EUROCONTROL

Link 2000+

FLIGHT CREW DATA LINK OPERATIONAL GUIDANCE in support of DLS Regulation No 29/2009

Version 5.0

LINK 2000+ PROGRAMME

Flight Crew Data Link Operational Guidance
in support of
DLS Regulation No 29/2009

Prepared by LINK 2000+ Operational Focus Group

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1. INTRODUCTION

1.1 Overview

Controller-Pilot Data Link Communications (CPDLC) enables the flight crew and controllers to exchange instructions, clearances and requests via data link text messages.

The implementation of data link is one of the key operational improvements that will alleviate voice channel congestion in busy European airspace. Communication errors such as simultaneous transmissions, misheard voice instructions and requests are reduced when data link is employed. By sending a text message directly to the aircraft, the controller can communicate instructions and clearances without having to repeat them. Flight crew can also read and acknowledge instructions and clearances directly sent to them in text.

In support of the EC Regulation No 29/2009 [1] on data link services, CPDLC provisions shall respect the following limitations in the Continental European airspace:

The CPDLC implementation is limited to the provision of a supplementary means of communication. Voice shall remain the primary means of communication. CPDLC shall be only used for routine CPDLC exchanges during en-route operations in upper airspace and not for time-critical situations.

Note: Time-critical situation is a situation when a prompt controlling action is required in the provision of air traffic services. (Refer to GOLD [11] for more details)

1.2 Scope

The scope of this document covers the implementation and the use of a number of data link services, derived from the CM and CPDLC applications and regulated by EC Regulation No 29/2009 [1]. In parallel to the Data Link Regulation, the EUROCONTROL Specification [2] has been developed as a Means of Compliance to the Data Link Regulation. The document is targeted at a readership comprising Ops managers, fleet managers, flight operations and flight crew training staff.

It is expected that the information contained in this document will contribute to the preparation of standard operating procedures, flight crew manuals and training material required by operators of CPDLC capable aircraft that will fly in the airspace of applicability as prescribed by the Data Link Regulation (see section 2).

The document will be updated as experience is gained during the use of CPDLC.

The EUROCONTROL Specification comprises the following data link services, used during en-route operations in upper airspace:

- DLIC - Data Link Initiation Capability (Logon and Contact)
- ACM - ATC Communications Management
- ACL - ATC Clearances
- AMC - ATC Microphone Check

The general provision of the DLIC, ACM, ACL and AMC services also apply to aircraft operators, operating FANS 1/A(+) based DLIC and CPDLC

implementations. Specific implementation details will be provided (e.g. in AIC or AIP) by those ANSPs which provide FANS1/A(+) services.

The LINK2000+ Flight crew Operational Guidance should be used in conjunction with ICAO's Global Operational Data Link Document (GOLD)-Ed 2.0 [11]. The GOLD document is an operational data link guidance that could be used in the entire ICAO EUR Region for all data link implementations and which is globally harmonized with guidance used in the oceanic/remote regions. This ensures global harmonization of the current data link implementations and provides a path to the convergence of the future data link communications systems.

Note 1: While the GOLD document functions as a globally operational document for DLIC, CPDLC and ADS-C operations, the LINK2000+ ATC Data Link Operational Guidance is specifically developed for the use of DLIC and CPDLC in support of EC Regulation No 29/2009.

Note 2: At the time of writing of the LINK2000+ ATC Data Link Operational Guidance-version 6.0, the GOLD-Ed 2.0 has not been published. Publication is foreseen for 1Q2013.

1.3 Document description

1.3.1 Acronyms

ACC	Area Control Centre
ACL	ATC Clearances Service
ACM	ATC Communications Management Service
ACSP	Air Communications Service Provider
AIC	Aeronautical Information Circular
AIP	Aeronautical Information Publication
AMC	ATC Microphone Check Service
ANSP	Air Navigation Service Provider
ATC	Air Traffic Control
ATN	Aeronautical Telecommunication Network
ATS	Air Traffic Services
CDA	Current Data Authority
CHG	ICAO defined Change message
CNS/ATM	Communication, Navigation, and Surveillance/Air Traffic Management
CPDLC	Controller Pilot Data Link Communications
CRO	Central Reporting Office
DLIC	Data Link Initiation Capability
ER	En Route
ET	Expiration Time
FIR	Flight Information Region

FL	Flight Level
FPL	Filed Flight Plan
GOLD	Global Operational Data Link Document
HMI	Human Machine Interface
ICAO	International Civil Aviation Organisation
LACK	Logical ACKnowledgement (used in air-ground data link)
MCDU	Multifunction Control Display unit
NDA	Next Data Authority
TMA	Terminal Control Area
UAC	Upper Airspace Control
UIR	Upper Information Region

Table 1-1: Acronyms

1.3.2 Glossary of terms

Term	Definition
Air traffic control clearance	Authorisation for an aircraft to proceed under conditions specified by an air traffic control unit. *Note 1: For convenience, the term "air traffic control clearance" is frequently abbreviated to "clearance".* *Note 2: The abbreviated term "clearance" may be prefixed by the words "taxi", "take-off", "departure", "en-route", "approach" or "landing" to indicate the particular portion of flight to which the air traffic control clearance relates. [ICAO]*
Air traffic control instruction	Directives issued by air traffic control for the purpose of requiring flight crew to take a specific action. [ICAO]
Air traffic control service	A service provided for the purpose of: preventing collisions: • between aircraft, and • on the maneuvering area between aircraft and obstructions, and • expediting and maintaining an orderly flow of air traffic [ICAO]
Air traffic management	The aggregation of the airborne functions and ground-based functions (air traffic services, airspace management and air traffic flow management) required, to ensure the safe and efficient movement of aircraft during all phases of operations.
Air traffic service	A generic term meaning variously, flight information service, alerting service, air traffic advisory service, air traffic control service (area control service, approach control service or aerodrome control service). [ICAO]

Term	Definition
Alert	A method to draw the attention of the flight crew or controller, visually and/or aurally (e.g. arrival of a message, time-out).
CPDLC application	Controller-Pilot Data Link Communications application, providing the air-ground data communication between flight crew and controller for ATC services.
Current Data Authority	The designated ground system through which a CPDLC dialogue between a flight crew and a controller currently responsible for the flight is permitted to take place. [PANS-ATM]
Data link application	A data link application is the implementation of data link technology to achieve specific air traffic management (ATM) operational functionalities (e.g. voice communications management).
Data link service	A data link service is a set of ATM related dialogues, both system and manually supported, within a data link application which have a clearly defined operational goal. (In this context DLIC, ACL, ACM, and AMC)
Dialogue	A two-way exchange of information between the originating user and the receiving user, from opening of the dialogue to closure of the dialogue
Expiration Timer-initiator (tts)	Timer used by a sending system to detect the absence of an operational response from the remote system in an acceptable period of time. The timer-sender starts when the message is released by the initiator. It ends when an indication of the receipt of the operational reply is provided to the initiator.
Expiration Timer-responder (ttr)	Timer used by a receiving system to detect the absence of a response to a received message in an acceptable period of time. The timer-responder starts when an indication of the receipt of the message is provided to the responder. It ends when the operational reply is released by the responder.

Term	Definition
Flight plan	Specified information provided to air traffic services units, relative to an intended flight or portion of a flight of an aircraft. [ICAO] A flight plan can take several forms, such as: Current flight plan (CPL). The flight plan, including changes, if any, brought about by subsequent clearances. *Note: When the word "message" is used as a suffix to this term, it denotes the content and format of the current flight plan data sent from one unit to another.* Filed flight plan (FPL). The flight plan as filed with an ATS unit by the flight crew or a designated representative, without any subsequent changes. *Note: When the word "message" is used as a suffix to this term, it denotes the content and format of the filed flight plan data as transmitted.*
LACK Timer (tr)	Technical response timer used by a sending system to detect the absence of an expected technical response (LACK) in an acceptable period of time.
Latency Time Monitor	A time check that is activated by a receiving system, when the uplinked CPDLC message is received after the permitted time. The system indicates to the recipient that the CPDLC message has become invalid for treatment or rejects the CPDLC message.
Next Data Authority	The ground system so designated by the current data authority through which an onward transfer of communications and control can take place. [PANS-ATM]
Supplemental means of communication	Communication capability that is not required for the intended operation, but if available can be used as an alternative to the primary means in accordance with operational approval.

Table 1-2: Glossary of terms

1.3.3 Mandating and recommending phrases

This document uses the words "shall," and "should" as follows:

1. **"Shall":**

   ICAO:

   Any specification for physical characteristics, configuration, matériel, performance, personnel or procedure, the uniform application of which is recognized as necessary for the safety or regularity of international air navigation and to which Contracting States will conform in accordance with the Convention; in the event of impossibility of compliance, notification to the Council is compulsory under Article 38.

   EUROCAE ED-120 and ED-110B

   Indicates a mandated criterion; i.e. compliance with the criterion is mandatory and no alternative may be applied;

2. **"Should":**
   ICAO:
   Any specification for physical characteristics, configuration, matériel, performance, personnel or procedure, the uniform application of which is recognized as desirable in the interest of safety, regularity or efficiency of international air navigation, and to which Contracting States will endeavour to conform in accordance with the Convention

   EUROCAE ED-120 and ED-110B
   Indicate that, although the criterion is regarded as the preferred option, alternative criteria may be applied. In such cases, alternatives should be identified in appropriate approval plans and agreement sought from the approval authority;

3. **"May"** means a procedure, or instruction is permissive, optional or alternative;
4. **"Will"** is only used for informative or descriptive writing, e.g. "transfer of CPDLC will coincide …." is not an instruction to the controller.
5. **"Instruct"** indicates that an ATM operator is required to issue binding positive commands to the addressee;
6. **"Advise"** means that an ATM operator is required to suggest a non-binding behaviour to the addressee;
7. Throughout this guidance document, whenever a noun is used referring to a person providing ATM services (e.g. controller or operator), that word is to be understood as covering both sexes. For user-friendliness purposes, the pronoun "he" is used in all cases and shall in no case imply any form of sexual discrimination.

1.3.4 Document organisation

Section 1 provides an introduction to this guidance document. It gives some background information, the scope of the EUROCONTROL Specification [2] and organisation of the document.

Section 2 gives a description of the airspace of applicability, the geographical scope of the data link service provision and key dates prescribed by the Data Link Regulation No 29/2009.

Section 3 provides the four operating principles that are applicable to the use of the four ACC en-route services.

Section 4 describes the data link services for DLIC, ACL, ACM and AMC.

Section 5 describes the different timers used in ground and aircraft systems and their behaviour on expiry.

Section 6 provides requirements and recommendations for the flight crew procedures related to the use of data link, which have been extracted from the relevant ICAO and EUROCAE documents.

Section 7 provides an analysis of Human Factors benefits and issues related to the use of CPDLC. On the basis of this analysis, recommendations for training and procedures are formulated.

Section 8 provides training guidelines for controller pilot data link communications to assist in the development of a training program for CPDLC for qualified flight crew.

Section 9 provides guidance for uplink and downlink concatenated messages and closure within the envisaged environment.

Annex A lists the error messages displayed to the flight crew.

Annex B provides the CPDLC message set for aircraft implementations in accordance with the EUROCONTROL Specification [2].

Annex C provides an overview of the Central Reporting Office for System Performance and Problem Reporting.

Annex D Service Provision to FANS 1/A(+) and Bilingual Aircraft in the Continental European Region.

Appendix A presents a list of contributors to this document.

1.4 References

The following references were used as input to this document:

1. Commission Regulation (EC) No29/2009, 16 January 2009 - laying down requirements on data link services for the single European sky.
2. EUROCONTROL Specification on Data Link Services, Edition 2.1, January 2009.
3. EUROCAE Document ED-110B – Interoperability Requirements Standard for ATN Baseline 1, December 2007.
4. EUROCAE Document ED-120 - Safety and Performance Requirements Standard for Air Traffic Data-Link Services in Continental Airspace, May 2004 and Change 1, April 2007 and Change 2, Oct 2007.
5. EUROCAE Document ED-154A – Future Air Navigation System 1/A – Aeronautical Telecommunication Network Interoperability Standard (FANS 1/A-ATN N1 Interop Standard), March 2012.
6. ICAO Annex 10 - Aeronautical Telecommunications - Volume II (Communications Procedures including those with PANS status).
7. ICAO Doc. 4444 - Procedures for Air Navigation Services - Air Traffic Management (PANS-ATM) – Ed15, 22 November 2007.
8. ICAO Doc 8400 - ABC- ICAO Abbreviations and Codes.
9. ICAO Doc 9694 - Manual Traffic Services Data Link Applications.
10. ICAO Doc 7030/5 – Regional Supplementary Procedures – EUR Region including Amendments for CDLC.
11. ICAO - Global Operational Data Link Document (GOLD) –Ed 2.0, xxxx2013
12. Goteman, Ö. - Flight crew and air traffic controller cooperation during Controller-Pilot Datalink communication trials. SAS Technical Report. Ref.nr. GOT-050426, 2007.
13. Helleberg, J.R. & Wickens, C.D. - Effects of data-link modality and display redundancy on pilot performance: An attentional perspective. *The International Journal of Aviation Psychology, 13(3),* 189 – 210, 2003.
14. Navarro, C. & Sikorski, S. - Datalink communication in flight deck operations: A synthesis of recent studies. *The International Journal of Aviation Psychology, 9(4), 361 – 376*, 1999

2. AIRSPACE

The image below illustrates the en-route upper airspace of applicability above FL285, the geographical scope of the data link service provision and key dates prescribed by the EC Regulation No 29/2009 [1].

