) from AMCP/4, and developed the following recommendation:

**Recommendation 4/1 — CNS systems evaluation**

That ICAO, in its further work on future CNS systems evaluation as per Recommendation 2/1 items c) and d) of AMCP/4, should take into account the “Report on the Assessment of CNS Digital Links”, as contained in the appendix to the report on Agenda Item 4.

4.2.6 It was further noted that ICAO was expected to task an appropriate ICAO body to undertake the above-mentioned work (paragraph 4.1.1 of the report on this agenda item refers).

4.3 **European Organisation for the Safety of Air Navigation (EUROCONTROL) activities**

4.3.1 The meeting was informed of the results of a study from EUROCONTROL on the implementation of ATN-compliant air-ground data links in the time frame up to 2005. The study examined in detail the feasibility of VDL Mode 2 and the proposed VDL Mode 4 as candidates for a main European Civil Aviation Conference (ECAC)-wide data link. Also, the feasibility of AMSS and secondary surveillance
radar (SSR) Mode S as candidates for complementary data links was addressed. The conclusions of the study led to recommendations to implement, as soon as possible, VDL Mode 2 as the first ATN subnetwork that will support initial air traffic services (ATS) and aeronautical operational control (AOC). The study also recommended to continue the investigation for a data link supporting more stringent quality of service (QOS) requirements. It was noted that two frequencies for VDL Mode 2 would be sufficient to satisfy medium-term (2005) requirement but locally a third one could be required. A similar conclusion with regard to the number of frequencies was drawn for VDL Mode 4 (2007).

4.3.1.1 The meeting was further informed that the study did not include VDL Mode 3 since the ECAC implementation of 8.33 kHz channel spacing is imminent and will provide additional capacity for VHF voice in the time frame considered by the study.

4.3.2 The study confirmed the findings of AMCP that none of the current available or considered subnetworks could provide the required quality of service for all candidate services.

4.3.3 The meeting was further informed of the EUROCONTROL Communication Team's recommendation to:

a) implement VDL Mode 2 as the first primary ATN subnetwork for ATS and AOC data link services and to develop an implementation plan;

b) consider the use of SSR Mode S to provide complementary ATN-compliant communication services where implemented for enhanced surveillance;

c) consider the use of aeronautical mobile-satellite (route) service (AMS(R)S) to provide complementary ATN-compliant communication services for the benefit of the already-equipped aircraft;

d) investigate the definition and selection of the QOS representative of future ATN air-ground data link services and assess the suitability of VDL Mode 4 to fulfil these requirements;

e) monitor VDL Mode 3 developments and assess its capabilities as appropriate;

f) investigate the capabilities of other technologies;

g) monitor HF data link development and assess its capabilities;

h) identify the required QOS of ATS broadcast data link services and air to air communication services and assess the suitability of VDL Mode 4 to fulfil these requirements; and

i) support the ICAO validation of VDL Mode 4 in the scope defined by AMCP.
4.4 **FUTURE OPERATIONAL AND SYSTEMS CONCEPT EXPLORATION**

### 4.4.1
The meeting noted that the following systems are operating or planned to operate in the VHF band 108 - 137 MHz:

<table>
<thead>
<tr>
<th>System</th>
<th>Frequency Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>ILS localizer</td>
<td>108 - 111.975 MHz</td>
</tr>
<tr>
<td>VOR</td>
<td>108 - 117.975 MHz</td>
</tr>
<tr>
<td>GBAS data (D8PSK)</td>
<td>108 - 117.975 MHz</td>
</tr>
<tr>
<td>25 kHz voice (DSB-AM)</td>
<td>1 1 7 9 7 5</td>
</tr>
<tr>
<td>137 MHz</td>
<td></td>
</tr>
<tr>
<td>8.33 kHz voice (DSB-AM)</td>
<td>1 1 7 9 7 5</td>
</tr>
<tr>
<td>ACARS data (MSK)</td>
<td>117.975 - 137 MHz</td>
</tr>
<tr>
<td>VDL Mode 1 data (MSK)</td>
<td>117.975 - 137 MHz</td>
</tr>
<tr>
<td>VDL Mode 2 data (D8PSK)</td>
<td>117.975 - 137 MHz</td>
</tr>
<tr>
<td>VDL Mode 3 voice/data (D8PSK)</td>
<td>117.975 - 137 MHz</td>
</tr>
<tr>
<td>VDL Mode 4 data (D8PSK/GFSK)</td>
<td>108 - 137 MHz</td>
</tr>
</tbody>
</table>

In particular, the new data link systems need to be accommodated in this frequency range. In some areas, these bands are currently already severely congested. The meeting considered a proposal for developing a new approach for a VDL for the post-2010 time frame and noted there was a need for an advanced technical/operational concept. In developing this concept, due account needs to be given to:

- a) the need for integration of voice/data;
- b) the need for further data integration;
- c) the need to avoid unnecessary proliferation of data links; and
- d) the need for (a) data link(s).

