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Working Group 3

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Agenda Item 6: Air/Ground Applications SARPS

REPORT OF SUBGROUP 2

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Summary

This paper reports on the activities of SG 2, responsible for the preparation of Standards and Recommended Practices (SARPs) for the Air/Ground data link applications Automatic Dependent Surveillance, Controller to Pilot Data Link Communications, Flight Information Services and Context Management. Proposed draft material is presented, and points requiring clarification are highlighted. It is recommended that the proposed SARPs material is released for validation. A future programme is outlined.

1. INTRODUCTION

1.1 Subgroup 2 (SG2) has been charged with producing Air/Ground SARPs for four data link applications identified by the Automatic Dependent Surveillance Panel (ADSP), namely

a. Context Management (CM)

b. Automatic Dependent Surveillance (ADS)

c. Controller/Pilot Data Link Communications (CPDLC), and

d. Flight Information Services (FIS)

It is visualised that they will be included as Parts 1-4 of the Air/Ground Volume of the Aeronautical Telecommunications Network Panel (ATNP) Standards And Recommended Procedures (SARPs).

1.2 The Terms of Reference (TOR) of the Sub Group are in Appendix A. A possible Part 0 (see Section 5 below) is at Appendix B, with four parts of the SARPs being at Appendix C-F.

1.3 SG 2 has met four times since the last Working Group meeting in Toulouse. This reflects the very tight time scales and the high workload faced by the SG. The original Rapporteur, Mike Murphy, had to resign the position due to pressure of work on being appointed Chief Executive Officer of ATN System Inc. His place was taken by Mike Asbury, of the UK NATS.

1.4 The fact that the SARPs have reached their present level of completeness is due to the very hard work put in by the editors - Jane Hamelink on behalf of the FAA for CPDLC and CM, Tim Maude on behalf of Eurocontrol for the ADS and Frederic Picard on behalf of STNA for the FIS. This is not to belittle the work of the rest of the SG in any way, but the editors have borne the brunt of the writing task.

1.5 As near as possible, and depending on the detailed contents, the format of the four parts is identical. This greatly facilitates comparison and standardisation, and should enable the reader to identify similar functionalities in the different Parts. This overall template design and configuration control is the responsibility of Stephen Pearce, of Airservices Australia, who will continue to carry out this task while the documents are being refined.

1.6 ICAO Sub Groups by their very nature tend to work rather in isolation, since working groups generally meet less frequently, and the actual Panels only occasionally. This means that the SGs have to take a lot on trust, relying on a mixture of professional and institutional experience and intuition. However, the SG believes that it has produced material for Draft SARPs which is in a form which can be used by industry to develop the necessary ground equipment and avionics to allow early validation.

1.7 This report will not cover all the material produced by the SG in detail (some 500 pages), but will seek only to highlight points of doubt, contention and clarification.

2. ICAO/OSI STANDARDS COLLABORATION

2.1 Because the new ICAO ATN-based SARPs related to an aviation application are being based on existing ISO-OSI Standards relating to computer networking, there was inevitably going to have to be some compromises made. There is a complex sequence of events decreed by ISO for the establishment of standard procedures, which is only matched by the convolutions of ICAO. In some cases the aviation applications cannot exactly comply with these ISO standards; where this happens, the ICAO requirements for SARPs has been given precedence.

2.2 Part of this problem is caused because in some cases implementation of the OSI descriptions and operating procedures seem to be open to differing interpretations. For example, two major reference guides are somewhat at variance in some of their explanations, and neither seemed to illustrate how to cope with a system as complex as the air/ground applications. Conversely, there are some areas where the SG felt seriously in need of positive guidance from ICAO, only to find that this did not exist.

2.3 Scrutiny of the material confirmed the SG feeling that they were restricted by some of the inflexibilities of the OSI methods of operation and implementation. They felt that to an extent they were inventing procedure as they went along. The result is likely to be that the documents prepared by SG 2 may not win any prizes from the ISO, but hopefully will meet the requirements of ICAO.