Note: Some ANSPs may have en-route sectors with upper airspace levels below FL285. It is preferred to continue using CPDLC. Such arrangements will be detailed in Letters of Agreement between adjacent units.

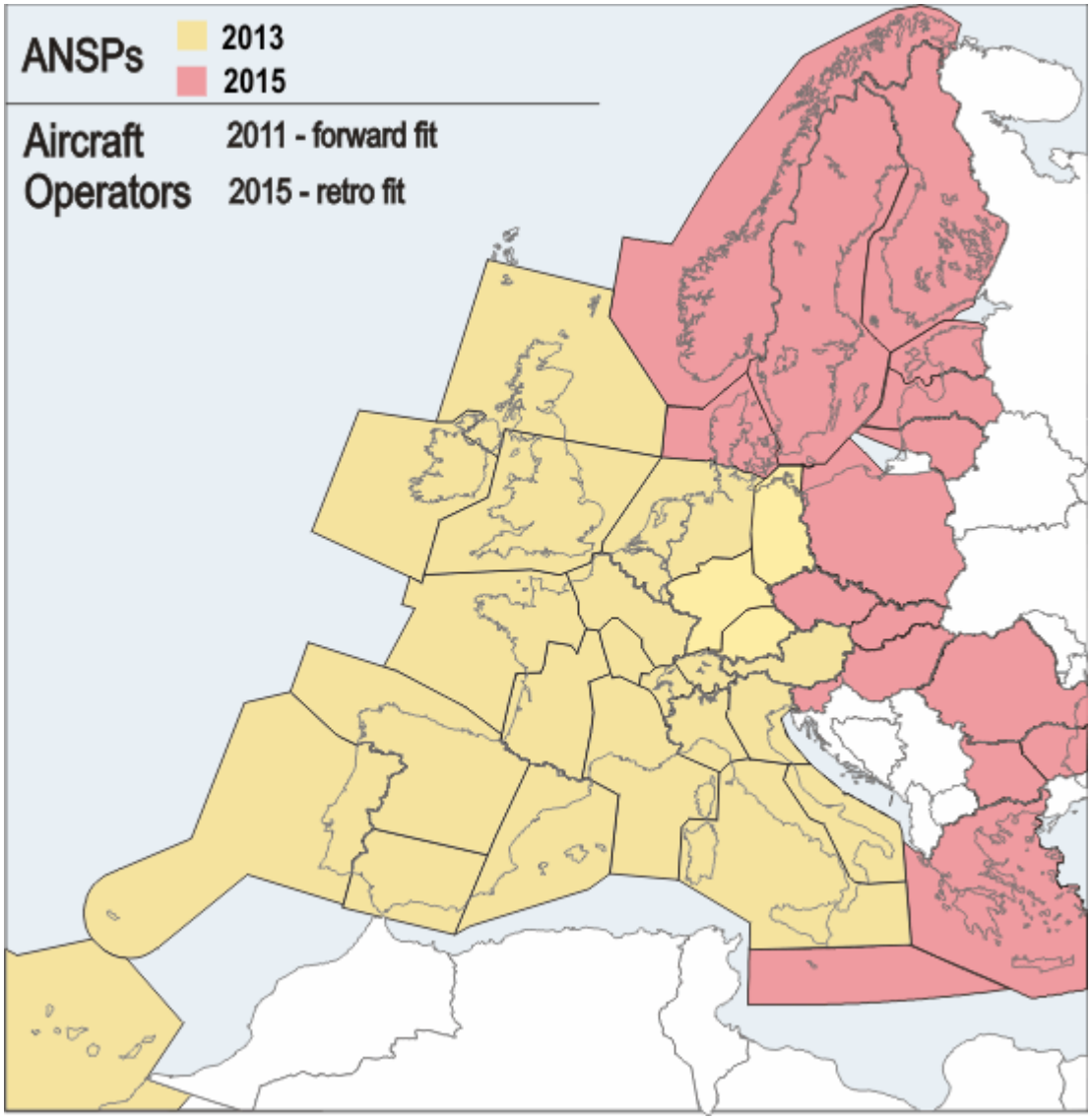

Figure 2-1: Geographical scope of the area of applicability and key dates

3. OPERATING PRINCIPLES

The following underlying principles apply to the use of CPDLC in the en-route upper airspace:

Principle A

In support of the EC Regulation No 29/2009, CPDLC provisions shall respect the following limitations in the Continental European airspace:

The CPDLC implementation is limited to the provision of a supplementary means of communication. Voice shall remain the primary means of communication. CPDLC shall be only used for routine CPDLC exchanges during en-route operations in upper airspace and not for time-critical situations.

Note: Time-critical situation is a situation when a prompt controlling action is required in the provision of air traffic services. (Refer to GOLD [11] for more details)

Principle B

The decision to use either voice or CPDLC is at the discretion of the controller and/or flight crew involved.

Principle C

The provisions regarding the use of CPDLC respect the following Standard as contained in ICAO Annex 11, Chapter 3, para 3.5.1: *"A controlled flight shall be under the control of only one air traffic control unit at any given time"*.

4. DESCRIPTION OF SERVICES

4.1 DLIC – Data Link Initiation Capability

DLIC, sometimes referred to as "logging on", provides the mechanism for exchanging and forwarding information between aircraft- and ATC ground systems.

It also provides the necessary information to establish flight plan / address association in the ATC system to ensure correct delivery of data link messages.

The logon request is initiated by the flight crew.

"Logging on" is a prerequisite to the use of ACM, ACL and AMC services.

Note: Once CPDLC-equipped ACCs are operating adjacent to each other, flight crews will not need to log on repeatedly along the route, as the logon information will be automatically forwarded via ground networks from ACC to ACC. Re-logon will then only be required for a flight transiting a non-equipped ACC between two CPDLC-equipped ACCs.

4.1.1 Logon on function

After successful log on, the CPDLC connection needs to be established. The CPDLC connection request is automatically generated by the ground system and its confirmation is automatically generated by the aircraft system (Refer to 8.4 for more details).

4.1.1.1 Operating method

The DLIC Logon function operating method is as follows:

Step	Operating Method
1	The flight crew initiates a logon request to the ATSU *Note: Flight crew should initiate a logon request, between 10 and 30 minutes before entering the airspace of an UIR. For aircraft departing from airports beneath, or in close proximity to, the ATSU's airspace, the logon can be initiated on the ground. Specific local requirements about the timing of logon initiation may be found in the AIC/AIP.*
2	The ATSU system attempts to associate the flight data received from the aircraft with the corresponding flight plan
3	ATSU system sends a logon response to the aircraft. *Note: The controller and flight crew may get an indication of the logon status on the HMI*

Table 4-1: DLIC - Operating Method for Logon function

4.1.1.2 Diagram

Figure 4-1 depicts a diagram of the Logon function. Numbers shown in the diagram reflect the steps shown in 4.1.1.1.

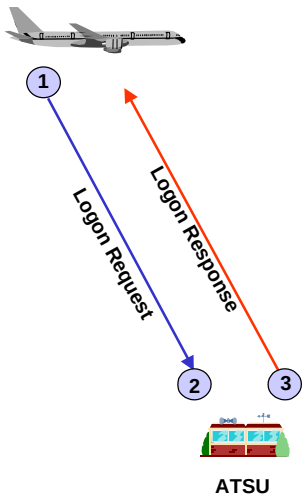

Figure 4-1: DLIC - Diagram for Logon Function

4.2 ACM – ATC Communications Management

The ACM service permits:

- The establishment and termination of the CPDLC connection with an ACC;
- The transfer of CPDLC from one ACC to another;
- The instruction to change voice frequency/channel within an ACC;
- The instruction to change voice frequency/channel when transferring from one ACC to another.

4.2.1 Establishment of a CPDLC Connection

After successful log on, the CPDLC connection needs to be established. The CPDLC connection request is automatically generated by the ground system and its confirmation is automatically generated by the aircraft system.

4.2.2 CDA – Current Data Authority

After establishment of a CPDLC connection, a CDA message is automatically generated by the aircraft system, notifying the ACC that the aircraft system considers the ACC as the current data authority (Refer to 8.5.1 for more details).

The flight crew is informed that the ACC is the Current Data Authority.

Note: From flight crew perspective, the flight may still be under control of the previous ACC.

4.2.3 NDA - Next Data Authority

When transferring communications to the next CPDLC equipped ACC, the current data authority (CDA) designates another ACC as the next data authority (NDA).

NDA is an automatically generated message from the CDA's ground system to the aircraft.

Upon receipt, an indication of the NDA is presented to the flight crew.

Upon completion of transfer, NDA becomes CDA.

Note: Anticipating future arrangements, some ground systems (e.g. Maastricht UAC) will always send an NDA automatically to the aircraft irrespective of whether the next ACC is CPDLC equipped or not.

4.2.4 Transfer of voice communications (CONTACT)

After CPDLC connection is established, the flight crew can expect to receive data link instructions containing the voice frequency/channel of the next sector within the present ACC or the first sector of the next ACC.

Note: The uplink message "MONITOR (UM120)" and downlink message "MONITORING (DM89)" are subject of evaluation regarding their operational use. To anticipate on potential operational use, aircraft are mandated to implement both messages.

4.2.5 Transfer of CPDLC with open dialogues

- **Open ground-initiated dialogues**

When a transfer of CPDLC results in a change of data authority, and the flight crew responds to the transfer instruction with a WILCO, the airborne system closes all open ground initiated dialogues. When responding with UNABLE or STANDBY, the aircraft system maintains the open dialogues.

When a transfer of CPDLC does **not** result in a change of data authority, the airborne system maintains all ground initiated dialogues open, regardless of the operational response to the transfer instruction.

- **Open air-initiated dialogues**

When there are open air initiated dialogues, and the flight crew responds to the transfer instruction with a WILCO, the airborne system closes all open air initiated dialogues. When responding with UNABLE or STANDBY, the aircraft system maintains the open dialogues.

4.2.6 Termination of CPDLC connection

Upon leaving the airspace of the CDA, controlling the aircraft, a disconnection will be initiated by the ground system. Following a WILCO from the flight crew to the CONTACT instruction, CPDLC will then be terminated with the aircraft.

4.3 ACL - ATC Clearance messages

CPDLC allows flight crews and controllers to conduct operational exchanges. The ACL service enables:

- flight crew to send requests and reports to controllers
- controllers to issue clearances, instructions and notifications to flight crew

ATC clearances and instructions will only be available after successful completion of the CPDLC connection through the ACM service.

4.4 AMC - ATC Microphone Check

The AMC service allows controllers to send the CHECK STUCK MICROPHONE instruction to all CPDLC-equipped aircraft on a given frequency, at the same time, in order to instruct flight crews to verify that their voice communication equipment is not blocking a given voice channel. This instruction will be issued only to those aircraft under his control.

The AMC service will only be available after successful completion of the CPDLC connection through the ACM service.

5. TIMERS

For ACL, ACM and AMC messages, the ATN Baseline1 INTEROP Standard (ED110-B) [3] defines the implementation of the following three timers in ground- and aircraft systems:

a. Technical response (LACK) timer (tr)

b. Expiration timer-initiator (tts)

c. Expiration timer-responder (ttr)

In addition, ED-110B specifies the use of a latency time monitor mechanism to monitor the time of reception of a message.

In accordance with ED110B and the EUROCONTROL Specification:

- aircraft systems, implementation of the expiration timer-responder (ttr), the LACK timer (tr) and the latency time monitor is mandatory. Aircraft systems are not required to implement the expiration timer–initiator (tts).

- Ground systems are required to implement the expiration timer–initiator (tts), LACK timer (tr) and expiration timer-responder (ttr). Ground systems are not required to implement the latency time monitor.

5.1 Technical Response (LACK) timer

The purpose of the LACK message is to inform the flight crew that the downlinked message was received and processed by the ground system, and that it was found acceptable for display to the controller.

In addition, the LACK may be used to monitor the performance of the air-ground communications network.

Each time the flight crew sends an operational message, the ground system returns a LACK.

A LACK informs the aircraft system that the message transmitted has been verified by the ground system (e.g. check on parameter ranges) upon receipt.

Note1: Aircraft systems do not request a LACK for the messages ERROR (DM62), NOT CURRENT DATA AUTHORITY (DM63), LACK (DM100), and NOT AUTHORIZED NEXT DATA AUTHORITY (DM107);

Note2: Receipt of LACKs is only applicable to ATN implementations. FANS 1/A+ aircraft systems cannot receive LACKs.

5.1.1 The LACK timer value should be set by the aircraft system at 40 seconds.
If the aircraft system does not receive a LACK within 40 seconds, the flight crew will be notified.

Note: Local implementers may decide whether the flight crew is notified on the receipt of each LACK (positive feedback) or is only notified upon a LACK time out (negative feedback).

5.1.2 When a LACK is received after expiry of the LACK timer, the LACK may be discarded.

5.2 Latency time monitor

Aircraft systems

The latency time monitor compares the time of transmission of an uplinked CPDLC message (from the CPDLC time-stamp) with the time of reception.

If the permitted latency time is exceeded, then the CPDLC message becomes invalid for the flight crew. After this time, the CPDLC message may have lost its operational meaning and the time to act upon the received CPDLC message may have become too short for the flight crew.
The aircraft system behaviour is intended to ensure that a delayed CPDLC message is not left active with the flight crew for a significant period of time after the dialogue has been closed at the ground side.

