INTERNATIONAL CIVIL AVIATION ORGANIZATION

ASIA AND PACIFIC OFFICE

GUIDANCE MATERIAL FOR

END-TO-END SAFETY AND PERFORMANCE MONITORING OF

AIR TRAFFIC SERVICE (ATS) DATA LINK SYSTEMS

IN THE ASIA/PACIFIC REGION

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1. Background

1.1 The Asia Pacific Airspace Safety Monitoring (APASM) Task Force established by the Asia Pacific Air Navigation Planning Implementation Regional Group (APANPIRG) during 2001 noted that requirements for monitoring aircraft height-keeping performance and the safety of reduced vertical separation minimum (RVSM) operations had been more comprehensively developed than for other Air Traffic Management (ATM) services, such as reduced horizontal separation based on required navigation performance (RNP) and the monitoring of ATS data link systems.

1.2 For example, to assist RVSM operations a handbook with detailed guidance on the requirements for establishing and operating Regional Monitoring Agencies (RMA) was developed by the ICAO Separation and Airspace Safety Panel (SASP). There was no comparable document under development by ICAO for ATS data link applications and so the APASM Task Force developed draft guidance material covering safety and performance monitoring for ATS data link applications.

1.3 The experience gained by the Informal Pacific ATC Coordinating Group (IPACG) and the Informal South Pacific ATS Coordinating Group (ISPACG) FANS Interoperability Teams (FITs) and the supporting Central Reporting Agencies (CRAs) to monitor automatic dependent surveillance - contract (ADS-C) and controller pilot data link communication (CPDLC) performance for both aircraft and ground systems was used as a resource from which to develop monitoring guidance material.

1.4 From 2004, the APASM Task Force was succeeded by the Regional Airspace Safety Monitoring Advisory Group (RASMAG) of APANPIRG, which decided to adopt and extend the APASM material to become the standard guidance material for end-to-end safety and performance monitoring of ATS data link systems in the Asia/Pacific region. Following significant development of the material, APANPIRG/16 (2005) adopted the *Guidance Material for the End-to-End Monitoring of ATS Data Link Systems in the Asia/Pacific Region* under the terms of Conclusion 16/20.

1.5 Within the remainder of the Asia/Pacific Region, the Bay of Bengal and South East Asia ATS Coordination Groups are following the lead of IPACG and ISPACG and have created FANS-1/A implementation teams and data link CRAs to accomplish this activity. These implementation teams also perform the interoperability activities which will continue after the implementation of CPDLC and ADS-C is complete. This guidance material focuses on interoperability issues, both prior to and following implementation of a data link system

1.6 During 2008, agreement was reached between Asia/Pacific and North Atlantic data link interoperability/implementation groups that the global harmonization of data link monitoring activities was desirable. Accordingly, the APANPIRG, NAT SPG and ICAO Secretariat would coordinate to the extent possible in order to develop proposals to implement required monitoring infrastructure and arrangements that would be global and cost effective.

2. Requirements for Safety and Performance Monitoring

2.1 Annex 11, at paragraph 2.27.5, states:

"Any significant safety-related change to the ATC system, including the implementation of a reduced separation minimum or a new procedure, shall only be effected after a safety assessment has demonstrated that an acceptable level of safety will be met and users have been consulted. When appropriate, the responsible authority shall ensure that adequate provision is made for post-implementation monitoring to verify that the defined level of safety continues to be met."

2.2 The *Manual of Air Traffic Services Data Link Applications* (Doc 9694) describes ATS data link applications as including DLIS, ADS, CPDLC, DFIS, AIDC and ADS-B. ATS data link applications, such as ADS-C, CPDLC and ATS interfacility data communication (AIDC), are increasingly being used in support reduced horizontal separation minima. It is therefore necessary to apply the safety monitoring requirements of Annex 11 to these data link services.

Note: *For the purposes of this guidance material, 'data link systems' (or applications) generally refer to CPDLC, ADS-C and/or AIDC.*

2.3 Data link applications comprise both a technical and an operational element. The guidelines in this document - which apply only to the technical element - propose a structure and methodology for monitoring the technical end-to-end safety performance of air-ground and ground-air data link services. The operational aspects of data link monitoring – such as reviewing the correct use of CPDLC message elements - are carried out by the appropriate safety monitoring agency.

2.4 Ground-ground data link systems supporting applications such as AIDC are essentially simpler and more direct than air-ground systems, and monitoring can be achieved directly between the concerned ATSUs. However, it should be noted that States have a responsibility to ensure that monitoring of ground-ground data link systems is carried out in support of the implementation of reduced separation minima. Monitoring of ground-ground AIDC performance is outlined in **Appendix A.**

2.5 The requirement for on-going monitoring after implementation of a data link system is based on several factors, including:

a) degradation of performance with time,

b) increasing traffic levels, and

c) changes to equipment and/or procedures which may occur from time to time,

2.6 On-going monitoring also permits the detection of errors that may have been introduced by a third party (e.g. a communications service provider).

2.7 The use of ADS-B to support separation and the introduction of the Aeronautical Telecommunication Network (ATN) will bring significant changes to operational systems that will also require the establishment of monitoring programmes.