3. 'TAILS OF TAILS'

3.1 The SG increasingly found itself having to take care of 'Tails of Tails' of distributions of events. System solutions to these problems would have led to the need for systems of even greater complexity - increased complexity means increased costs, possibly slower running systems and greater difficulty in testing and validation. The industry-based member of the SG continually emphasised the KISS & MISS principle (Keep It Simple, Stupid, & Make It Simpler Still).

3.2 The SG have therefore been fairly ruthless in chopping off some of the more obscure tails, in many cases by aborting the dialogue. There will always be voice communications to at least a limited extent as a fall back position, and local procedures will have to be developed to cope with some other rare events.

3.3 With pilots and air traffic controllers likely to involved in the end to end user communications path, there will always be some human 'intelligence' and flexibility in the network. It will never be wholly automatic, and this element of 'manual over-ride' has allowed the SG to limit some of the wilder excesses of probability.

4. CNS/ATM-1 PACKAGE AND COMPATIBILITY

4.1 Although the main task of the SG has been to prepare Package-1 SARPs, the TOR covered the need to bear in mind that there will be a Package-2 follow on, at least. The SG has to an extent covered this contingency by putting the necessary facilities in place which will allow implementation of additional functionality without changing the basic structure of the material.

4.2 Permitting any element of backward and forward compatibility is a major problem. The stucture of the Packed Encoding Rules (PER) and the very limited use of extensibility markers will be a significant factor in the restricted availability of compatibility of multiple versions. Industry and the administrations had put the point forcefully concerning the problems of certification of software. Version compatibility cost money, in that not only had the system to be proven to work in its own right - it had to be proven to be compatible with previous versions. It was likely that the airlines would only wish to have one version installed, and leave the ground systems to support multiple versions.

4.3 It is not only the airlines that are cost and safety conscious - ground systems were now being approved to a standard almost as rigorous as that applied to aircraft, and administrations did not want to support multiple versions if they could avoid it. It may be possible in the future for a single version to be used, and if a new version was developed, for example that for CNS/ATM Package 2, there could be an 'all change' on an Airac day, with say, 18 months notice.

4.4 The SG accepts that the options for backward/forward compatability have not yet been fully explored.

5. SYSTEM TECHNICAL TIMERS

5.1 The data link applications invoke several service provider timers, the absolute values of which are as yet undetermined. The SG discussed who would be responsible for the derivation of the values, which related to technical necessities. The ADSP had suggested some operational times in their guidance material, but they had yet to be verified. An early meeting of this SG had proposed an eight level classification of communications service performance timer values, developed as part of the QOS work.

5.2 Requests for information regarding transport communications performance capabilities had not elicited any absolute figures. It had been made clear that the current provider philosophy was '... you tell us what you want, and we will give you it .....'. The SG therefore decided to use the FAA-developed tables (Appendix G) as a basis for the communications classification. These tables were based on the latest Operational Requirements Definition, and the FAA did not visualise a performance worse than their level 4.

5.3 It was decided to classify the performance capabilities as meeting classes c, e, f and g, and to plan the a/g requirements around these values. This would allow for two levels of superior performance, and one intermediate set of values. Given time, the SG would probably prepare a full set of criteria, if only by interpolation and

extrapolation. At least this would give a set of initial values to which industry could build. If during initial testing, the values were found to be seriously in error, they could be changed before final implementation.

5.4 As an interim solution it was agreed that an editor's note would be included in each Part to the effect that timer values will be determined in consultation with ADSP, when operational requirements have been assessed and taken into account.

6. INCORPORATION OF THE USER ELEMENT

6.1 Although the TOR indicate that the task of the SG is to develop SARPs for an air/ground communications service, the SG felt that this was impossible to do without an indication of the user operational requirements. The problems then arose as to how much of the user element should be incorporated into the communication service. The options ranged from 'nothing' to 'everything produced by the ADSP'.

6.2 Where possible, the SG has tried to avoid specifying anything which would influence user implementation. For example, if there is a requirement for the user to be notified, perhaps on occasions when a local error occurs, the SARPs will not say how this should be done. This was contrary to OSI procedures, whereby local errors should be specified and an indication should be given as to how they should be covered. Likewise, with few exceptions operational timers are not quantified (but values are needed soon!)