5.2.1 The message latency value is set in aircraft systems at 40 seconds.

5.2.2 Upon activation of the latency check, the aircraft system:

either

- does not present the CPDLC message to the flight crew and automatically downlinks an error message 'UPLINK DELAYED IN NETWORK AND REJECTED; RESEND OR CONTACT BY VOICE' for display to the controller.

  The controller reverts to voice as described in procedure 6.8.1.

or

- presents the CPDLC message to the flight crew with the appropriate indication.

  The flight crew reverts to voice as described in procedure 6.8.1.

Ground systems

If an ANSP has implemented the latency check (not required), a similar behaviour exists as mentioned above. When the flight crew sends a CPDLC request to the ground, the CPDLC message becomes invalid for the controller when it is received after the allowed limit. If the permitted latency time is exceeded, then the downlinked request is either discarded, and an ERROR response sent, or else the message is displayed to the controller with an appropriate warning.

5.2.3 If used, the value for the message latency is set by ground systems at 40 seconds.

5.2.4 Upon activation of the latency timer, the ground system:

either

- does not present the CPDLC message to the controller and automatically uplinks an error message 'DOWNLINK DELAYED - USE VOICE' for display to the flight crew.

  The flight crew reverts to voice as described in procedure 6.8.1.

or

- presents the CPDLC message with the timestamp to the controller.

  The controller reverts to voice as described in procedure 6.8.1.

5.3 Expiration timers

Expiration timers are used for messages requiring an operational response to prevent that a data link dialogue becomes open-ended. Two expiration timers exist:

a. Expiration timer-initiator (tts);

b. Expiration timer-responder (ttr).

Different values are specified, depending on whether the dialogue is controller or flight crew initiated.

5.3.1 Controller initiated dialogues

5.3.1.1 When the controller uplinks a CPDLC message, requiring an operational response, the ground system starts the expiration timer-initiator (tts).

5.3.1.2 The timer value for the operational response to be received is set at 120 seconds.

5.3.1.3 The timer-initiator expires if no operational response has been received by the ground system within 120 seconds. The controller is notified and reverts to voice to resolve the situation (see procedure in 6.8.1).

The dialogue is closed locally by the ground system, ensuring that the dialogue doesn't remain open at the ground side.

5.3.1.4 When the aircraft system receives the message, it starts the expiration timer-responder (ttr).

5.3.1.5 The timer value for the response to be sent is set at 100 seconds.

5.3.1.6 The timer-responder (ttr) expires if the flight crew fails to respond within 100 seconds. The flight crew is notified and reverts to voice to complete the dialogue (see procedure in 6.9).

The aircraft system closes the dialogue and downlinks an error response 'AIRSYSTEM TIME-OUT'. The error response ensures that the dialogue will also be closed at the ground side, if the timer-initiator has not expired.

Note: In normal circumstances, the timer-responder should expire before the timer-initiator times out.

5.3.1.7 If the flight crew responds to a clearance with a STANDBY, the aircraft and ground timers are re-started.

Figure 5-1 depicts the LACK, and expiration timers used in a controller-initiated dialogue.

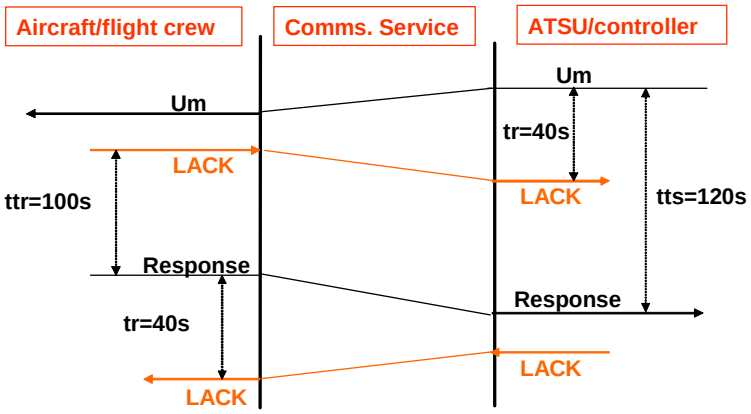

Figure 5-1: Timers used in a controller-initiated dialogue

5.3.2 Flight crew-initiated dialogues

5.3.2.1 When the flight crew downlinks a request, requiring an operational response, and when implemented, the aircraft system starts the expiration timer-initiator (tts).

5.3.2.2 If used, the timer value for the operational response to be received is set at 270 seconds.

5.3.2.3 The timer-initiator (tts) expires, if no operational response has been received by the aircraft system within 270 seconds. The flight crew is notified and reverts to voice to resolve the situation (see procedure in 6.8.1).
The dialogue is closed locally by the aircraft system, ensuring that the dialogue doesn't remain open at the aircraft side.

5.3.2.4 When the ground system receives the request, then it starts the expiration timer-responder (ttr).

5.3.2.5 The timer value for this response to be sent is set at 250 seconds.

5.3.2.6 The timer-responder (ttr) expires, if the controller fails to respond within 250 seconds. The controller is notified and reverts to voice complete the dialogue (see procedure in 6.9).

The ground system closes the dialogue and uplinks an error response 'ATC TIME OUT – REPEAT REQUEST'. The error response ensures that the dialogue will also be closed at the aircraft side, if the timer-initiator (tts) has not expired.

Note: In normal circumstances, the timer-responder (ttr) should expire before the timer-initiator times out.

5.6.3.1.7 If the controller responds to a request with a STANDBY, the aircraft and ground timers are re-started.

Figure 5-2 depicts the LACK, and expiration timers used in a flight crew-initiated dialogue.

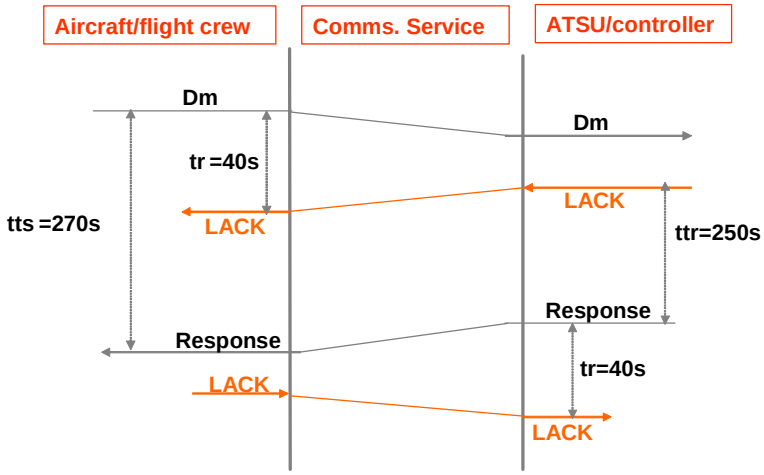

Figure 5-2: Timers used in a flight crew-initiated dialogue

6. CPDLC PROCEDURES

The procedures listed below are a collection of CPDLC related procedures, relevant to flight crews and operators, and are cited from ICAO documents 4444 (PANS-ATM), Annex 10 (Communication Procedures), and 7030/5 (Regional Supplementary Procedures-EUR Region) and EUROCAE documents ED-120 (Continental SPR Standard) and ED-110B (ATN B1 INTEROP Standard). The procedures below should be used in conjunction with GOLD ED 2.0 [11].

In addition, the OFG has recommended some procedures to support the use of CPDLC operations. These recommended procedures are enumerated with the "OFG-Recom-# " tag.

It should be noted that some procedures are exemplified with examples (highlighted in blue) or accompanied by a note. These examples or notes are not part of the cited documents, but are provided for clarification purposes.

6.1 General

6.1.1 Where applicable, the communication procedures for the provision of CPDLC shall be in line with ICAO Annex 10, Volume III, Part I, Chapter 3. — PANS-ATM 14.1.5

CPDLC message element intent and text and associated procedures are, in general, consistent with ICAO Doc 4444 PANS-ATM Chapter 12 - Phraseologies. It is, however, recognised that the CPDLC message set and the associated procedures differ somewhat from the voice equivalent used because of the differences between the two media; one being direct-speech and the other an exchange of data, the latter of which can be displayed and/or printed.

6.1.2 The **pilot** shall be able to identify the air traffic control unit providing the air traffic control service at any time while the service is being provided. — Annex 10 V2-8.2.8.4

6.2 Flight Planning Provisions

6.2.1 Capabilities comprise the following elements: — PANS-ATM Appendix 2

a) presence of relevant serviceable equipment on board the aircraft;

b) equipment and capabilities commensurate with flight crew qualifications; and — Item 10 – Equipment

c) where applicable, authorization from the appropriate authority.

6.2.2 **Operators** of CPDLC capable aircraft, equipped with either FANS 1/A or ATN-B1, shall insert in Item 10 of the ICAO flight plan form, one or more of the following items: — PANS-ATM Appendix 2, Item 10 - Equipment

J1 for CPDLC-ATN-B1 VDLM2

J2 for CPDLC-FANS 1/A HFDL

J3 for CPDLC-FANS 1/A VDL MODE A

J4 for CPDLC-FANS 1/A VDL MODE 2

J5 for CPDLC-FANS 1/A SATCOM (INMARSAT)

J6 for CPDLC-FANS 1/A SATCOM (MTSAT)

J7 for CPDLC-FANS 1/A SATCOM (Iridium)

6.2.3 Operators of CPDLC capable aircraft, equipped with independent FANS 1/A and ATN-B1, shall insert in Item 10 of the ICAO flight plan form item J1 and one or more of the items J2 to J7, as applicable.

Not specified in PANS-ATM

TBD at OPLINKP

6.2.4 Operators of CPDLC capable aircraft, equipped with integrated FANS 1/A and ATN-B1 shall insert in:

Not specified in PANS-ATM

TBD at OPLINKP

- Item 10 of the ICAO flight plan form item J1 and one or more of the items J2 to J7, and

- Item 18 shall specify the equipment carried, preceded by COM/ followed by INTEGRATED.

6.2.5 **Flights**, planning to use CPDLC ATN-B1, shall include in Item 18 of the flight plan the indicator CODE/ followed by the 24-bit aircraft address (expressed in the form of alphanumerical code of six hexadecimal characters).

PANS-ATM Appendix 2

Item 18 – Equipment

Example: CODE/ F00001

6.2.6 Flights, planning to use CPDLC FANS 1/A, shall include in Item 18 of the flight plan the indicator REG/ followed by the nationality or common mark and registration mark of the aircraft, if different from the aircraft identification in Item 7.

PANS-ATM Appendix 2

Item 18 – Equipment

6.2.7 For flights, conducted wholly or partly in the EUR CPDLC airspace specified in 3.3.1.1 (of Doc 7030/5), and not equipped with CPDLC-ATN-B1, but which have been granted an exemption, either automatic or by EC Decision, shall include in Item 10A the letter Z and in Item18 of the flight plan the indicator DAT/CPDLCX.

7030/5, Amendment EUR/NAT-S 09/03 – EUR 2-4 and 3-2

6.2.8 For a **flight** operating based on a repetitive flight plan (RPL), during which the pilot intends to use CPDLC, a modification message (CHG) shall be submitted to indicate that the flight is capable of, and authorised for CPDLC, in accordance with 6.2.4, 6.2.5 and 6.2.7.

OFG-Recom-1

6.2.9 When there is a change to the CPDLC capability status for a flight planned to operate in the area specified in section 2, the **operator** should send a modification message (CHG) with the appropriate indications in the relevant items of the ICAO flight plan form, including any change to the aircraft address. A modification message for the day of operation should be sent not earlier than 20 hours before the estimated off-block time.

OFG-Recom-2

6.2.10 To avoid an automatic rejection of the logon/notification, the **pilot** should ensure that the Flight Number and Destination/Arrival parameters contained in the logon message are exactly the same as the Flight Number and Destination/Arrival parameters filed in the

OFG-Recom-3

flight plan.

6.3 Testing of CPDLC

6.3.1 Where the testing of CPDLC with an aircraft could affect the air traffic services being provided to the aircraft, coordination shall be effected prior to such testing.

Annex 10 V2-8.2.13

PANS-ATM 14.3.8

6.4 Transfer of CPDLC

6.4.1 Time and Place of CPDLC transfer

Note: The transfer of CPDLC between two adjacent ATC units (Current Data Authority-CDA, Next Data Authority-NDA) consists of:
a) The initiation of CPDLC by the accepting ATC unit [NDA] and,
b) The termination of CPDLC by the transferring ATC Unit [CDA]

6.4.1.1 When CPDLC is transferred, the transfer of voice communications and CPDLC shall commence concurrently.

Annex 10 V2-8.2.9.6.1

PANS-ATM 14.3.3.1

6.4.1.2 When an aircraft is transferred from an ATC unit where CPDLC is available to an ATC unit where CPDLC is not available, CPDLC termination shall commence concurrent with the transfer of voice communications.

Annex 10 V2-8.2.9.6.2

PANS-ATM 14.3.3.2

6.4.2 Transfer of CPDLC when open dialogues exist

6.4.2.1 When a transfer of CPDLC results in a change of data authority, and there are still messages for which the closure response has not been received (i.e. messages outstanding), the controller, transferring the CPDLC, shall be informed.

Annex 10 V2-8.2.9.6.3

PANS-ATM 14.3..3.3

6.4.2.2 When the controller decides to transfer the aircraft without receiving **pilot** responses to any uplink message(s) outstanding, before initiating the transfer the controller should revert to voice communications to clarify any ambiguity associated with the message(s) outstanding.