3. Purpose of Guidance Material

3.1 The purpose of this guidance material is to:

a) Provide a set of working principles common to all Asia/Pacific States implementing ATS data link systems;

b) Provide detailed guidance on the requirements for establishing and operating a FANS-1/A implementation/interoperability team (FIT);

c) Provide detailed guidance on the requirements for establishing and operating a Central Reporting Agency (CRA);

d) Promote a standardized approach for implementation and monitoring within the Asia/Pacific Region; and

e) Promote interchange of information among different Regions to support common operational monitoring procedures.

4. Establishment and Operation of an Implementation/Interoperability Team and CRA

4.1 Recognizing the safety oversight responsibilities necessary to support the implementation and continued safe use of ATS data link systems, the following standards apply to any organization intending to fill the role of an implementation/interoperability team:

a) The organization must receive authority to act as an implementation/ interoperability team as the result of a decision by a State, a group of States or a regional planning group, or by regional agreement.

b) States should appoint a CRA that has the required tools and personnel with the technical skills and experience to carry out the CRA functions.

c) States should ensure that the CRA is adequately funded to carry out its required functions.

5. Interoperability Teams

5.1 ATS data link functionality exists in several different domains (e.g. aircraft, satellite, ground network, air traffic service units and human factors) and these elements must be successfully integrated across all domains. Airborne and ground equipment from many different vendors, as well as the sub-systems of several different communication networks, must inter-operate successfully to provide the required end-to-end system performance. In addition, standardised procedures must be coordinated among many different airlines and States to provide the desired operational performance. Technical and operational elements must then combine to allow the various applications to demonstrate mature and stable performance. It is only when this has been achieved that benefits can start being realized.

5.2 A team approach to interoperability is essential to the success of any ATS data link implementation, an important lesson learned by ISPACG, whose members were the first to implement CNS/ATM applications using FANS-1/A systems. Stakeholders had worked closely together during the initial development and subsequent certification of FANS-1/A. However, even though a problem-reporting system was in place when FANS-1/A operations commenced, many problems went unresolved. Consequently it was not possible in the short term to adopt the new operational procedures that would provide the expected benefits of higher traffic capacity and more economic routes.

5.3 An interoperability team (the ‘FIT’) was formed and tasked to address both technical and operational issues and to assist in ensuring that benefits would result. Because daily attention and occasional significant research would be required, ISPACG realized that a traditional industry team approach would not be effective. To address these concerns, the FIT created a dedicated sub-team, the CRA, to perform the daily monitoring, coordination, testing and investigation of the problem reports submitted by the team. This approach aligns with that taken for RVSM implementations where specialist supporting groups provide height keeping monitoring services.

5.4 Although the monitoring process described above was developed for FANS-1/A based CPDLC and ADS-C applications, it applies equally to AIDC and to ATN-based ATS applications. The latter was validated during the Preliminary EUROCONTROL Test of Air/ground data Link (PETAL) implementation of ATN-based ATS data link services in Maastricht ACC.

Role of the Interoperability Team

5.5 The role of the interoperability team is to address technical and operational problems affecting the transit of data link aircraft through international airspace. To do this, the interoperability team must oversee the end-to-end monitoring process to ensure the data link system meets, and continues to meet, its performance, safety and interoperability requirements and that operations and procedures are working as specified.

5.6 The specific tasks of an interoperability team are to:

a) Initiate and oversee problem reporting and problem resolution processes;

b) Establish a CRA to undertake performance monitoring on its behalf;

c) Initiate and oversee end-to-end system performance monitoring processes;

d) Oversee the implementation of new procedures;

e) Report to the appropriate State regulatory authorities and to the appropriate ATS coordinating group; and

f) Provide reports to the RASMAG.

The section on CRAs below shows that a CRA requires considerable technical resources and skills. It is likely to be more efficient to employ one of the existing CRAs than to set up a new CRA; this would also improve the standardisation of methods and results across the Region.

5.7 Terms of reference for an interoperability team are shown at **Appendix B.**

Interoperability Team Members

5.8 The principal members of an interoperability team are the major stakeholders of the sub-systems that must interoperate to achieve the desired system performance and end-to-end operation. In the case of ATS data link systems, the major stakeholders are aircraft operators, air navigation services providers (ANSPs) and communication services providers (CSPs). Other stakeholders such as international organizations, and airframe and avionics manufacturers also play an important role and should be invited by the major stakeholders to contribute their expertise.

6. Central Reporting Agencies

6.1 Work must be conducted on a daily basis for an interoperability team to achieve its important goals of problem resolution, system performance assurance, and planning and testing of operations that will enable benefits. A dedicated sub-team, the CRA, is required to do the daily monitoring, coordination, testing and problem research tasks for the interoperability team. **Appendix C** shows a table of CRA tasks and the associated resource requirements.

6.2 A CRA should be established in order to determine the safety performance of the ADS-C and CPDLC data link systems before the implementation of reduced separation minima in a particular area, and it should remain active throughout the early stages of implementation. However, as the performance of the systems stabilises to a satisfactory level, it should be possible to reduce the number of CRAs in the region by combining responsibility for different areas.