6.3 Consequently the SG has tried to steer a middle road, and hopefully the SARPs as prepared will not be seen to over-ride any possible operation procedures which may be prepared by any other ICAO Panels.

7. HIGHLIGHTS OF INDIVIDUAL PARTS

7.1 General

7.1.1 It is anticipated that this Volume of the SARPs will contain the 4 parts outlined above. However, there are some elements (Chapters, Sections or Paragraphs) which are almost common to all four parts. These include lists of acronyms, definitions, descriptions of the Abstract Functional Model, Communications Requirements etc.

7.1.2 It is suggested that these could be included in a Part 0, which would contain general introductory material. This could reduce the overall bulk of the document, while still enabling the Volume to stand on its own, rather like the two Volumes of Annex 10. It would also facilitate amendment procedures and configuration management, in that only one document would have to be amended, rather than four, where changes to common material are made.

7.1.3 The next four sub-sections highlight individual points of note arising from the preparation of the material for the individual parts. Problems common to all four parts are not repeated.

7.2 Part 1 - Context Management (CM)

Operational Requirements

7.2.1 There are no operational requirements from the ADS Panel relating to CM, except insofar as OR 2 requires '.... data link connection will need to be established between the avionics and the FDPS on order to .... start the DS dialogue where necessary. Normally this will be initiated from the aircraft ....'. Therefore to the extent necessary, the operational requirements have been defined by the SG.

7.2.2 It was agreed that CM should allow the aircraft to log on to a ground service, and request only those services it required. If the aircraft required ground initiated services, eg ADS and/or CPDLC, it needed to pass sufficient additional information to ensure unambiguous association with the relevant flight plan held in the ground data base. If, on the other hand, the aircraft only wanted to use an air-initiated application, eg FIS for ATIS, a minimum of information needed to be passed. This was the most cost/beneficial solution, reducing message length and freeing up spectrum

7.2.3 QOS had to be taken into account in this application, again at present only to the extent of indicating class of communiction service. In addition, it was confirmed that multiple log on messages could be sent to the same destination if required, even if the dialogues were still being maintained.

Version Numbers

7.2.4 The question of allowing multiple versions has resulted in added complexity. It is the CM application which will be responsible for determining version compatibility, and how to deal with the differences. This therefore implied that CM would have to be the system baseline. There will have to be total backward compatibility, such that any CM version could talk to any other, even if only at version 1 level.

7.2.5 This version compatibility will be achieved through the use of extensibility markers in ASN.1.

7.3 Part 2 - Automatic Dependent Surveillance (ADS)

Event Contract

7.3.1 In reviewing the Event contract, discussion focussed on the problems of way-point changes. Normally a way-point event would be triggered by the normal sequence of a flight, but it could be triggered by an ad hoc way-point insertion made by the pilot for operational reasons (e.g. last point to divert). The SG did not consider that it was a communications service responsibility to differentiate between whether a way-point was a route demarcation point or an operational marker - it merely had to provide notification that there had been a change.

Extended Projected Profile

7.3.2 To an extent a similar reasoning applied to the Extended Projected Profile (EPP) message. The ADSP WG B had identified a need to be able to specify the number of way points (N) in an EPP request. If N way-points are requested, then N way-points on the route of flight will be given - they may not be the next N way-points defining the route, as per clearance or flight plan.

Emergency Mode Operation

7.3.3 ADSP Operational Requirement 19, concerning Emergency Mode operation, is capable of being interpreted and implemented in more than one way. For example, a new ground user, who may be required to monitor an emergency, and needing more information than available in the default report, could not access the aircraft for periodic reports, if some other requirements from the OR were incorporated into the system.

7.3.4 The SG therefore proposed that, when the aircraft is in emergency mode, the ground user may initiate a revised or new periodic contract. The aircraft would acknowledge the contract, but will put it into abeyance, sending down only the default emergency information at the relevant Emergency Reporting Rate (ERR), this being the lesser of 60 seconds or one half of the rate stipulated in the periodic contract existing at the time the emergency mode was invoked.

7.3.5 When the ground or air user cancelled the emergency mode contract between them, the latest periodic contract held in abeyance is invoked. While this is theoretically open to abuse, it is likely that common sense and local procedures will ensure that realistic operations are maintained in emergency.