PANS-ATM 14.3.3.3.2

6.4.3 Inability to CONTACT the assigned voice communication channel

6.4.3.1 When the **pilot** is unable to contact the assigned voice communication channel when instructed to do so by the controller via CPDLC, the **pilot** should revert to the voice communication channel of the transferring ATC unit for instructions.

OFG-Recom-4

6.5 Construction of CPDLC messages

6.5.1 The text of messages shall be composed in standard message format (e.g. CPDLC message set), in plain language or in abbreviations and codes, as prescribed in Annex 10, paragraph 3.7. Plain language shall be avoided when the length of the text can be

Annex 10 V2-8.1.1.1

reduced by using appropriate abbreviations and codes. Non-essential words and phrases, such as expressions of politeness, shall not be used.

6.5.2 The **pilot** or controller shall construct CPDLC messages using the defined message set, a free text message or a combination of both. PANS-ATM 14.3.1

Note: Per ED-110B [2], it is not recommended, except when appended to an ERROR message element, to use free text messages for CPDLC exchanges. This, to reduce the possibility of misinterpretation and ambiguity.

6.5.2.1 The use of free text messages by **pilots** or controllers, other than pre-formatted free text messages referred to in paragraph 6.5.1, should be avoided. Annex 10 V2-8.2.11

Note 1.- Whilst it is recognized that non-routine and emergency situations may necessitate the use of free text, particularly when voice communication has failed, the avoidance of utilizing free text messages is intended to reduce the possibility of misinterpretation and ambiguity.

*Note 2.- In support of the recommendation in ED-110B on 'free text', some aircraft manufacturers don't allow the **pilot** to enter free text on the HMI.*

6.5.3 When CPDLC is being used, and the intent of the message is included in the CPDLC message set contained in PANS-ATM, Appendix 5, the associated message shall be used. Annex 10 V2-8.2.9.1.1

PANS-ATM 14.3.1.2

6.5.4 The composition of a CPDLC message shall not exceed five message elements, only two of which may contain the route clearance variable. Annex 10 V2 8.2.9.2

6.5.4.1 The use of long messages or messages with multiple clearance elements, multiple clearance request elements, or messages with a combination of clearances and information should be avoided where possible. Annex 10 V2-8.2.9.2.1

PANS-ATM 14.3.1.1

6.5.5 Multi-element messages:

Note – For detailed guidance on the use of multi-element messages, see section 9.

6.5.5.1 When a multi-element message requires a response, and the response is in the form of a single message element, the response shall apply to all message elements. Annex10 V2-8.2.9.3.3.1

PANS-ATM 14.3.2.3.2

Example: in a multi-element message containing CLIMB TO FL310 MAINTAIN MACH .80, a WILCO response applies to and indicates compliance with both elements of the message.

6.5.5.2 When a single message element clearance or any part of a multi-element clearance message cannot be complied with, the **pilot** shall send an "UNABLE" response for the whole message. Annex10 V2-8.2.9.3.3.2

PANS-ATM 14.3.2.3.3

An "UNABLE" response indicates that the pilot will not comply with any of the message elements.

DM 01 UNABLE – The instruction cannot be complied with.

Example: ATC has sent a multi-element message containing:

CLIMB TO FL310
MAINTAIN MACH .80

If the pilot cannot climb as requested or cannot maintain Mach .80, the reply will be:
UNABLE

6.5.5.3 The controller shall respond with an “UNABLE” message that applies to all elements of the request when no element(s) of a single or multi-element clearance request can be approved. The current clearance(s) shall not be restated.

Annex10 V2-8.2.9.3.3.3

PANS-ATM 14.3.2.3.4

6.5.5.4 When all elements of a single or multi-element clearance request can be accommodated, the controller shall respond with clearances corresponding to each element of the request. This response should be a single uplink message.

Annex10 V2-8.2.9.3.3.5

PANS-ATM 14.3.2.3.6

Note.— For example, whilst messages containing multi-element clearance requests are to be avoided, a multi-element downlink message containing the indicated message elements:

REQUEST DIRECT BCN
REQUEST CLIMB TO FL350
REQUEST MACH 0.80

could be responded to with:

CLEARED DIRECT TO BCN
CLIMB TO FL350
MAINTAIN MACH 0.80

6.5.5.5 When a multi-element clearance request can only be partially accommodated, the controller shall respond with an UNABLE response applying to all the message elements of the request and, if appropriate, include a reason and/or a clearance expectation.

Annex10 V2-8.2.9.3.3.4

PANS-ATM 14.3.2.3.5

Note — A separate CPDLC message (or messages) may subsequently be transmitted to respond to those elements that can be accommodated.

6.5.5.6 When a CPDLC message contains more than one message element and the response attribute for the message is Y, the single response message shall contain the corresponding number of replies and in the same order.

Annex10 V2-8.2.9.3.3.6

PANS-ATM 14.3.2.3.7

Example: a multi-element uplink message containing:
REPORT PRESENT LEVEL
STATE-TOP-OF-DESCENT

could be responded to with:
PRESENT LEVEL 310
TOP OF DESCENT 1200

Note: For more details on response attributes, see Annex C

6.6 Responding to CPDLC messages

6.6.1 Except as provided by 14.3.5.1, when a **pilot** or controller communicates via CPDLC, the response should be via CPDLC. When a controller or pilot communicates via voice, the response should be via voice.

Annex 10 V2-8.2.9.1.2

PANS-ATM 14.3.1.3

6.6.2 Unless specified by the appropriate ATS authority, voice read-back of controller-pilot data link communications (CPDLC) messages shall not be required.

Annex 10 V2-8.2.7

PANS-ATM 4.5.7.5.2.1

Note — The procedures and provisions relating to the exchange and acknowledgement of CPDLC messages are contained in Annex 10, Volume II and the PANS-ATM, Chapter 14.

6.6.3 When replying to a CPDLC message the corresponding message reply shall be used.

ED-110B-Vol II, B1 and B4

*Note: Controller/**pilot** replies to a received CPDLC message with a corresponding message, related to the received message. The design of the HMI should limit the options for responding to a message to the operationally relevant possibilities.*

6.7 ATC Phraseologies Related to the Use of CPDLC

*The list of phrases is not intended to be exhaustive, and when circumstances differ, **pilots** and ATS personnel will be expected to use plain language, which should be as clear and concise as possible, to the level specified in the ICAO language proficiency requirements contained in Annex 1 — Personnel Licensing, in order to avoid possible confusion by those persons using a language other than one of their national languages*

6.7.1 When voice communications are used to correct CPDLC clearances instructions, information or requests for which no operational response has been received, the **pilot's** or controller's transmission shall be prefaced by the phrase: "DISREGARD CPDLC *(message content or type)* MESSAGE, BREAK" — followed by the correct clearance, instruction, information or request. PANS ATM 14.3.1.4.1

Note 1 — For example, if SAS445, maintaining FL290, had been instructed to climb to FL350, and the controller needs to correct the clearance, the following voice message might be used:

SAS445 DISREGARD CPDLC CLIMB MESSAGE, BREAK, CLIMB TO FLIGHT LEVEL 310.

[Although the example above conforms to communication procedures as set out in PANS-ATM (Doc4444), implementers should be aware that some States have decided not to use the word "TO" in connection with assignment/reporting of levels]

Note 2 — When the CPDLC message to be corrected contains multiple clearances, instructions, information or request, the parts that are not affected by the correction should however be repeated. For example, if SAS445, maintaining FL290, had been instructed to climb to FL350 and to proceed direct to ABC, and if the controller needs to correct the level clearance, the following voice message may be used:

SAS445 DISREGARD CPDLC CLIMB AND PROCEED MESSAGE, BREAK, PROCEED DIRECT TO ABC, CLIMB TO FLIGHT LEVEL 310.

[Although the example above conforms to communication procedures as set out in PANS-ATM (Doc4444), implementers should be aware that some States have decided not to use the word "TO" in connection with assignment/reporting of levels]

Note 3 — The concept of operations for the use of CPDLC within the area, defined in the current guidance document, allows only one open dialogue per type of message. Therefore, the disregarding of the CPDLC message will be performed only with respect to the type of message.

6.7.2 When a **pilot** or controller is alerted that a single CPDLC message has failed, the **pilot** or controller shall take one of the following actions as appropriate: PANS ATM 14.3.8

a) via voice, confirm the actions that will be undertaken with respect to the related dialogue, prefacing the information with the phrase:

CPDLC MESSAGE FAILURE;

b) via CPDLC, reissue the CPDLC message that failed.

6.7.3 When a **pilot** or controller is alerted that CPDLC has failed, and the **pilot** or controller needs to communicate prior to CPDLC being restored, the **pilot** or controller should revert to voice, if possible, and preface the information with the phrase "CPDLC FAILURE". Annex 10 V2-8.2.12.5.3 PANS-ATM 14.3.6.2

6.7.4 Controllers having a requirement to transmit information with respect to a complete CPDLC ground system failure to all stations concerned should preface such transmission by the general call "ALL STATIONS CPDLC FAILURE", followed by the identification of the calling station. Annex 10 V2-8.2.12.5.4 PANS-ATM 14.3.6.3

6.7.5 Discontinuation of the use of CPDLC **pilot** requests

6.7.5.1 When a controller requires all stations or a specific flight to avoid sending CPDLC requests for a limited period of time, the following phrase shall be used: PANS ATM 14.3.9.1

((*call sign)* or ALL STATIONS) STOP SENDING CPDLC REQUESTS [UNTIL ADVISED] [*(reason)*]

Note — Under these circumstances, CPDLC remains available for the pilot to, if necessary, respond to messages, to report information and, to declare and cancel an emergency.

6.7.5.2 The resumption of the normal use of CPDLC shall be advised by using the following phrase: PANS ATM 14.3.9.2

((*call sign)* or ALL STATIONS) RESUME NORMAL CPDLC OPERATIONS

6.8 Reverting from CPDLC to voice

The following procedures may be applied by the controller, in terms of correcting clearances, instructions or information, or by a **pilot**, in terms of correcting a reply to an uplink message or correcting previously advised requests or information:

6.8.1 Whenever a correction to a message sent via CPDLC is deemed necessary, or the content of a message needs to be clarified, the **pilot** or controller shall use the most appropriate means available for issuing the correct details or for providing clarification. PANS ATM 14.3.1.4

The following circumstances describe potential situations where the air ground communications should revert to voice:

a) When it is required to clarify the meaning or the intent of any unexpected, inappropriate or ambiguous CPDLC message;

b) Whenever is deemed necessary to ensure the timely execution of a clearance or instruction previously issued by CPDLC. CPDLC may be used for clearances or instructions that should be complied with within a period of time. If the required action needs to be occurring in lesser time, voice communications shall be used to trigger such action.

*c) Whenever corrective actions are required with respect to unintended clearances, instructions, information or request that have been sent using CPDLC. Controllers/**pilots** shall be aware that once a message is sent via CPDLC, no means exist to cancel or to recall that message. If a message containing incorrect values, unintended clearances, instructions, information or requests has been sent, the controller/**pilot** shall take prompt actions to correct the message sent by CPDLC. Consequently the only solution is to use voice to instruct the controller/**pilot** to ignore the CPDLC message. When reverting to voice, controller/**pilots** should be aware of the possibility that the CPDLC message they want the addressee to ignore may not be yet displayed to the addressee.*

In that respect, the following actions should be taken by the addressee:

- if response to the referred CPDLC message was sent, cancel any action initiated on the basis of the initial CPDLC message and comply with the voice message;

*- if the referred message is not responded to or not displayed, let the dialogue close on time-out. Since it may be possible to be asked to ignore a message that was not yet displayed, the controller/**pilot** should take all measures to note that the message is no longer valid.*

*In case the controller/**pilot** has already received an operational response to the initial CPDLC message, he shall use appropriate voice phrases to stop/cancel the actions of the addressee.*

d) Whenever a system generates a time-out or an error for a CPDLC message.

6.8.1.1 When voice communications are used to correct a CPDLC message for which no operational response has been received, the **pilot's** or controller's transmission shall be prefaced by the phrase: "DISREGARD CPDLC *(message content or type)* MESSAGE, BREAK" — followed by the correct clearance, instruction, information or request. PANS ATM 14.3.1.4.

Note. — It is possible that, at the time the voice communicated clarification is transmitted, the CPDLC message being referred to has not reached the recipient, or has reached the recipient but not acted upon, or has reached the recipient and acted upon.

6.8.1.2 When referring to, and identifying, the CPDLC message content to be disregarded, caution should be exercised in its phrasing so as to avoid any ambiguity with the issuance of the accompanying corrected clearance, instruction, information or request. PANS ATM 14.3.1.4.2

Note — For example, if SAS445, maintaining FL290, had been instructed via CPDLC to climb to FL350, and the controller needs to correct the clearance utilizing voice, the following phrase might be used:

"SAS445 DISREGARD CPDLC CLIMB MESSAGE, BREAK, CLIMB TO FLIGHT LEVEL 310"

[Although the example above conforms to communication procedures as set out in PANS-ATM (Doc4444), implementers should be aware that some States have decided not to use the word "TO" in connection with assignment/reporting of levels]

6.8.2 When a **pilot** or controller is alerted that a single CPDLC message has failed, the controller or pilot shall take one of the following actions as appropriate: PANS ATM 14.3.8

a) via voice, confirm the actions that will be undertaken with respect to the related dialogue, prefacing the information with the phrase:

CPDLC MESSAGE FAILURE;

b) via CPDLC, reissue the CPDLC message that failed.