6.3 The functions of a CRA are:

a) To develop and administer problem report processes;

b) To maintain a database of problem reports;

c) To receive and process monthly end-to-end system performance reports from air navigation service providers;

d) To coordinate and test the implementation of new procedures resulting from ATS data link systems for a given region;

e) To administer and monitor an informal end-to-end configuration process;

f) To manage data confidentiality agreements as required;

g) To identify trends; and

h) To provide regular reports to the interoperability team.

<u>CRA Resource Requirements</u>

6.4 To be effective, the CRA must have dedicated staff and adequate tools. Staffing requirements will depend on the complexity of the region being monitored. There are several factors that affect regional complexity from an ATS monitoring standpoint such as dimensions of the airspace, variety in operating procedures, number of airlines, number of airborne equipment variants, number of ANSPs, number of ground equipment variants and number of CSPs.

6.5 The CRA must be able to simulate an ATS ground station operational capability to the extent of exercising all combinations and ranges of CPDLC uplinks and ADS-C reports. The CRA must also have access to airborne equipment: a test bench is adequate, though engineering simulators that can be connected to either the ARINC or SITA communication network can offer additional capability for problem solving. In support of the data link audit analysis task, the CRA must have software that can decode CSP audit data and produce usable reports. Without these tools it is virtually impossible for a CRA to resolve problems or monitor system performance.

6.6 Coordination is an important component of the CRA's function. In the pursuit of problem resolution, action item resolution, monitoring and testing, many issues arise that require coordination among the various stakeholders. The CRA has a primary responsibility to provide this coordination function as delegated by the implementation/interoperability team. Coordination between CRAs is also important, particularly to expand the information database on problems and trends; there may be a need for CRA coordination within the region and with CRAs in other regions. An incident may appear to be an isolated case, but the collation of similar reports by a number of CRAs might indicate an area that needs more detailed examination.

7. Working Principles for Central Reporting Agencies

7.1 The working principles in this guidance material result from the combined experience of the North Atlantic FANS Implementation Group (NATFIG), ISPACG FANS Interoperability Team, IPACG FANS Interoperability Team, and the ATN implementation in Maastricht ACC.

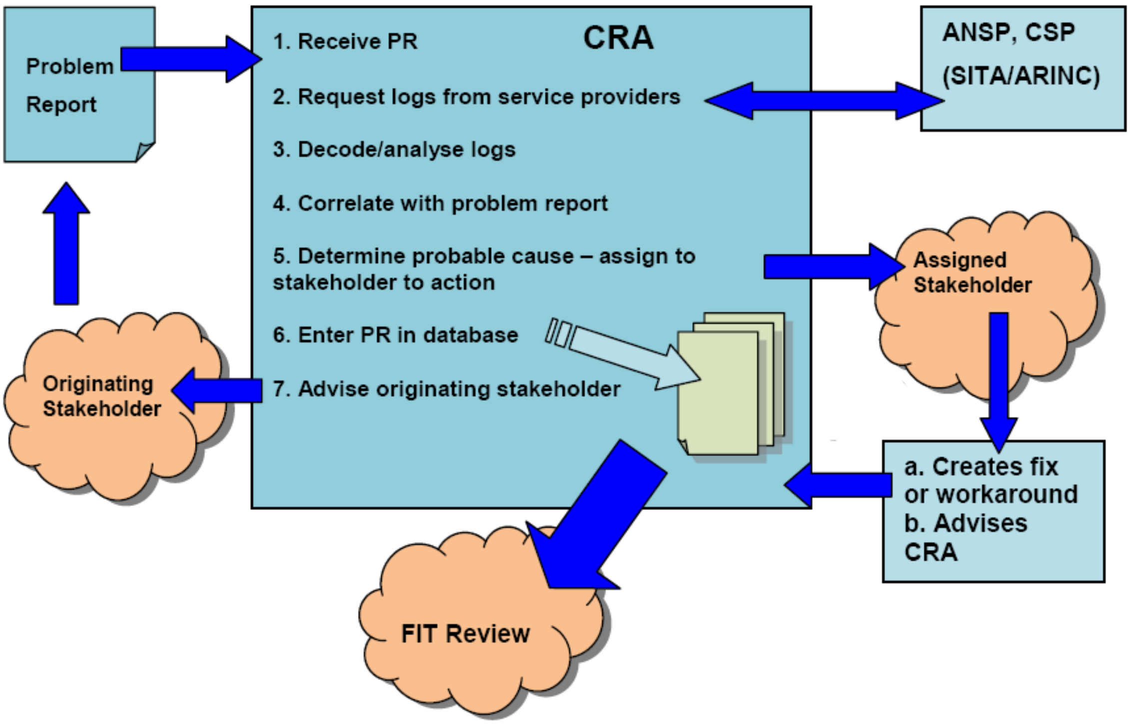
Confidentiality Agreements

7.2 Confidentiality of information is an established principle for problem reporting, and so reports must be de-identified before being made accessible to other agencies. However, it is necessary for the CRA to retain the identity of the original reports so that problem resolution and follow-up action can be taken.