7.3.6 There was also a need to scrutinise the proposal concerning the cancelling of the aircraft emergency mode by the ground user. The SG clarified this by indicating that a particular ground user could cancel its emergency mode contract with the aircraft, but the aircraft itself would remain in emergency mode with any other users with whom it had an emergency contract. There was no question of any ground user usurping the pilot's authority to declare or cancel an aircraft state of emergency.

7.3.7 The SG considered a revised proposal to the emergency mode operation, which would still meet the requirements of ADSP OR 19, but which was radically different in concept to the method proposed in the ADSP Guidance Material. The essence of the proposal was -

a. The periodic reports should contain a flag to indicate Emergency Mode in operation

b. Ground initiated messages concerning emergency reports ('modify emergency contract' and 'cancel emergency') are removed

c. The initiation of Emergency Mode simply changes the existing periodic contract

d. Changes to the Emergency mode ae simply changes to the existing contract.

These changes, which would significantly decrease implementation effort, will be presented to the ADSP WG for initial review.

Periodic Contract Reporting Rate

7.3.8 The ADSP Guidance Material (GM) p 1/5 C-18 said that if one contract requested a one second reporting rate, then constraints were enforced on the reporting rates of any other contracts. The SG agreed that implementation of this condition would be extremely convoluted. Industry had pointed out on behalf of the implementers that the more complex the system became, the slower it would run - it was the law of diminishing returns.

7.3.9 It was highly likely that except for a few specialist applications, reporting rates would be limited by communications class and transport protocols. Very fast reporting rates would generally be operationally unrealistic, leaving the dialogue to terminate in an overload condition. It was agreed that this request would be catered for by having a reason for rejection of a contract as 'cannot meet reporting rate', and leaving the question of the sensible use of reporting rates to local operational procedures.

Acceptance of Contracts

7.3.10 In reviewing the abstract service definitions, The SG agreed that as a matter of principle, the system would not accept another contract of the same type until the previous contract request had been confirmed.

7.3.11 The SG has proposed that only the ground user can end a contract gracefully. The air user always has the option to abort the contact, but this is assumed to be a non-standard procedure. In addition, the ADS cancel all contracts service terminates all contacts with a particular aircraft, including any emergency mode operations.

Units, Ranges and Resolution

7.3.12 The ASN.1 notation was reviewed in detail. The units, ranges and resolutions are currently being revised by the ADSP, and will be made available upon approval by the next WG meeting. Certain values, which will not be determined by the ADSP, but are required to allow the ASN.1 to compile, were added to the existing material, based on operational experience. However, the changes approved by the ADSP WG will be included as soon as they can be made available.

Abort Functions

7.3.13 Because of the message handling structure, (and contrary to the impression of at least some of the SG) the handling of user and provider aborts through the Abort Module meant that an Abort message was not generally interruptive, but followed other messages down the line. Consequently there could be times when the user was not aware of either a provider abort or a user abort generated by the 'other end'. A statement would be put in the SARPs to say that if the user was aware of the existence of the dialogue, they had to be aware of the abort.

7.4 Controller to Pilot Data Link Communications (CPDLC)

CPDLC Control Function

7.4.1 The SG reviewed the possible architecture of the CPDLC Control Function (CF). SG 3 had reviewed its application at its last meeting, and had developed several alternative abstract implementations. Several tasks currently proposed to be carried out in the CPDLC Application Entity could be done by the CF, and the CPDLC SARPs have assumed a specific architecture.

Start Service

7.4.2 There is nothing technically to prevent the CPDLC start service being initiated by either the air or ground user. The SG identified that in some cases air initiation would be beneficial, for example in the requesting of the Pre-Departure Clearance (PDC). RTCA Doc 219, reflecting the then current ATC opinion, had originally proposed the idea of ground-only initiation, but the SG agreed that the facility should be technically available to both users - local applications and procedures could determine whether it was taken to full advantage.

7.4.3 Several precautions to prevent misuse were already available. For example the air user cannot enter into a dialogue if one exists already (service message 'Not Current Data Authority'). Either end could reject a dialogue start request, but must give a reason.