6.9 Synchronisation of the CPDLC dialogue when reverting to voice communications

6.9.1 If a CPDLC message that requires an operational response is subsequently negotiated via voice, an appropriate CPDLC message closure response shall be sent, to ensure proper synchronisation of the CPDLC dialogue. This could be achieved either by explicitly instructing the recipient of the message via voice to close the dialogue or by allowing the system to automatically close the dialogue. Annex 10 V2-8.2.9.1.3

*In the absence of the possibility to close an open dialogue by disregarding/ignoring it, the **pilot**/controller is recommended to allow the system to close the respective dialogue when timers expire. Taking into account the fact that the use of UNABLE/WILCO/AFFIRM/NEGATIVE/ROGER has a described operational meaning, if the controller/pilot intends to close a dialogue by using one of these messages, they shall explicitly instruct the other to do so in their voice message*

(Example: SAS445 DISREGARD CPDLC LEVEL MESSAGE, RESPOND WITH UNABLE BREAK, CLIMB TO FLIGHT LEVEL 310).

[Although the example above conforms to communication procedures as set out in

PANS-ATM (Doc4444), implementers should be aware that some States have decided not to use the word "TO" in connection with assignment/reporting of levels]

6.10 Intentional shutdown of CPDLC

6.10.1 When a system shutdown of the communications network or the CPDLC ground system is planned, a NOTAM shall be published to inform all affected parties of the shutdown period and, if necessary, the details of the voice communication frequencies to be used.

Annex 10 V2-8.2.12.6.1

PANS-ATM 14.3.7.1

6.10.2 Aircraft currently in communication with the ATC unit shall be informed by voice or CPDLC of any imminent loss of CPDLC service.

Annex 10 V2-8.2.12.6.2

Such aircraft shall be instructed to discontinue the use of CPDLC. The controller should clarify by voice communications the status of any outstanding uplink messages.

PANS-ATM 14.3.7.2

6.11 Use of CPDLC in the event of voice radio communication failure

6.11.1 The existence of a CPDLC connection between the ATS unit and the aircraft should not pre-empt the **pilot** and ATC from applying all the ICAO provisions in the event of radio communication failure.

OFG-Recom-5

*ICAO Annex 2 – Rules of the Air, requires that a **pilot** establishes two way voice communication and maintains a continuous watch of the voice communication channel, including the situation where CPDLC is established. When the **pilot** cannot comply with the requirement above, he will have to apply the provisions stipulated for the event of radio communication failure.*

6.12 Failure of CPDLC

6.12.1 When a controller or pilot is alerted that CPDLC has failed, and the **pilot** or controller needs to communicate prior to CPDLC being restored, the **pilot** or controller should revert to voice, if possible, and preface the information with the phrase: “CPDLC FAILURE”.

Annex 10 V2-8.2.12.5.3

PANS-ATM 14.3.6.2

6.12.2 Controllers having a requirement to transmit information concerning a complete CPDLC ground system failure to all stations likely to intercept should preface such transmission by the general call: “ALL STATIONS CPDLC FAILURE”, followed by the identification of the calling station.

Annex 10 V2-8.2.12.5.4

PANS-ATM 14.3.6.3

Note - No reply is expected to such general calls unless individual stations are subsequently called to acknowledge receipt.

6.12.3 When CPDLC fails and communications revert to voice, all CPDLC messages outstanding should be considered as not delivered and the entire dialogue involving the outstanding CPDLC messages should be recommenced by voice.

Annex 10 V2-8.2.12.5.5

PANS-ATM 14.3.6.4

6.12.4 When CPDLC fails but is restored prior to a need to revert to voice communications, all messages outstanding should be considered as not delivered, and the entire dialogue involving the CPDLC outstanding messages should be recommenced via CPDLC.

Annex 10 V2-8.2.12.5.6

PANS-ATM 14.3.6.5

7. HUMAN FACTORS GUIDELINES FOR CPDLC

7.1 Consideration of Human Factors

Controller-pilot data link communication (CPDLC) differs in some important characteristics from air/ground voice communication and, therefore, will change parts of the flight crew's tasks. These changes are mainly related to communication, but can also refer to other - more cognitive - tasks such as building an understanding of surrounding traffic. The aim of this chapter is to provide an overview of those characteristics of CPDLC that are different from R/T communication and that have an impact on the flight crew's tasks.

Two classes of impacts are identified: CPDLC can either make tasks easier – these changes are referred to as Human Factors *benefits* – or it can make the tasks more demanding – these changes are referred to as Human Factors *issues.* For all identified Human Factors issues, recommendations will be made on how to prevent or at least substantially reduce unwanted effects of CPDLC. Recommendations refer to operational procedures and training.

Note that this approach is fully in line with ICAO: according to ICAO, it is necessary to resolve Human Factors issues related to pilot and air traffic controllers before the implementation of a data link based system can take place (ICAO Doc. 9694, I-3-7). As this guidance document is aimed at the airline community, issues and potential resolutions are limited to those relevant for the flight crew.

In the following, Human Factors benefits and Human Factors issues related to the usage of CPDLC are summarized. The identification of benefits and issues is based on ICAO documentation (in particular, Doc 9694, 9758, and 4444), Human Factors literature reviews (e.g. Goteman, 2005; Helleberg & Wickens, 2003; Navarro & Sikorski, 1999), as well as pilots' feedback on the operational use of CPDLC.

The Human Factors considerations summarized in this chapter refer to the usage of CPDLC in general; considerations related to a specific data link service (DLIC, ACM, ACL, AMC) is included in the chapters on the respective service.

7.2 Human Factors benefits associated with the use of CPDLC

Human Factors benefits refer to aspects of the flight crew's tasks that become easier with the introduction of CPDLC. 'Easier' means that the task poses fewer demands on cognitive processes such as attention, perception, interpretation, memory, decision making, as well as response selection and execution. In the following, the main Human Factors benefits related to the implementation of CPDLC are described.

7.2.1 Reduction of voice channel congestion

By reducing voice channel congestion, the number of communications that is missed or blocked by transmissions of other users is decreased. For the flight crew, this means that there is a reduced need for re-transmitting a call as well as

for requesting the re-transmission of an ATC call. Furthermore, the timing of a communication is to a larger extent under the control of the flight crew, rather being dictated by the availability of the frequency. Although the majority of pilot transmissions are responses to ATC calls (and, hence, timing is determined by ATC), there are some transmissions (i.e. pilot requests) in which the flight crew decides on when to initiate the dialogue.

7.2.2 Reduction in communication workload

Due to the lower number of calls on the frequency, monitoring the frequency to identify relevant R/T calls becomes less demanding for the flight crew. Furthermore, read-back of the ATC message will not be required for data link messages and the modification of the flight guidance system (auto-pilot or FMS) can be done using the information on a visual display. This means that there is a substantial decrease in working memory demand compared to a situation in which the read-back and modification of the flight guidance system has to be done on the basis of auditory information. This decrease in workload is related to a decrease in error potential (see below).

7.2.3 Decrease in communication errors

Errors in voice communication can be caused by miscomprehension of messages (i.e. failure to understand the message), working memory restrictions (i.e. failure to retain the message in memory), vulnerabilities of the read-back process (i.e. read-back and hear-back errors), and message confusion (i.e. erroneous receipt of messages). These errors are less likely in data link communication as the content of the dialogue is available in a more permanent written format. The permanent nature of the dialogue makes messages less prone to misperception or miscomprehension on the one hand and forgetting or mis-remembering on the other.

7.2.4 Increased flexibility in handling R/T calls

Compared to data link messages, R/T communication messages are perceived as more urgent as they require an immediate response from the recipient (at least a “stand-by” response). For this reason, R/T messages are more likely to disrupt other ongoing activities, for instance, tasks related to flying and navigating the aircraft. The disruption may lead to a failure to complete the activity in time. Data link messages, in contrast, allow for a higher level of flexibility. For the flight crew, this flexibility relates to the time when the message is responded to and, thus, whether or not responding to a message is given priority over other tasks.

7.3 Human Factors issues associated with the use of CPDLC

Human Factors issues refer to aspects of the flight crew tasks that become more difficult or more prone to error with the introduction of CPDLC. ‘More difficult’ means that the task poses increased demands on cognitive processes such as attention, perception, interpretation, memory, decision making, as well as response selection and execution. Furthermore, the implementation of CPDLC may result in new tasks or task components for the flight crew. In the following, the main Human Factors issues related to the implementation of CPDLC are described and recommendations on how to resolve the issues are made.

Note that the recommendations provided in this chapter are restricted to interventions that can be taken by the target audience of this document (i.e. ops

managers, fleet managers, flight operations and flight crew training staff). If there are other ways of addressing the issue (e.g., through the design of the cockpit interface for CPDLC or ATC procedures) they will be mentioned in the corresponding section, but will not be highlighted as recommendations.

7.3.1 Communication delays in CPDLC

Completing an air-ground message exchange by data link takes considerably longer than exchanging information between air and ground by R/T. ICAO refers to studies showing that "total transaction time (i.e. the entire time span when a controller would be concerned with a given communication) was twice as long for data link as for voice". Exact numbers, however, are difficult to derive. The reason is that transaction times are composed of a number of different delays, including technical delays for transmitting the message, and operator-based delays, such as latencies in detecting, processing and composing a data link message (pertaining to both the air traffic controller and the pilot). In any case, communication speed has been identified as one of the main issues in the implementation of CPDLC.

Recommendations:

7.3.1.1 Operational procedure design and training should include the fact that CPDLC shall only be used in the context of routine CPDLC exchanges Voice communications are the preferred option for transmitting immediate action messages (see Chap. 3 of this document and ICAO Doc 9758-AN/966, Chap. 5-2, Goteman & Dekker, 2005).

7.3.1.2 Pilots should be trained on how to assess a routine dialogue.

7.3.2 Detection and processing of visual information

Visual information (used in CPDLC exchanges) shows qualitatively different properties than auditory information (used in voice communication). These differences can have an impact on human information detection and processing. For instance, an advantage of visual information is that it is less transient than auditory information; thereby reducing working memory demands and the potential for error (see Section 7.2.3). On the other hand, visual information is more difficult to detect than auditory information. This means that (a) the detection latency for auditory information tends to be longer, and (b) there is a higher risk of not detecting visual information (particularly, if the information is not presented within the operator's focus of attention).

This issue can be addressed by designing the HMI in such a way that it supports a timely detection of an incoming message by the flight crew. In order to achieve this, indications of incoming messages are usually presented in the flight crew's primary visual field, that is, on displays that are regularly scanned.

Furthermore, an aural attention getter (i.e. chime) can notify the flight crew of an incoming CPDLC message. Consideration needs to be given to (a) whether the aural alert should be unique to messages related to CPDLC and (b) whether the use of the aural alert should be strictly limited to operationally relevant CPLDC messages (or should be equally used for technical information messages, such as on ATN coverage).

Recommendation:

7.3.2.1 Training for flight crews should raise awareness of the fact that visual information (i.e. CPDLC) is easier missed than aural information (i.e. an ATC voice call).

7.3.3 Competition for visual resources

The task of the flight crew is already based on the detection, interpretation and integration of large amounts of visually presented information. By shifting formerly auditory information (that is, voice) to the visual modality, there may be a risk to overload the visual channel. Two different aspects have to be considered: First, it has to be ensured that the perception and composition of data link messages do not distract the flight crew's visual attention unduly from any safety-critical displays (above all, the flight instruments). Second, if data link information is not presented on a dedicated display, it needs to be ensured that it does not obscure other information necessary for the safe operation of the aircraft.

Resolutions to this issue mainly relate to the design of the cockpit interface for CPDLC. To minimize the flight crew's head-down time, the number of inputs needed to compose or respond to a message should be minimized. For the presentation of data link messages, it needs to be ensured that text messages do not obscure information relevant for flying and navigating the aircraft. Although it is beneficial to present visual alerts related to a data link message on one of the flight instruments (to facilitate detection), the full text of the message is better displayed on a less critical display (to avoid clutter of flight instruments).

7.3.4 Composition of CPDLC messages

Composing a data link message takes more time and effort than using voice for air-ground communication. The extent of the additional effort will depend on the specific interface chosen. For his reason, the interfaces need to be designed in such a way that they are efficient, easy to operate and provide a rapid message input mechanism.

To reduce time and effort related to the composition of CPDLC messages, the number of inputs needed to compose or respond to a message should be minimized.

7.3.5 Loss of party-line information

In an R/T environment, pilots who are not actively involved in an R/T conversation can overhear the communication between ATC and other aircraft in the sector. This is referred to as the "party-line". In a CPDLC environment, in contrast, the content of a data link message is only known to the addressee of the message. With the disappearance of the party-line, the following types of information become unavailable to the flight crew:

a) weather information provided to other aircraft (e.g. wind shear, visibility, surface winds);

b) information on surrounding traffic (e.g. clearances given to other aircraft, routings in the TMA, missed approaches);

c) information on the level of workload and emotional state of the sector controller; this information can be used by the flight crew to adapt their behaviour accordingly (e.g. length of calls, requests to ATC).

Although the loss of party-line information undoubtedly constitutes an important Human Factors issue, the impact on the flight crew strongly depends on the operational environment in which CPDLC is used. In order to assess the importance of party-line information for the flight crew, the type of information contained in the party-line, the operational concept for use of CPDLC, and the airspace type/flight phase need to be considered.