7.3 The CRA must initiate and maintain confidentiality agreements with each entity providing problem reports.

Problem Identification and Resolution

7.4 The problem identification and resolution process, as it applies to an individual problem, consists of a data collection phase, followed by problem analysis and coordination with affected parties to secure a resolution, and recommendation of interim procedures to mitigate the problem in some instances. This is shown in the diagram below.



7.5 The problem identification task begins with receipt of a report from a stakeholder, usually an operator, ANSP or CSP. If the person reporting the problem has used the problem reporting form provided in the appropriate regional manual, then data collection can begin. If not, additional data may have to be requested from the reporter.

7.6 The data collection phase consists of obtaining message logs from the appropriate parties, which will depend on which service providers were being used and the operator service contracts in place at the time. Today, this usually means obtaining logs for the appropriate period from the CSPs involved. In the future, with ATN development, additional providers will become involved and airborne recordings as per EUROCAE ED-112 should become available. Usually, a log for a few hours before and after the event that was reported will suffice but, once the analysis has begun, it is sometimes necessary to request additional data, perhaps for several days prior to the event if the problem appears to be an on-going one.

7.7 Additionally, some airplane-specific recordings may be available that may assist in the data analysis task. These are not always requested initially as doing so would be an unacceptable imposition on the operators, but may occur when the nature of the problem has been clarified enough to indicate the line of investigation that needs to be pursued. These additional records include:

- Aircraft maintenance system logs, and
- Built-In Test Equipment data dumps for some airplane systems, and
- SATCOM activity logs.

7.8 Logs and printouts from the flight crew and recordings/logs from the ATSUs involved in the problem may also be necessary. It is important that the organization collecting data for the analysis task requests all this data in a timely manner, as much of it is subject to limited retention.

7.9 Once the data has been collected, the analysis can begin. For this, it is necessary to be able to decode all the messages involved, and a tool that can decode every ATS data link message type used in the region is essential. These messages include:

- AFN (ARINC 622), ADS-C and CPDLC (RTCA DO-258A/EUROCAE ED-100A) in a region operating FANS-1/A;
- Context Management, ADS-C and CPDLC applications (ICAO Doc 9705 and RTCA DO-280/ED-110) in a region using ATN; and
- FIS or ARINC 623 messages used in the region.

7.10 The analysis of the decoded messages requires a thorough understanding of the complete message traffic, including:

- Media management messages;
- Relationship of ground-ground and air-ground traffic; and
- Message envelope schemes used by the particular data link technology (ACARS, ATN, etc).

7.11 The analyst must also have a good understanding of how the aircraft systems operate and interact to provide the ATS data link functions, as many reported problems are airplane system problems.

7.12 This information will enable the analyst to determine a probable cause by working back from the area where the problem was noticed to where it began. In some cases, this may entail manual decoding of parts of messages based on the appropriate standard to identify particular encoding errors. It may also require laboratory testing using the airborne equipment (and sometimes the ground networks) to reliably assign the problem to a particular cause.

7.13 Once the problem has been identified, the task of coordination with affected parties begins. The stakeholder who is assigned responsibility for fixing the problem must be contacted and a corrective action plan agreed.

7.14 This information (the problem description, the results of the analysis and the plan for corrective action) is then entered into a database covering data link problems, both in a complete form to allow continued analysis and monitoring of the corrective action and in a de-identified form for the information of other stakeholders. These de-identified summaries are reported at the appropriate regional management forum.

Mitigating Procedures

7.15 The CRA's responsibility does not end with determining the cause of the problem and identifying a fix. Procedural methods to mitigate the problem may have to be developed because a considerable period may elapse while a solution is being developed and implemented, particularly if software updates are to be applied to all aircraft in a fleet. The CRA should identify the need for such procedures and develop recommendations for implementation by the service providers and operators involved.

Routine Data Link Performance Reporting

7.16 An important part of data link safety performance is the measurement of the end-to-end performance. This should be carried out prior to implementation of new separation minima, but should continue regularly to provide assurance that the safety requirements continue to be met. Data link performance assessment is based on round-trip time, availability, integrity, reliability and continuity, and ANSPs should provide the CRA with regular measurements of these parameters.

7.17 The CRA will use the information supplied by ANSPs to produce a performance assessment against the established data link requirements for the region. The implementation of Required Communication Performance (RCP) in a region will assist the CRA by providing a statement of the performance requirements for operational communication in support of specific ATS functions. These requirements are set according to the separation minima being applied, and so may differ within different areas according to usage.

7.18 The CRA performance assessment should be made available to the RVSM RMA and horizontal plane En-route Monitoring Agency (EMA) for their calculation of system performance against the minimum values defined in the Oceanic SPR Standard (RTCA DO-306/EUROCAE ED-122 Safety and Performance Standard for Air Traffic Data link Services in Oceanic and Remote Airspace). The system performance criteria are included in **Appendix D**.

7.19 ADS-C round-trip times are normally measured as the time between sending a contract request and receiving the associated Acknowledgement (ACK) or Message Assurance (MAS) message. CPDLC round-trip times are normally determined from the ATSU end-system time stamps for transmission of the uplink message and reception of the associated MAS.