Also, matters such as flexibility in design and certification need to be addressed. The meeting recalled that AMCP had tried, but failed, to merge the proposed Modes 3 and 4 in the past.

### 4.4.2
It was agreed that there is a need to consider a new approach for the use of digital links in the VHF bands for the post-2010 time frame. In developing this approach, due consideration needs to be given to the points ranged in section 4.4.1 above. In particular, it was noted that the current functional distinction in the various data links could possibly converge towards a limited number of systems.

### 4.4.3
It was explicitly stated that although ICAO should consider the new approach on a short notice, the current activities carried out by ICAO (VDL Mode 3, VDL Mode 4 and ground-based augmentation system (GBAS)) should not be affected by these studies.

* Standards and Recommended Practices (SARPs) available
4.4.4 Combined communications, navigation and surveillance system performance characteristics have not yet been developed in ICAO. Such requirements could support the validation of SARPs supporting multiple communications, navigation and surveillance functions. The meeting noted the on-going work towards a standard which is intended to support the various communications, navigation and surveillance applications.

4.4.5 The meeting was informed about the decision to establish in ICAO a panel responsible for a comprehensive air traffic management (ATM)-operational concept, as well as the decision of ECAC States to establish a concept and system domain team (CSDT) whose perspective would span from long-term operational concepts (including “free flight” or similar) to horizontal integration of CNS technologies. It is, therefore, expected that ATM-operational concepts might significantly change in the 2010 - 2020 time frame, compared with present (1995-2005) practice. The meeting, therefore, agreed that operational concepts should be studied prior to adopting new system Standards for the considered time frame.

4.4.6 In conclusion, the proposal for developing a new approach for the future aeronautical VHF systems in the post-2010 time frame was widely supported. Such new system concept should improve safety, should not have a single point of failure and should meet the requirements for the communications, navigation, and surveillance elements, through the minimum number of digital protocols and modulations. Also, the spectrum availability and efficiency should be considered. A timely beginning of such a work in ICAO should reduce the risk of development of regional solutions.

4.4.7 In relation to the above consideration, the meeting developed the following recommendation:

**Recommendation 4/2 — Future operational and system concept exploration**

That an appropriate ICAO body be tasked to:

a) develop an ATM-operational concept, scenarios for all phases of flight and operational requirements for implementation beyond 2010;

b) explore the long-term system requirements for aeronautical VHF systems in the light of a) above;

c) explore the likely airspace user needs for VHF systems beyond 2010; and

d) acquire the current implementation plans for aeronautical VHF systems in the various ICAO regions, in order to develop recommendations for gradual reduction in the total number of systems operating therein.

4.5 **Revision of VDL Mode 2 RF SARPs**

4.5.1 The meeting was informed of the results of preliminary studies by two administrations on the mutual interference effects of a VDL transmitter onto AM-DSB receiver performance, which will impact especially during transition. These studies were conducted originally in the framework of AMCP Working
Group B under the task of setting up frequency planning criteria for VDL Modes 2 and 3 against AM-DSB stations and vice versa. Results so far obtained by both studies showed unacceptable effects to a large number of channels adjacent to the VDL channel. Furthermore, the effects are inherent to the digital nature of the modulation. The radio manufacturers have agreed to address the feasibility and affordability of tightening the VDL emission mask.

4.5.2 The initial findings of the work undertaken so far are:

a) the implementation of a digital system in the 118 - 137 MHz band under the present RF SARPs will create intolerable interference effects to existing AM-DSB services;

b) a tightening of the VDL emission mask, as presently in the RF SARPs, is required.

4.5.3 The meeting pressed for a timely solution to these problems in view of the implementation plans for VDL Mode 2 in various regions and, therefore, agreed to the following recommendation:

**Recommendation 4/3** — **Revision of VDL Mode 2 RF SARPs**

That, as a matter or urgency, an appropriate ICAO body be tasked with amending the VDL RF SARPs in Annex 10, Volume III, with a view to providing the necessary protection to VHF-voice reception.

The meeting noted that the changes to the RF SARPs for VDL Mode 2 might affect the development of SARPs for VDL Modes 3 and 4. Such changes would need to be co-ordinated with other panels, such as the GNSSP.