Operational Concept. Given an operational concept in which non-routine instructions are given by R/T, party-line information will be more limited, but will not cease to exist. Non-nominal events such as flight level busts and missed approaches will still be handled via R/T and, thus, will be known to other aircraft on the frequency. Also, the number of R/T dialogues on the frequency can still be used as an indicator of the air traffic controllers' workload.

Airspace & flight phase. The importance of party-line information strongly depends on the airspace and flight phase. In the en-route phase and core European airspace (with a high percentage of aircraft on directs and a large number of crossing points), it may be extremely difficult to build a correct representation of surrounding traffic on the basis of party-line information. Even if building such a representation was possible, it can be questioned whether it facilitates flight crew tasks in the en-route phase. In contrast, party-line information in the approach phase (in particular, instructions that are issued to aircraft ahead in the sequence) can help the flight crew to anticipate on the evolution of their flight in the near future (including likely routings, time in holding, or met conditions at the airport).

Thus, a fine-grained level of analysis is required in order to determine (a) which information in the party line is relevant for which flight tasks, and (b) whether any of this information becomes unavailable, given the proposed operational concept for CPDLC. In case relevant information becomes unavailable, possible mitigations relate to the provision of information on surrounding traffic by alternative means (e.g. Cockpit Displays of Traffic Information (CDTIs) or procedures (e.g. restricting the use of CPDLC to flight phases/operational situations in which information on surrounding traffic is less relevant).

As the EC Regulation No 29/2009 restricts the use of CPDLC to routine exchanges in the En-Route upper airspace, the latter mitigation has been put in place, which means that the loss of party-line information should not become an issue for the flight crew.

7.3.6 Flight Crew Team Situation Awareness

One advantage of voice communications is that both pilots are able to hear ATC messages and check to ensure that they both heard the same thing. With CPDLC, the Pilot Not Flying (PNF) is responsible for managing data link communications. However, to maintain the safety net of flight crew verification of ATC instructions, each pilot should read all 'data linked' clearances (silently) before discussing the message and response.

When the Pilot Flying (PF) reads the clearance, it affords the same opportunity provided by voice communications for the PF and PNF to confer and ensure that their understanding of the clearance is the same. Having the PNF read the message *silently*, before the PF reads the clearance prevents the PNF from setting up an expectation bias. That is, if the PNF was to read the message aloud, the PF would likely 'see' the clearance that he heard, making it more

difficult to detect any discrepancy between the clearance that the PNF read and the one actually displayed. Independent assessment and verification of the message provides a strong safety net to trap errors. This safety net is critical to maintaining flight crew situation awareness and preventing pilots from executing an incorrect response, such as prematurely acting on a conditional clearance.

Recommendation:

7.3.6.1 Operational procedure design and training should include measures to ensure that the PF and PNF silently read all ATC clearances and then confer, before executing a clearance.

7.3.7 Concatenated messages

A concatenated CPDLC message is a message containing more than one CPDLC message element (see Chap. 9.3). If a concatenated message is sent via data link to the flight crew there may be a risk of the crew overlooking some message elements. This is due to the fact that concatenated messages can be displayed on two separate pages of the CPDLC interface (e.g., the MCDU) and a response to a message can be sent without accessing all pages of the message first. This increases the risk of the PNF overlooking the second part of the message, but accepting it nevertheless. An example of a concatenated message is a conditional clearance. If the flight crew fails to detect the conditional part, the executed maneuver will result in a flight path that differs from the ATC cleared flight path. Without a readback requirement, such a mistake can only be detected by ATC once the aircraft has departed from the cleared flight path.

This issue can be addressed through HMI design solutions and ATC procedures: With respect to the HMI design, concatenated messages should either not be split over more than one page in the CPDLC interface (e.g. MCDU) or the HMI should only enable a response, if all parts of a concatenated message were accessed. With respect to ATC procedures, controllers should be required to use separate CPDLC messages for messages containing more than one clearance element. Also, controllers should be discouraged to use conditional clearances (cf. ICAO Doc 9758-AN/966, Chap. 5-4).

Recommendation:

7.3.7.1 Training for flight crews should raise awareness of the opportunities for human error when conditional clearances are issued by CPDLC (cf. ICAO Doc 9758-AN/966, Chap. 5-4).

7.3.8 Rigidity of data link communication

There is a higher degree of rigidity in the exchange of data link messages than in the exchange of voice messages. One reason is that data link dialogues are restricted to a specific message set, as the use of free text is not recommended. As a consequence, data link dialogues are less suitable for complex dialogues and negotiations that may require explanations.

Recommendation:

7.3.8.1 Operational procedure design and training for air traffic controllers and flight crews should incorporate the fact that voice communications are the preferred option for carrying out complex dialogues or negotiations (cf. ICAO Doc 9758-

AN/966, Chap. 5-4). Guidelines for the use of complex/concatenated messages are also provided in Chapter 9 of this document.

7.3.9 Reversion to voice communication

During a CPDLC dialogue, it may become necessary to revert to voice. There are various reasons for a reversion to voice: CPDLC failure, a timed-out dialogue, the need for corrective actions or clarifications to a CPDLC message, and changes in the time-criticality of an instruction. Some of these reasons can only be judged by ATC (e.g. changes in time-criticality of an instruction), which means that it will be the decision of ATC to revert to voice. There may be, however, instances in which the flight crew decides to revert to voice. Regardless of whether the reversion to voice has been initiated by the flight crew, the PNF needs to apply procedures and use appropriate phraseology as applicable in the situation.

Recommendations:

7.3.9.1 Operational procedure design and training should specify the situations that require a reversion from CPDLC to voice.

7.3.9.2 Operational procedures should clearly describe the actions required to revert from CPDLC to voice.

7.3.9.3 The flight crew should be trained on the phraseology related to the reversion from a CPDLC dialogue to voice communication.

8. TRAINING GUIDELINES FOR CPDLC

These guidelines may be used to assist in the development of a training programme for CPDLC for qualified flight crews. They are based on the training needs identified so far in CPDLC implementation and are targeted at transition training.

8.1 CPDLC awareness

CPDLC is used to replace voice for routine messages only. Voice remains the primary means of communication for tactical instructions, for time-critical messages, or for messages/requests that are better handled by voice.

Flight crews should always revert to voice, if in any doubt about a CPDLC message, or if a request is urgent.

8.2 Airspace awareness

Flight crew should be aware of the airspace in which CPDLC services are provided and how these areas relate to their intended flight plan route. NOTAM (or AIP) must be available to specify the existence of a data link zone.

Flight crew should only attempt log-on with an ACC providing CPDLC services if their route takes them through this airspace. See 8.4.3 for more details.

Note: The aircraft system may indicate the ATN network availability or unavailability to the flight crew. However, the aircraft system does not know whether the flight is planned through CPDLC airspace.

8.3 Log-on and CPDLC connection

Log-on is a flight crew initiated action and is used to provide the ground system with information required for FPL association as well as the CPDLC application information required for the subsequent connection establishment. The log-on itself does not establish a CPDLC connection.

A CPDLC connection establishes a ‘path’ through the network between the aircraft and ACC. Once this ‘path’ has been established, the systems are ready to transfer data link messages. Unlike log-on, CPDLC connection establishment is done automatically system-to-system and does not require human intervention.

The log-on and CPDLC connection cover the entire area of responsibility of an ACC. Aircraft do not need to log-on separately into each ACC sector.

Once CPDLC-equipped ACCs are operating adjacent to each other, flight crews will not need to log on repeatedly along the route, as the logon information will be automatically forwarded via ground networks from ACC to ACC. Re-logon will then only be required for a flight transiting a non-equipped ACC between two CPDLC-equipped ACCs.

8.4 Log-on

When logging on, the flight crew should check that they have correctly entered:

- the address of the first ACC with whom they will be conducting CPDLC
- the aircraft identification (callsign) of the flight, taken from their flight plan

- the four-letter ICAO designators of the flight's airports of departure and destination.

An indication of the logon status will be provided to the flight crew.

8.4.1 Log-on Address

The address of the ACC to which the aircraft logs on shall conform to the 4 character ICAO facility designation (Ex**: EDYY** for Maastricht UAC)

8.4.2 Log-on Callsign

Flight crews should log-on using their ICAO callsign (ex: SAS593, DLH23) as filed in the ICAO flight plan, field 7a.

Flight crews should **not** use the two-letter IATA flight ID (ex: **SK**593, **LH**23), or insert a leading zero [0] into a callsign (ex: SAS**0**593, LH**00**23), as doing so will result in a failed log-on.

8.4.3 Log-on time

The appropriate time for a flight crew to initiate a log-on request, prior to entering the airspace of an UIR, is between 10 and 30 minutes.

For aircraft departing from airports beneath, or in close proximity to the airspace of the concerned ACC, log-on may be initiated on the ground.

Note: Some aircraft implementations will logoff automatically a certain time after IN-state for a flight [normally door opening]. If the flight crew log-on for their next flight before that time is up, the system will still log-off when the time expires

8.5 CPDLC Connection

Flight crews should be aware that a CPDLC connection is initiated and terminated by the ground.

8.5.1 CPDLC initiation

Following successful log-on, and prior to entry into the airspace of the concerned ACC, the ground system will initiate CPDLC connection through a CPDLC-Start Request being sent to the aircraft. This message is transparent to the flight crew.

*Note: The time at which the ground system will attempt a CPDLC connection may be different for each ACC. (Ex: For Maastricht UAC, it occurs approximately **10 minutes** prior to the entry of the aircraft into its airspace.)*

The aircraft system replies automatically with a CPDLC-Start Confirmed message. The aircraft system subsequently also sends a Current Data Authority [CDA] message to the ground. Both messages are transparent to the flight crew.

Note: CDA is the notification for the receiving ACC that the aircraft is ready to conduct CPDLC with that ACC.

The flight crew is finally presented with an indication that the ACC is the Current Data Authority.

8.5.2 Early CPDLC attempt

The log-on, CPDLC connection and CDA sequence will normally be conducted outside the airspace of the ACC with whom the aircraft intends to conduct CPDLC.

Whilst the aircraft is not under the control of the ACC in which CPDLC exchanges will be conducted, the flight crew should not attempt to downlink CPDLC messages.

CPDLC messages initiated by flight crew for flights not yet transferred to or under the control of the concerned ACC will result in the uplink error message “CPDLC TRANSFER NOT COMPLETED - REPEAT REQUEST” being displayed to the flight crew.

To avoid the receipt of such error message, flight crews should not initiate CPDLC messages before the ACC has enabled CPDLC. (For more details on ‘CPDLC enabled’, see 8.5.3)

8.5.3 CPDLC enabled

The flight crew will know that the ACC has enabled CPDLC, when:

a. The flight crew have established initial voice contact with the first controller of the ACC providing the service; and

b. A CPDLC message is displayed to the flight crew, indicating the name and function of the current ATC unit. (Ex: for Maastricht UAC the message reads: **EDYY, Maastricht, Center**).

8.5.4 Inter-Sector transfer

As previously stated, a single CPDLC connection is established and maintained for the entire working area of an ACC.

The data link authority is automatically transferred by the ground system from sector to sector along the route of the flight within the ACC.

Aircraft, transferring from sector to sector within an ACC sector, may be transferred via data link with a Voice Change Instruction [VCI].

8.5.5 Inter-ACC transfer and CPDLC termination

Prior to leaving the airspace of the current data authority, an aircraft will automatically receive a Next Data Authority [NDA] message from the ground system. The purpose of that message is to alert the aircraft to its next intended data link partner.

Note: Anticipating future arrangements, some ground systems [e.g. Maastricht] will send an NDA automatically to the aircraft whether the next ACC is CPDLC-equipped or not.

Aircraft leaving the airspace of the current data authority may be transferred via data link with a Voice Change Instruction [VCI] and a CPDLC disconnection will be initiated by the ground. Following a WILCO from the flight crew, CPDLC will be terminated with the aircraft.

If the NDA is offering CPDLC services then the NDA will become the CDA for the aircraft.

Aircraft implementations display that CPDLC connection has been terminated.

8.6 HMI limitations

Flight crews should be aware of the HMI limitations of the display units on which they will conduct CPDLC.

For some implementations, the HMI is only refreshed, if the page is changed. If this is not done, then the flight crew may get the false impression that the same message has been received twice.

8.7 Error messages

In the event of receiving an 'ERROR' message, the flight crew should revert to voice to clarify the situation with the controller.

The most frequent error messages that are generated are:

1. Time-out from aircraft system

When the controller uplinks a clearance, the flight crew should reply within 100 seconds to the clearance, otherwise the aircraft system automatically downlinks an error message 'AIRSYSTEM TIME-OUT'.

The flight crew is notified on the time-out (see also 5.3.1). They should revert to voice.

2. Time-out from ground system

When the flight crew downlinks a request, the controller should reply within 250 seconds to the request, otherwise the ground system automatically generates an error message 'ATC TIME-OUT – REPEAT REQUEST' (see also 5.3.2).

In this case, the flight crew should not attempt to repeat the request by CPDLC, but should revert to voice.

3. Downlink Request before CPDLC enabled

Reception of a downlink request before the flight is transferred and under control of the current data authority, results in the generation of an error message 'CPDLC TRANSFER NOT COMPLETED - REPEAT REQUEST' by the ground system.

The flight crew should not attempt to repeat the request until the CPDLC transfer has been completed and they are under the control of the ACC, being the CDA. (See also 8.5.2 and 8.5.3)

4. Messages not supported by the ACC

Messages not supported by the ACC result in the generation of an error message 'SERVICE UNAVAILABLE' by the ground system.