7.20 ADS-C and CPDLC downlink one-way times are defined by the difference between the aircraft time stamp and the ASTU end-system reception time stamp.

7.21 ADS-C and CPDLC success rates are only available for uplink messages. The success rate is expressed as the percentage of messages that receive a successful ACK or MAS within a specified time.

7.22 CPDLC Actual Communications Performance (ACP) used for monitoring the RCP TRN (transaction) is the difference between the time stamp on the CPDLC uplink from the ATSU requiring a WILCO/UNABLE response to reception of the associated downlink from the aircraft.

> ***Note 1.*** *TRN is the overall transaction time, and denotes that part of the operational communication used to define start and end points for monitoring; it <u>does not include uplink message composition or reviewing of the downlink message response by the Controller</u>.*

> ***Note 2.*** *When monitoring RCP only those transactions requiring a WILCO/UNABLE response are assessed in order to provide the best modeling of the performance of a CPDLC message used for intervention in a reduced separation scenario.*

7.23 CPDLC Actual Communications Technical Performance (ACTP) used for monitoring RCTP is the sum of the following two time intervals:

1. The difference between the time stamp on the CPDLC uplink and the ATSU end-system reception time stamp of the corresponding MAS divided by two; and
2. The associated CPDLC downlink transit time (calculated by determining the difference between the aircraft time stamp and the ATSU end-system reception time stamp).

7.24 CPDLC Crew Performance (sometimes referred to as Pilot Operational Response Time - PORT) is the difference between ACP and ACTP for the same transaction.

7.25 Communication transaction time - The maximum time for the completion of the operational communication transaction after which the initiator should revert to an alternative procedure.

7.26 Position report delivery time – The maximum time for the delivery of a position report from the aircraft to the ATSU.

7.27 Monitored operational performance (TRN) - The portion of the operational communication transaction (used for intervention) that does not include message composition or recognition of the operational response.

7.28 Required Communication Technical Performance (RCTP) – The technical portion of the operational communication transaction (used for intervention) that does not include message composition, operational response, and recognition of the operational response times.

7.29 Continuity - The probability that an operational communication transaction or position report delivery can be completed within the communication transaction time.

- The proportion of intervention messages and responses that can be delivered within the specified TRN for Intervention.
- The proportion of intervention messages and responses that can be delivered within the specified RCTP for Intervention.

7.30 AIDC round trip times may be obtained from the difference between message transmission and reception of the associated application response (Logical Acknowledgement Message (LAM), or Logical Rejection Message (LRM)). The success rate is expressed as the percentage of messages that are delivered to the destination ATSU.

7.31 The integrity of AIDC messaging is not normally monitored, although an analysis of operational data over a long period could reveal undetected errors and their effects. It may also reveal interoperability issues between ground systems in adjoining ATSUs.

Time Standards

7.32 It is critical to the successful measurement and analysis of the data link performance that all elements of the system use a common time system and that the system time is maintained within the required tolerance. In accordance with Annexes 2 and 11, all times used in data link communications must be accurate to within 1 second of UTC.

7.33 It is important to note that, at the time of publishing this guidance material, GPS time is more than 10 seconds ahead of UTC; where GPS time is used as the source, the system time must be corrected to UTC.

Configuration Monitoring

7.34 A variety of technical systems are involved in the data link process and changes, particularly to software and/or software parameters, are not infrequent. Any system change may have an impact on the overall performance of the data link, and it is therefore important that the CRA is kept informed of each change of configuration to each system. With this information it is often possible to identify changes that result it improvements or deteriorations in data link performance or that may be associated with particular problems.

7.35 All ANSPs, CSPs, aircraft operators and avionics suppliers should therefore report all system configuration changes to the CRA. The CRA will then maintain a database of configuration changes for each system or sub-system. It is not necessary for the CRA to know the details of changes, but where a change is expected to affect performance, information on the likely effect should be provided.

New Procedures and Improved Performance Requirements

7.36 The CRA may recommend new end-to-end data link system performance requirements, either to accommodate new operational procedures or to take account of recognised problems.

7.37 The CRA may recommend the testing and implementation of new procedures.

APPENDIX A METHODOLOGY FOR MONITORING AIDC

1 Introduction

1.1 AIDC plays an important role in ATC coordination, and may become a significant element of ATC in the support of reduced separation minima. The performance of AIDC operations should therefore be monitored as part of the required monitoring process prior to the implementation of reduced separation minima.

1.2 AIDC operates essentially over fixed networks and generally has only two or three involved parties, generally comprising the ATSUs at either end of the network and the network provider. It is therefore generally unnecessary to develop a FIT-type approach to safety monitoring; instead such monitoring and problem identification and resolution can be carried out directly by the concerned parties.

1.3 Because fixed networks are used for AIDC, continuous performance monitoring after the implementation of reduced separation minima is not generally necessary, though annual performance and availability checks are recommended. Monitoring should also take place after any changes to the network or the end-user equipment. This will be particularly important during the implementation of the ATN.