Timers - Start and End Dialogue

7.4.4 Apart from the general problems of timers referred to in Section 5 above, there were specific problems relating to the Start and End Dialogue timers in CPDLC. It had been agreed at earlier meetings that overall technical system timers could not be invoked where there was a human in the loop. However, a CPDLC start dialogue request could be rejected by the other user, and since there was a possibility that this could include the human as a user element, there was a real possibility that the system could lock up, waiting for a reply, possibly due to human workload.

7.4.5 It was therefore agreed that a start dialogue request could only be rejected on system grounds (e.g. 'not next data authority'), and therefore technical timers could be introduced to prevent system lock up. The timer in this case would have to be linked to the potential expected message transit time, as determined by the QOS class parameters a-h (+ null) yet to be absolutely defined. The worst case absolute

value would be class g (h was 'best effort'). A value of 2g+10 seconds was accepted by the SG as an acceptable timer value in the start dialogue case.

7.4.6 However, in the case of ending the dialogue, there was definitely an operational element to the decision. A scenario could be that the ground had sent up a message including an end dialogue request. The pilot could find that there were problems in carrying out the message instruction, or he could carry it out and fail to end the dialogue. In this case the contact would be kept open unnecessarily. It was therefore decided to introduce a long stop technical timer of 15 minutes to take care of this exceptional case. If an end dialogue interaction timed out, the ground system would initiate a user abort, which would immediately terminate the service.

Multiple CPDLC Contacts

7.4.7 There are some aspects of the communications service which would allow more flexible operation than has been prescribed by the ADSP (for example multiple CPDLC connections!) As spin-off from their earlier decision to allow air user initiation of the CPDLC dialogue, the SG agreed to facilitate the aircraft transferring data authority, by means of a 'You are next data authority' message.

7.4.8 In addition, if the aircraft had been given the correct addresses, it should, in certain circumstances, be able to initiate a dialogue with the Next Data Authority (NDA). It is appreciated that some authorities may feel that only the Current Data Authority (CDA) should be able to initiate a hand-over to the NDA by means of an end dialogue message, and this will have to be subject to local procedures.

7.4.9 It is possible that allowing the aircraft to open a dialogue would allow it to open a dialogue to a ground segment which was neither CDA nor NDA, and that this could provide a possible solution to some frequency change and downstream clearance probems currently being considered by ADSP. These are not communications service problems, and should be dealt with by local operational procedures.

Logical Acknowledgement

7.4.10 During discussions within the ADSP WGs, some European members had advocated the use of a logical acknowledgement (LACK), which would inform the ground user that the ATC message had reached the highest level of user interface, for example the display driver, or display queue. It was proposed that the LACK would be sent by the system after a fixed time, if the pilot had not replied to the message (for example by a Roger or Wilco), as a form of confirmation. It would not be used for every message, but only those for which positive and rapid acknowledgement was deemed safety critical by the controller.

7.4.11 The need for the LACK was not received with universal acclaim by all members of the SG, particularly as incorporation in the SARPs was by no means routine. It was proposed that the tagged message principle be implemented. A tag could be set by the controller if a LACK was needed, and this would generate a

service message in return. The disadvantage of this implementation was that a controller may get both a pilot acknowledgement and a LACK - the advantage was that it could be enabled or disabled easily, and carried a low technical overhead.

Inclusion of CPDLC Message Set

7.4.12 The SG debated whether the CPDLC message set as approved by the ADSP WGs should be included in the SARPs themselves, or whether it should be included as Guidance Material. The SG ultimately accepted that it should not be included in the SARPs material, principally because the ASN.1 notation contained all the necessary information. However, it should be included as the Guidance, for a number of reasons, including -

a. The set was an intrinsic part of the communications service, and had to stay compatible with the compiled ASN.1 implementation

b. It would provide a standard message set, allowing subsets to be developed for specific applications, while maintaining global compatibility

c. Boeing had already showed that Industry were not averse to amending the existing Doc 219 message set to suit their particular application, and the SG wanted to have an ICAO compliant list which anyone could build to.