Note: The text 'SERVICE UNAVAILABLE' is just an ICAO intention. The text 'MESSAGE NOT SUPPORTED BY THIS ATS UNIT' is displayed in the aircraft.

8.8 Message awareness

Flight crews should only use downlink messages supported by the ground system of the airspace in which they are flying.

The downlink message set supported by each ground system will be notified by each State through an Aeronautical Information Publication (AIP) or Notification To AirMen (NOTAM).

8.9 CPDLC message alert

Flight crews should be aware of when they have received a message and how they can access the message.

8.10 Responding to CPDLC messages

Flight crews should be aware that in a normal situation, messages received via data link, should also be replied to via data link.

Note: When the flight crew receives a message via voice the response should also be via voice.

However, flight crews should be aware that in situations, where clarification or corrections to requests sent via CPDLC are deemed necessary (see Procedures - 6.8), the request may be responded to by voice.

If a downlink request is responded to by voice, the original CPDLC dialogue will time-out and an error message will be displayed to the flight crew.

8.11 Time-out awareness

Flight crews should be aware of the time parameters used for CPDLC. See section 5 for the different timer values.

8.12 Phraseology

Flight crews should be aware of the phraseology used in conjunction with general CPDLC operations.

They should also be specially aware of, and familiar with, the appropriate phraseology when reverting from CPDLC to voice.

8.13 Execution of instructions

Any instructions received by CPDLC should be responded to by the flight crew in a timely fashion.

The flight crew should first give the appropriate CPDLC response to the instruction, then execute the instruction.

If, at any stage a significiant delay occurs in execution of a CPDLC instruction, or, if having acknowledged an instruction, the flight crew find they are unable to complete the instruction, they should revert to voice and advise ATC.

8.14 Use of Degrees in CPDLC Messages

The Display of [degrees] parameter is used in the following 3 CPDLC messages:

- UM94 TURN *(direction)* HEADING *(degrees)*
- UM190 FLY HEADING *(degrees)*
- UM215 TURN *(direction) (degrees) DEGREES*

UM94 and UM190 represent an absolute change towards the instructed HEADING, while UM215 is a relative change with reference to the current HEADING.

ICAO requires that the HEADING in UM94 and UM190 is expressed in 3 digits (e.g. ‘015’) and should be displayed accordingly.

However, UM215 is expressed in 2 digits (e.g. 15 degrees). To ensure that flight crews execute UM215 as a relative change, UM215 is displayed as TURN *(direction) (degrees)* DEGREES (e.g. TURN RIGHT 15 DEGREES)

Flight crews should be aware that Airframe and avionics manufacturers are adding a leading ‘0’ for degrees less than 100°for UM94 and UM190.

8.15 Display of 8.33 KHz channels of VCI instructions in CPDLC

Upon receipt of the VCI instruction, the 8.33 KHz channel is displayed in 6 digits.

Flight crew should be aware that some airframe manufacturers round off the 6-digit 8.33 Khz frequency for display to the flight crew, which may cause confusion to them.

9. GUIDELINES FOR CONCATENATED MESSAGES AND CLOSURE

9.1 Introduction

A concatenated CPDLC message is a message containing more than one CPDLC message element. ICAO PANS-ATM [7] and the EUROCAE-Document ED-110B [3] do not impose strict rules with respect to concatenated CPDLC messages, they allow a maximum of **5** message elements in a concatenated message. This could give the possibility of creating concatenated messages not always having an operational meaning.

This section provides additional guidance to avionics implementers and HMI designers on the composition of concatenated messages and their respective closure responses. It also provides recommendations to flight crews on their operational use and informs flight crews on the ground implementations, when responding to specific controller-initiated concatenated messages.

9.2 CPDLC message attributes

Each CPDLC message element has Response, Urgency and Alert attributes. Ground and aircraft systems, compliant to the EUROCONTROL specification, are required only to use and adhere to the 'Response' attribute. The use of the other two attributes (Urgency and Alert) is a local implementation option.

As required by the above ICAO and EUROCAE standards, each uplink and downlink message element **shall** have associated Response attributes with precedence as defined in table 9-1 and table 9-2, respectively below:

Type	Response Required	Valid Responses Description	Precedence
W/U	Yes	Response required: **W**ILCO, **U**NABLE, STANDBY, NOT CURRENT DATA AUTHORITY, NOT AUTHORIZED NEXT DATA AUTHORITY, ERROR, LOGICAL ACKNOWLEDGMENT (only if required)	1
A/N	Yes	Response required: **A**FFIRM, **N**EGATIVE, STANDBY, NOT CURRENT DATA AUTHORITY, NOT AUTHORIZED NEXT DATA AUTHORITY, ERROR, LOGICAL ACKNOWLEDGMENT (only if required)	2
R	Yes	Response required: **R**OGER, UNABLE, STANDBY,NOT CURRENT DATA AUTHORITY, NOTAUTHORIZED NEXT DATA AUTHORITY, ERROR,LOGICAL ACKNOWLEDGMENT (only if required),	3
Y	Yes	Any CPDLC downlink message, LOGICAL ACKNOWLEDGMENT (only if required),	4
N	No, unless logical acknowledgment required	LOGICAL ACKNOWLEDGMENT (only if required), ERROR, NOT CURRENT DATA AUTHORITY or NOT AUTHORIZED NEXT DATA AUTHORITY	5

Table 9-1: Response Attribute for Uplink messages

Type	Response Required	Valid Responses Description	Precedence
Y	Yes	Any CPDLC downlink message, LOGICAL ACKNOWLEDGMENT (only if required),	1
N	No, unless logical acknowledgment required	LOGICAL ACKNOWLEDGMENT (only if required), ERROR, NOT CURRENT DATA AUTHORITY or NOT AUTHORIZED NEXT DATA AUTHORITY	2

Table 9-2: Response Attribute for Downlink messages

In accordance with ICAO Annex 10 [6] – *"When a message contains multiple message elements, the highest precedence message element attribute for each attribute type associated with any element in the message **shall** be the message attribute for each attribute type for the entire message."*

(e.g.: the concatenation of UM20 (W/U) with UM222 (R) - CLIMB TO [level] NO SPEED RESTRICTION - will have the response attribute of the UM20 - W/U.)

9.3 Flight crew initiated concatenation of message elements

9.3.1 Operational guidance for the use of concatenated messages

Aircraft- and ground systems compliant to the EUROCONTROL Specification, should allow for a downlink concatenated message, containing maximum 2 message elements.

9.3.2 Concatenation of Request type message elements

The table below presents the list of downlink concatenated messages, which ground systems, compliant to the EUROCONTROL Specification, are required to support.

One message element from the left table column can be concatenated with one message element from the table right column and vice-versa.

*Note: Message elements in **bold** are mandatory for systems compliant to the EUROCONTROL Specification.*

DM6 REQUEST [level]	**DM65 DUE TO WEATHER**
DM9 REQUEST CLIMB TO [level]	**DM66 DUE TO AIRCRAFT PERFORMANCE**
DM10 REQUEST DESCENT TO [level]	
DM22 REQUEST DIRECT TO [position]	

9.4 Flight crew responses to controller-initiated concatenated messages

According to the ICAO Annex 10 [6]:

*"When the CPDLC-air-user receives a message with a W/U RESP attribute, the only permitted responses **shall** be messages that contain a LOGICAL ACKNOWLEDGMENT (if required), STANDBY, WILCO, UNABLE, NOT*

CURRENT DATA AUTHORITY, NOT AUTHORIZED NEXT DATA AUTHORITY or ERROR message element."

*"When the CPDLC-air-user receives a message with a W/U RESP attribute, the closure response message **shall** contain at least a WILCO, UNABLE, NOT CURRENT DATA AUTHORITY, NOT AUTHORIZED NEXT DATA AUTHORITY or ERROR message element."*

*"A CPDLC-user **shall** only be permitted to respond to a received message in its entirety."*

9.4.1 Responding to concatenation of message elements with response attribute other than Y

This paragraph indicates how the flight crew should respond to uplink messages given in 9.5.2 below.

The permitted response will be messages containing one of the following message elements: LOGICAL ACKNOWLEDGMENT (if required), STANDBY, WILCO, UNABLE, NOT CURRENT DATA AUTHORITY, NOT AUTHORIZED NEXT DATA AUTHORITY or ERROR message element.

The closure response message will be a message containing one of the following message elements: WILCO, UNABLE, NOT CURRENT DATA AUTHORITY, NOT AUTHORIZED NEXT DATA AUTHORITY or ERROR message element.

The WILCO or UNABLE response messages will operationally apply to the entire uplink concatenated message – see 6.5.5.1and 6.5.5.2.

As responses to a ground initiated dialogue, ground systems compliant to the EUROCONTROL Specification are required to also support the following downlink concatenated messages:

DM1 UNABLE	**DM65 DUE TO WEATHER**
DM82 WE CANNOT ACCEPT [level] [1)]	**DM66 DUE TO AIRCRAFT PERFORMANCE**

[1)] Support required only if UM148 is supported

Note 1: Each message element from the left table column can be concatenated with each message element from the table right column.

*Note 2: Message elements in **bold** are mandatory for systems compliant to the EUROCONTROL Specification.*

9.5 Controller-initiated concatenation of message elements

9.5.1 Operational guidance for the use of concatenated CPDLC messages

9.5.1.1 Clearances

In accordance with GOLD Ed 2.0 [11], the controller should only combine clearance or instruction message elements that are dependent on each other into a single uplink message as the flight crew can only provide a single unambiguous response.

Note 1.— A dependent clearance is a message consisting of more than one clearance element, where the flight crew is required to comply with each of the

elements. A rejection of any of the elements, either singly or in combination, renders the entire clearance invalid.

Note 2.— Sending the elements as individual messages may compromise safety or separation if the flight crew accepts the first uplink of a dependent clearance, complies with the instruction, and then responds UNABLE to the next message when received.

Note 3.— The flight crew will respond to the multi-element uplink message with either WILCO or UNABLE, which applies to the entire message per paragraph 6.5.6.2.

Note 4.— The controller should not send two independent clearances in a single message because the flight crew cannot individually respond to each clearance, if necessary (e.g. WILCO one clearance and UNABLE the other).

9.5.1.2 Number of concatenated message elements

For ground systems compliant to the EUROCONTROL Specification [2], an uplink concatenated message should contain maximum 2 clearances, instructions or report/information requests.

It is strongly recommended **not** to use message element UM165 – [THEN] for concatenation of messages as it does not reflect sufficiently clear the intended operational use, and it may lead to ambiguities.

Recognising that the implementation of concatenated messages is dependent on the airspace operational particularities, it is expected that each ground system, compliant to the EUROCONTROL specification, will develop its own subset of concatenated messages, based on the ones given in the tables below.

Note: Interoperability requirements for concatenated messages are specified in ED-110B [3].

9.5.2 Concatenation of message elements with response attribute other than Y

The six tables below present the list of uplink concatenated messages for ground systems compliant to the EUROCONTROL Specification. Within each table, one instruction from the left table column can be concatenated with one of the instructions from the right column, except for the table in 9.5.2.2, where instructions to Climb or Descend can be concatenated with both a maximum and minimum ‘Climb or Descend Rate’ instruction

Note 1: It is expected that the message elements order in a concatenated message is preserved when the concatenated message is displayed to the pilots.

*Note 2: Message elements in **bold** are mandatory for systems compliant to the EUROCONTROL Specification.*

Note 3: In accordance with 9.2 above, the response attribute of the concatenated message resulting from the combination of such message elements is ‘W/U’.

9.5.2.1 Level instruction concatenated with Speed instruction

UM20 CLIMB TO [level]	UM106 MAINTAIN [speed]
UM23 DESCEND TO [level]	UM107 MAINTAIN PRESENT SPEED
	UM108 MAINTAIN [speed] OR GREATER
	UM109 MAINTAIN [speed] OR LESS
	UM222 NO SPEED RESTRICTION

9.5.2.2 Level instruction concatenated with Level Constraint

UM20 CLIMB TO [level]	UM171 CLIMB AT [verticalRate] MINIMUM UM172 CLIMB AT [verticalRate] MAXIMUM
UM23 DESCEND TO [level]	UM173 DESCEND AT [verticalRate] MINIMUM UM174 DESCEND AT [verticalRate] MAXIMUM

9.5.2.3 Level instruction concatenated with Route modification instruction

UM20 CLIMB TO [level]	**UM74 PROCEED DIRECT TO [position]**
UM23 DESCEND TO [level]	UM79 CLEARED TO [position] VIA [route clearance]
	UM80 CLEARED [route clearance]

9.5.2.4 Level instruction concatenated with Heading instruction

UM20 CLIMB TO [level]	**UM190 FLY HEADING [degrees]**
UM23 DESCEND TO [level]	UM94 TURN [direction] HEADING [degrees]
	UM96 CONTINUE PRESENT HEADING
	UM215 TURN [direction] [degrees]

9.5.2.5 Route modification instruction concatenated with Speed instruction

UM74 PROCEED DIRECT TO [position]	UM106 MAINTAIN [speed]
UM79 CLEARED TO [position] VIA [route clearance]	UM107 MAINTAIN PRESENT SPEED
UM80 CLEARED [route clearance]	UM108 MAINTAIN [speed] OR GREATER
	UM109 MAINTAIN [speed] OR LESS
	UM222 NO SPEED RESTRICTION

9.5.2.6 Heading instruction concatenated with Speed instruction

UM190 FLY HEADING [degrees]	UM106 MAINTAIN [speed]
UM94 TURN [direction] HEADING [degrees]	UM107 MAINTAIN PRESENT SPEED
UM96 CONTINUE PRESENT HEADING	UM108 MAINTAIN [speed] OR GREATER
UM215 TURN [direction] [degrees]	UM109 MAINTAIN [speed] OR LESS
	UM222 NO SPEED RESTRICTION

9.5.3 Concatenation of message elements with W/U, A/N, R or Y response attribute with message elements with Y response attribute.