2 AIDC Technical Performance

2.1 Two major criteria for monitoring AIDC technical performance are the achievement of acceptable delivery times and the reliability of message delivery. Delivery times can best be measured in terms of the end-to-end round trip time. Reliability is measured as the AIDC message delivery success rate.

3 End-to-End Round-Trip Time

3.1 The end-to-end round trip message time may be measured as the time difference between the transmission of an AIDC message and the reception of the corresponding Logical Acknowledgement Message (LAM) or Logical Rejection Message (LRM). If the originating AIDC system receives neither a LAM nor an LRM from the receiving system within a specified time limit (a variable system parameter, typically between 1 and 3 minutes), it will declare a time-out, and the time-out parameter must be used as the round-trip time.

3.2 All AIDC message requiring a LAM response may be used; measuring results from a variety of message types should give a more representative overall result.

3.3 Because of variations in circuits used for AIDC, separate measurements should be made and reported for each ATSU with which AIDC messages are exchanged.

3.4 A large number of measurements of round-trip times should be averaged for performance reporting.

Note: *If it is not practical to measure end-to-end times, one-way trip times may be measured by comparing the time stamps of the outgoing AIDC message and the received LAM or LRM. The reverse path may be measured from the time stamps of the received AIDC message and the corresponding LAM or LRM.*

4 Message Delivery Success Rate

4.1 The Message Delivery Success Rate is expressed as the percentage of messages successfully delivered to the destination ATSU.

4.2 Unsuccessful delivery is indicated by a time-out due to non-reception of either a LAM or LRM within a specified time.

Note: *For the purpose of this measurement, even if an AIDC message is responded to with an LRM, it is considered to have been "successfully delivered".*

4.3 The time-out indicates non-delivery of the message (and initiates various actions within the AIDC system).

$$\text{Message Delivery Success Rate} = 1 - \frac{TO}{TOT}$$

Where:

TO = number of Time Outs

TOT = total number of messages

4.4 A large number of measurements of delivery success rates should be averaged for performance reporting. Non-typical extensive transit times should also be investigated.

5 Results

5.1 An ANSP should share the results of AIDC performance monitoring with relevant ANSPs. This will enable problems to be identified and remedial actions agreed upon.

6 Caution

6.1 It is known that there are incompatibilities between some ATS end-systems leading to a situation in which a satisfactorily received message may not be able to be properly processed. In at least one case, the receiving system has been programmed to send neither LAM nor LRM in response to such messages.

6.2 This will result in a distortion of the average round-trip time and success rate for the originating end-system.

6.3 It is recommended that ANSPs ensure that all involved parties are aware of such situations so that affected messages may be excluded from the performance measurement data.

APPENDIX B MODEL TERMS OF REFERENCE FOR AN INTEROPERABILITY TEAM

Reporting and problem resolution processes

- To establish a problem reporting system;
- To review de-identified problem reports and determine appropriate resolution;
- To identify trends;
- To develop interim operational procedures to mitigate the effects of problems until such time as they are resolved;
- To monitor the progress of problem resolution; and
- To prepare summaries of problems encountered and their operational implications.

System performance and monitoring processes

- To determine and validate system performance requirements;
- To establish a performance monitoring system;
- To assess system performance based on information from the CRA;
- To authorise and coordinate system testing;
- To identify accountability for each element of the end-to-end system;
- To develop, document and implement a quality assurance plan that will provide a path to a more stable system; and
- To identify configurations of the end-to-end system that provide acceptable data link performance, and to ensure that such configurations are maintained by all stakeholders.

New procedures

- To coordinate testing in support of implementation of enhanced operational procedures

Reporting

- To report safety-related issues to the appropriate State or regulatory authorities for action;
- To provide reports to each meeting of the implementation team or ATS coordinating group, as appropriate; and
- To provide reports to RASMAG.

APPENDIX C CRA TASKS AND RESOURCE REQUIREMENTS

CRA Task	Resource Requirement
Manage data confidentiality agreements as required.	Legal services Technical expertise
Develop and administer problem report process: • de-identify all reports, • enter de-identified reports into a database, • keep the identified reports for processing, • request audit data from communication service providers, • assign responsibility for problem resolution where possible, • analyse the data, and • identify trends.	Problem reporting data base, ATS audit decode capability and Airborne test bench as a minimum, simulator highly recommended as well as ATS simulation capability (CPDLC and ADS-C)
Coordinate and test the implementation of new procedures	Airborne test bench as a minimum, simulator capability highly recommended ATS simulation capability (CPDLC and ADS-C) ATS audit decode and report capability Technical expertise Operational expertise
Administer and monitor an informal end-to-end configuration process.	Technical expertise
Report to the interoperability team.	Technical expertise

APPENDIX D SYSTEM PERFORMANCE CRITERIA

The Global Operational Datalink Document (GOLD), which is published as Regional Guidance Material, contains the detailed safety and performance requirements for data link services that need to be met and verified. These requirements are derived from *RTCA DO-306/EUROCAE ED-122 Safety and Performance Standard for Air Traffic Data link Services in Oceanic and Remote Airspace* (Oceanic SPR Standard). This does not prevent ATS service providers from negotiating more constraining contractual requirements with their communication service providers if necessary.