7.4.13 The ADSP had indicated an operational priority of attention-getting and alerting attributes. These would be replaced by precedence numbers - 1-4 for uplink messages, and 1-3 for downlink. Implementation would be a local application. The SG also felt that there was no need for a data structure presentation guide in the SARPs, but it could be included in the Guidance Material, along with the description of possible uplink operator alerting mechanisms.

7.5 Flight Information Services

Automatic Terminal Information Service (ATIS)

7.5.1 The FIS application is currently limited to a single service, namely ATIS. Since the ATIS OR in its present form had not yet been approved by all members of the ADSP, it was agreed that the service description should be appended to Part 4 for reference.

7.5.2 In reviewing the ASN.1 Formal Definition of Messages, there was a problem of defining the necessary contents of a 'Combined ATIS' message. Neither the ADSP Working Group nor the relevant ICAO documentation had so far clarified the information required. Operationally, a combined ATIS gave information relating to both landing and take off runways, along with other general airfield data. This required the transmission of less data than a message with both Arrival and Departure ATIS, which had a lot of information duplicated.

7.5.3 The SG therefore proposed that the formal definition of messages would take account of this by allowing runway type (ie landing or take off or both) to be included

as an option. In the interests of future compatibility, extensibility markers were added wherever necessary.

7.5.4 The problem of user and provider aborts were reviewed at length. In an FIS dialogue, messages relating to the same dialogue are uniquely identified. In the event of an abort, messages may be lost, and there could be possible scope for the duplication of identifiers. Direction was now provided as to how to 'clear out' the user elements, prior to the next dialogue start being initiated and a new contract being established.

7.5.5 Due to the OSI operating restrictions, the SG had to decide whether to implement a construction which would allow optimisation of either single or multiple ATIS requests. A decision was made to optimise multiple requests, as this would allow requests for multiple FIS services in the future.

8. FUTURE WORK PROGRAMME

8.1 The SG recognises that there is still much work to be done. Some aspects of the TOR have hardly been touched, for example the preparation of Guidance Material. In addition, it is expected that there will be many comments related to the proposed material, and these will have to be reviewed in detail.

8.2 It is therefore proposed that the work of the SG should continue, with the next meeting to be held in January 1996. This meeting will -

a. Review the comments arising from this initial circulation of information, and take the appropriate action (eg immediate action for allowing a workable system for validation);

b. Prepare an outline of Draft Guidance Material;

c. Identify R & D tasks which have to be carried out to meet specific operational and technical requirements and,

d. In co-operation with industry, operators and providers, develop a suitable validation programme which will enable data link application implementation by the appropriate target dates.

8.3 In addition, it will be necessary to institute a formal configuration control for this Volume - whether there are four or five parts. The SG would take on this task, principally under the aegis of the Airservice Australia member. Change control procedures would be instigated with immediate effect - provision for this has already been made at the front of each Part. Each part would be controlled separately, minimising paperwork. (This is where an overall Part O would be of benefit, reducing the need for common changes.)

9. CONCLUSION

9.1 The SG recognised that the SARPs are not faultless, and that it could spend from now until the end of the century checking and improving them in detail.

9.2 Nevertheless the members of the SG most deeply involved with the preparation of the documents agreed that the proposed SARPs material is more than 95% complete, correct, consistent and, just as important, stable. The individual parts 1-4 were at a level where they could be released to industry for the initial validation process to start.

9.3 The SG recognised that, particularly in Section 7 of Part 3 (CPDLC) the user operational requirements have not yet been adequately defined. The ADSP will be responsible for providing some of this information, but is likely that other user requirements will be generated as a result of the early validation process.

9.4 This would enable users, operators and ATC providers to start implementing them in planned equipment, and to administrations for constructive comment.

9.5 The Parts have been standardised as much as possible within the time scales provided, and this has helped with rapid production. However, there are places where the editors have not implemented certain functions identically, although each method fulfils the requirements of both ICAO and ISO. These differences are perhaps no bad thing, and may serve to emphasise the flexibility of the OSI concepts.

10. RECOMMENDATIONS

10.1 It is recommended that the WG reviews the proposed draft material prepared by the SG, and releases it for initial validation, comment and action as required by interested parties.

10.2 Furthermore, it is recommended that the WG approves the future programme of the Air Ground Subgroup, for the continued support of the a/g SARPs.

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