The tables below summarise the requirements in Appendices B and C of the GOLD.

D.1 Required Communication Performance Specifications

The rationale for the criteria provided in these specifications can be found in ICAO Annex 11, ICAO Doc 4444, ICAO Doc 9689 and RTCA DO-306/ED-122.

RCP specification	
Term	**Description**
RCP expiration time (ET)	The maximum time for the completion of the operational communication transaction after which the initiator is required to revert to an alternative procedure.
RCP nominal time (TT 95%)	The maximum nominal time within which 95% of operational communication transactions is required to be completed.
RCP continuity (C)	The required probability that an operational communication transaction can be completed within the communication transaction time, either ET or TT 95%, given that the service was available at the start of the transaction.
RCP availability (A)	The required probability that an operational communication transaction can be initiated when needed.
RCP integrity (I)	The required probability that an operational communication transaction is completed with no undetected errors. Note *Whilst RCP integrity is defined in terms of the "goodness" of the communication capability, it is specified in terms of the likelihood of occurrence of malfunction on a per flight hour basis, e.g. 10^{-5}, consistent with RNAV/RNP specifications.*
/D transaction time	
Term	**Description**
Monitored operational performance (TRN)	The portion of the transaction time (used for intervention) that does not include the times for message composition or recognition of the operational response.
Required communication technical performance (RCTP)	The portion of the (intervention) transaction time that does not include the human times for message composition, operational response, and recognition of the operational response.
Responder performance criteria	The operational portion of the transaction time to prepare the operational response, and includes the recognition of the instruction, and message composition, e.g. flight crew/HMI for intervention transactions.
$RCTP_{ATSU}$	The summed critical transit times for an ATC intervention message and a response message, allocated to the ATSU system.

RCP specification	
Term	**Description**
$RCTP_{CSP}$	The summed critical transit times for an ATC intervention message and a response message, allocated to the CSP system.
$RCTP_{AIR}$	The summed critical transit times for an ATC intervention message and a response message, allocated to the aircraft system.

D.1.1 RCP 240

RCP communication transaction time and continuity criteria		
Specification: RCP 240/D	**Application: CPDLC**	
Transaction Time Parameter	**ET (sec) C = 99.9%**	**TT (sec) C = 95%**
Transaction Time Value	240	210
RCP Time Allocations		
Initiator	30	30
TRN	210	180
TRN Time Allocations		
Responder	60	60
RCTP	150	120
RCTP Time Allocation		
$RCTP_{ATSU}$	15	10
$RCTP_{CSP}$	120	100
$RCTP_{AIR}$	15	10

RCP availability criteria		
Specification: RCP 240/D	**Application: CPDLC**	
Availability parameter	**Efficiency**	**Safety**
Service availability (A_{CSP})	0.9999	0.999
Unplanned outage duration limit (min)	10	10
Maximum number of unplanned outages	4	48
Maximum accumulated unplanned outage time (min/yr)	52	520
Unplanned outage notification delay (min)	5	5
Note 1— DO 306/ED 122 specifies an availability value based on safety assessment of the operational effects of the loss of the service. The more stringent (efficiency) value is based on an additional need to maintain orderly and efficient operations. *Note 2— DO 306/ED 122 specifies a requirement to indicate loss of the service. Unplanned outage notification delay is an additional time value associated with the requirement to indicate the loss to the ATS provider.*		

RCP integrity criteria	
Specification: RCP 240/D	**Application: CPDLC**
Integrity (I)	Malfunction = 10^{-5} per flight hour

D.1.2 RCP 400

RCP communication transaction time and continuity criteria		
Specification: RCP 400/D	**Application: CPDLC**	
Transaction Time Parameter	**ET (sec)** **C = 99.9%**	**TT (sec)** **C = 95%**
Transaction Time Value	400	350
RCP Time Allocations		
Initiator	30	30
TRN	370	320
TRN Time Allocations		
Responder	60	60
RCTP	310	260
RCTP Time Allocation		
$RCTP_{ATSU}$	15	10
$RCTP_{CSP}$	280	240
$RCTP_{AIR}$	15	10

RCP availability and integrity criteria	
Specification: RCP 400/D	**Application: CPDLC**
Availability (A) 0.999	**Integrity (I)** Malfunction= 10^{-5} per flight hour

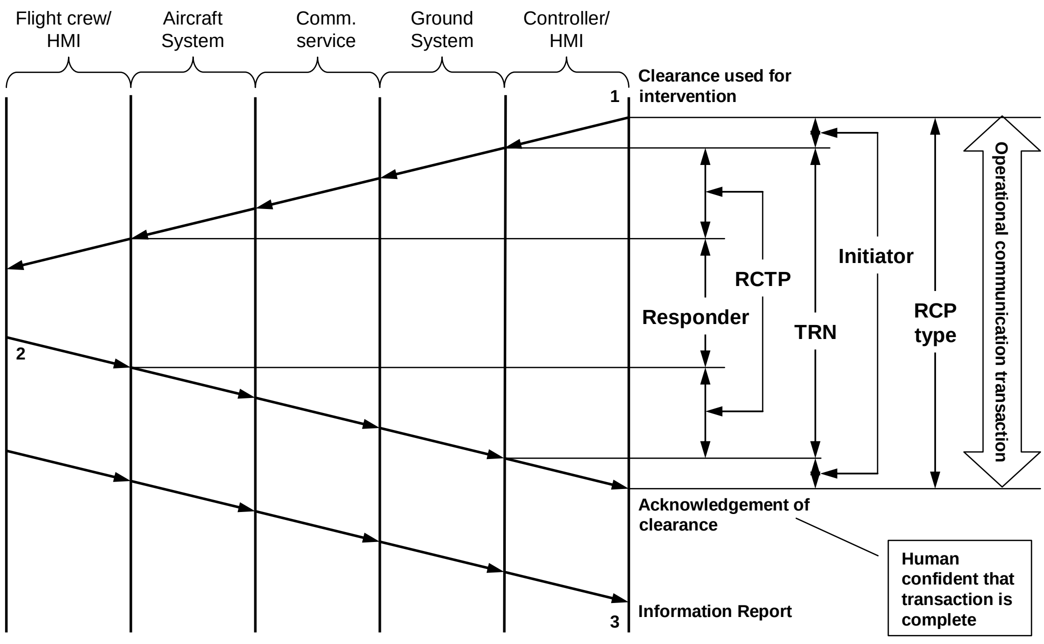


Figure 1: *RCP allocations for intervention capability (DO-306/ED-122, Figure 5-3)*

D.2 Surveillance Performance Specifications

The rationale for the criteria provided in these specifications can be found in ICAO Annex 11, ICAO Doc 4444, ICAO Doc 9689, and RTCA DO-306/ED-122.

Surveillance performance specification and related terms	
Term	**Description**
Surveillance overdue delivery time (OT)	The maximum time for the successful delivery of surveillance data after which the initiator is required to revert to an alternative procedure.
Surveillance nominal delivery time (DT 95%)	The maximum nominal time within which 95% of surveillance data is required to be successfully delivered.
Surveillance continuity (C)	The required probability that surveillance data can be delivered within the surveillance delivery time parameter, either OT or DT 95%, given that the service was available at the start of delivery.
Surveillance availability (A)	The required probability that surveillance data can be provided when needed.
Surveillance integrity (I)	The required probability that the surveillance data is delivered with no undetected error. *Note* *Surveillance integrity includes such factors as the accuracy of time, correlating the time at aircraft position, reporting interval, data latency, extrapolation and/or estimation of the data.*

Surveillance data transit time criteria	
Term	**Description**
$RSTP_{ATSU}$	The overdue (OD) or nominal (DT) transit time for surveillance data from the CSP interface to the ATSU's flight data processing system.
$RSTP_{AIR}$	The overdue (OD) or nominal (DT) transit time for surveillance data from the aircraft's avionics to the antenna.
$RSTP_{CSP}$	The overdue (OD) or nominal (DT) transit time for surveillance data allocated to the CSP.

D.2.1 Surveillance performance type 180 specification

Surveillance data transit time and continuity criteria		
Specification: Type 180/D	**Application: ADS-C, FMC WPR**	
Data Latency Parameter	**OT (sec)** **C = 99.9%**	**DT 95%(sec)** **C = 95%**
Delivery Time Value	180	90
RSTP Time Allocation		
$RSTP_{ATSU}$	5	3
$RSTP_{CSP}$	170	84
$RSTP_{AIR}$	5	3
Surveillance availability and integrity criteria		
Availability (A)	**Integrity (I)**	
0.999 0.9999 (efficiency) Note.— *The surveillance availability criteria for type 180/D are the same as the for RCP 240/D. See D.1.1 above.*	**Navigation FOM**	*The navigation figure of merit (FOM) is specified based on the navigation criteria associated with this spec. For example, if RNP 4 is prescribed, then for ADS-C surveillance service, the FOM level would need to be 4 or higher.*
	Time at position accuracy	+/- 1 sec (UTC)
	Data integrity	Malfunction = 10^{-5} per flight hour

D.2.2 Surveillance performance type 400 specification

Surveillance data transit time and continuity criteria		
Specification: Type 180/D	**Application: ADS-C, FMC WPR**	
Data Latency Parameter	**OT (sec)** **C = 99.9%**	**DT 95%(sec)** **C = 95%**
Delivery Time Value	400	300
RSTP Time Allocation		
$RSTP_{ATSU}$	30	15
$RSTP_{CSP}$	340	270
$RSTP_{AIR}$	30	15
Surveillance availability and integrity criteria		
Availability (A)	**Integrity (I)**	
0.999	**Navigation FOM**	*The navigation figure of merit (FOM) is specified based on the navigation criteria associated with this spec. For example, if RNP 10 is prescribed, then for ADS-C surveillance service, the FOM level would need to be 3 or higher.*
	Time at position accuracy	+/- 1 sec (UTC)
	Data integrity	Malfunction = 10^{-5} per flight hour