The use of concatenated messages composed of message elements with W/U, A/N, R or Y response attribute with message elements with Y response attribute would represent a deviation from the operational guidance stated in 9.5.1. Furthermore, future system improvements foresee the availability of the information requested through the messages with Y response attribute via other services (e.g. 4D-TRAD), thus making the use of such concatenation or message elements obsolete.

For these reasons, such concatenated messages should not be used. Ground systems choosing to implement such concatenations can find additional recommendations/ guidance in 9.6 below.

9.6 Guidance for ground- and aircraft systems supporting concatenation of message elements W/U with Y response attributes

9.6.1 Recommended concatenation of uplink message elements

As stated in 9.5.3, the use of concatenations of a message element with the 'W/U' response attribute and a message element with the 'Y' response attribute should be avoided. In case ANSPs wish to use such concatenations, the following uplink concatenated message elements are recommended:

UM20 CLIMB TO [level]	UM148 WHEN CAN YOU ACCEPT [level]
	UM231 STATE PREFERRED LEVEL

UM74 PROCEED DIRECT TO [position]	UM231 STATE PREFERRED LEVEL
	UM148 WHEN CAN YOU ACCEPT [level]
	UM133 REPORT PRESENT LEVEL
	UM232 STATE-TOP-OF-DESCENT

UM190 FLY HEADING [degrees]	UM231 STATE PREFERRED LEVEL
	UM133 REPORT PRESENT LEVEL

*Note 1: Message elements in **bold** are mandatory for systems per EUROCONTROL Specification.*

Note 2: In accordance with 9.2 above, the response attribute of the concatenated message resulting from the combination of such message elements is 'W/U'.

Note 3: In accordance with section 9.5.2 within each table, one instruction from the left column can be concatenated with one of the report/information requests in the right column and vice-versa.

9.6.2 Responding to uplink concatenated messages

As stated above, the response attribute of the concatenated message from 9.6.1 is 'W/U'.

A WILCO or UNABLE response from the pilot will technically close the dialogue. However, from operational perspective a single WILCO or UNABLE (a message not containing the respective response to the message element with Y attribute) may not provide all the operational information requested in the uplink concatenated message.

Two valid options for responding to these concatenated messages could be envisaged:

Option A:
The pilot responds first with a message containing a WILCO or UNABLE (technically closing the dialogue) and later on with the information requested in the message element with response attribute Y.

Example 1: UM - PROCEED DIRECT TO DIK STATE PREFERRED LEVEL, DM – WILCO, and after a while PREFERRED LEVEL FL350

Example 2: UM - FLY HEADING 350 DEGREES STATE PREFERRED LEVEL, DM – UNABLE DUE TO WEATHER and after a while PREFERRED LEVEL FL350

Aircraft HMI designer's attention is drawn to the fact that should this option be selected for implementation, **the aircraft HMI will have to include means to inform the pilot on the additional required response message (audio and visual alerts)**.

Option B:
The pilot responds with a concatenated message containing all operational responses required.

Example: UM - PROCEED DIRECT TO DIK STATE PREFERRED LEVEL; DM – WILCO PREFERRED LEVEL FL350 or UNABLE PREFERRED LEVEL FL350

Should this option be selected for implementation, the aircraft HMI **will not allow the pilot to send the WILCO/UNABLE as single message element.**

The preferred option by the operational experts is **B**. Option A is not recommended as it would represent a deviation from the cockpit workflow and is error-prone to omissions.

It should be emphasized that a concatenated response (WILCO/UNABLE response to the instruction + STANDBY response to the message element with 'Y' attribute) is strongly dissuaded from use. A partial STANDBY would be confusing to the controller.

If a STBY has to be answered, it should be sent as a single message element, applying thus to the entire concatenated message. This is then followed by responses to operationally close the concatenated message.

Ground systems, implementing concatenation of message elements with W/U response attribute with message elements with Y response attribute, should be able to accept responses from aircraft systems compliant to either option A or B.

ANNEXES AND APPENDIX

ANNEX A: UPLINK ERROR MESSAGES

This Annex lists the operational and technical errors as specified in ED-110B [3] for display to the flight crew.

1. DOWNLINK MESSAGE REQUEST REJECTED - SEND (number) ELEMENTS MAX

Description:
The ground system receives a message that contains more message elements than it can support in a message.
Ex: The flight crew sends a combined message (REQUEST level, REQUEST heading, DUE TO WEATHER) and the ground system accepts only a maximum of two message elements.

Note: It is a local choice of the ground system to reject downlink messages containing more than 1, 2 or 3 message elements or to accept up to 5 message elements.

Procedure:
The flight crew may resend the request in the form of separate messages, or make the request/s by voice.

2. (Dialogue type) NOT AVAILABLE AT THIS TIME – USE VOICE

Description:
The ground system receives a downlink message that is discarded because the associated dialogue type is disabled. Dialogue type is one of the following: LEVEL, HEADING, SPEED, ROUTE REQUEST, FREE TEXT, DOWNLINK MESSAGE.

Procedure:
The flight crew should make the request by voice.

3. ELEMENT COMBINATION REJECTED – USE VOICE

Description:
The ground system receives a concatenated downlink message that it does not support, (invalid element combination, or at least one message element is not supported, or invalid element order).

Note: Whether a combination of message elements is valid or not, is determined through local choice of the ground system. Examples of obvious invalid combinations: request climb to + request descend to, WILCO + UNABLE, etc.

Procedure:
The flight crew may resend the message/request in the form of separate messages, or make the request/s by voice

4. TOO MANY (dialogue type) REQUESTS – EXPECT ONLY ONE REPLY

Description:
Dialogue type is one of the following: LEVEL, HEADING, SPEED, ROUTE
The ground system receives a downlink request, and there is an existing open downlink request containing the same type and it discards the second request.
Ex: The flight crew sends two successive CLIMB TO requests and the ground system discards the second one.

Procedure:

The flight crew should be aware that only one downlink request for a single type will be presented to the controller, and that this open dialogue must be closed before a second request of that type may be treated.

5. (Dialogue type) REQUEST REJECTED – REPLY TO (dialogue type) UPLINK FIRST
Description:
Dialogue type is one of the following: LEVEL, HEADING, SPEED, ROUTE.
The ground system receives a downlink request, and there is an existing open uplink containing the same type. The downlink request is discarded.

Note: Ground systems only accept one data link exchange of a given type at the same moment. This means that if e.g. a CLIMB TO [level] clearance has been sent, a REQUEST DESCEND TO [level] request will be rejected until the flight crew has responded to the clearance.

Procedure:
The flight crew must respond to the uplink before being able to send a downlink request of this type. For example, if CLIMB TO [altitude] has been received, the flight crew must answer WILCO or UNABLE before being able to send REQUEST CLIMB TO [altitude].

6. TOO MANY CPDLC REQUESTS - USE VOICE
Description:
The ground system receives a downlink request, and discards a message because the maximum number of open operational dialogues with the aircraft is exceeded and there is no pending uplink message.

Note: The total number of data link exchanges with an aircraft may be limited by some ground systems. This means that further requests will be rejected. If there are only downlink requests, the flight crew cannot do anything about it. If there is at least one uplink expecting a response, the flight crew can respond to that clearance first to enable reception of a downlink request.

Procedure:
The flight crew should make the request/s by voice

7. CPDLC TRANSFER NOT COMPLETED – REPEAT REQUEST
Description:
Until CPDLC is enabled, the ground system rejects any downlink message; except DM99 (CURRENT DATA AUTHORITY), DM89 (MONITORING), DM62 (ERROR), and DM62 concatenated with DM98 (ERROR + Free text).

Note: This error case is related to a situation of transfer of communications (voice and data). Ground systems check that certain conditions are met before enabling communications between controllers and flight crew. These conditions are usually at least:
- The flight is expected at that moment in the ATC sector
- The message DM99 has been received. DM99 (CURRENT DATA AUTHORITY) informs the ground that the aircraft is ready to conduct CPDLC with the current ATC.
- Satisfaction of local conditions, e.g. ASSUME input

When the conditions to enable CPDLC have been met, the ground system will accept the CPDLC messages received from the aircraft.

Procedure:

The flight crew cannot use data link now, but when CPDLC is enabled, a CPDLC message is uplinked and displayed to the flight crew, indicating the name and function of the current ATC unit.

8. ATC TIME OUT – REPEAT REQUEST

Description:
Upon expiry of the timer-responder, the ground system automatically sends an error message in response to the downlink message request.

Note: The timer-responder is a timeout on the ground that is triggered on reception of a downlink request. Upon expiry, the ground system will send an error in response to the flight crew request and inform the controller.

Procedure:
The flight crew should repeat the request/s by voice

9. DOWNLINK DELAYED – USE VOICE.

Description:
The ground system receives a message and discards the message because it contains a timestamp that is older than the allowed limit.

Procedure:
The flight crew should revert to voice.

10. DOWNLINK TIMESTAMP INDICATES FUTURE TIME.

Description:
The ground system receives a message timestamp that indicates a future time greater than 2 seconds from the current time.

Procedure:
The flight crew should revert to voice.

11. SERVICE UNAVAILABLE

Description:
The ground system receives a downlink message that it does not support, whether or not the message contains a message reference number, and discards the received message.

Note: Text 'SERVICE UNAVAILABLE' is just an ICAO intention. The text 'MESSAGE NOT SUPPORTED BY THIS ATS UNIT' is displayed in the aircraft.

Procedure:
The light crew should revert to voice.

12. FREE TEXT MESSAGE TOO LARGE - USE VOICE.

Description:
The ground system receives a downlink free text message element containing more than 80 characters, and the system cannot support the number of characters in a free text message element, and discard the received message.

Procedure:
The flight crew should revert to voice.

Note1: The flight crew should not use "Free text" if a relevant CPDLC message already exists for the situation.
Note2: Ground systems may not accept downlinked free text messages, or may not display them to the controller.

13. CPDLC MESSAGE FAILED - USE VOICE.
Description:
A CPDLC downlink message is received that results in an error, that is not already covered in the ATN SARPs,,and the ground system discards the message.

Procedure:
The flight crew should revert to voice.

14. INVALID USE OF FREE TEXT MESSAGE - CONTACT ATC
Description:
The ground system does not support a message containing a free text message element because the message does not also contain the DM62 (ERROR *(error information*) message element and discards the message.

Procedure:
The flight crew should revert to voice.

15. RADAR TRACKING TERMINATED - TERMINATING CPDLC.
Description:
The ground system decides to terminate a CPDLC connection with an aircraft because it has lost radar data, the ground system terminates the CPDLC connection.

Procedure:
The flight crew should revert to voice.

16. CPDLC FOR (dialogue type) FAILED - USE VOICE.
Description:
Dialogue type is one of the following: LEVEL, HEADING, SPEED, ROUTE
The ground system receives a downlink message containing a dialogue type that it does not support and discards the message.

Procedure:
The flight crew should revert to voice.

17. MESSAGE DOES NOT CONTAIN FACILITY NAME.
Description:
The ground system receives a downlink message that contains the *unitname* data type, but rejects the message because it does not also contain the *facilityname* data type and discards the message.

Procedure:
The flight crew should revert to voice.

ANNEX B: EUROCONTROL SPECIFICATION CPDLC MESSAGE SET FOR AIRCRAFT IMPLEMENTATIONS

The uplink and downlink CPDLC message set to be implemented by the aircraft systems are presented in the tables below. The message set is based on the EUROCONTROL Specification [2].

M = Mandatory message [must be implemented by the air craft system]

O = Optional message [may be implemented by the airborne system]

Messages in *italics* indicate the messages that are currently most frequently used by controllers and flight crews.

Operational Elements	**EUROCONTROL Specification**
UM0 UNABLE	M
UM1 STANDBY	M
UM3 ROGER	M
UM4 AFFIRM	M
UM5 NEGATIVE	M
UM19 MAINTAIN [level]	M
UM20 CLIMB TO [level]	M
UM23 DESCEND TO [level]	M
UM26 CLIMB TO REACH [level] BY [time]	M
UM27 CLIMB TO REACH [level] BY [position]	M
UM28 DESCEND TO REACH [level] BY [time]	M
UM29 DESCEND TO REACH [level] BY [position]	M
UM46 CROSS [position] AT [level]	M
UM47 CROSS [position] AT OR ABOVE [level]	M
UM48 CROSS [position] AT OR BELOW [level]	M
UM51 CROSS [position] AT [time]	M
UM52 CROSS [position] AT OR BEFORE [time]	M
UM53 CROSS [position] AT OR AFTER [time]	M
UM54 CROSS [position] BETWEEN [time] AND [time]	M
UM55 CROSS [position] AT [speed]	M
UM61 CROSS [position] AT AND MAINTAIN [level] AT [speed]	M
UM64 OFFSET [specifiedDistance] [direction] OF ROUTE	M
UM72 RESUME OWN NAVIGATION	M
UM74 PROCEED DIRECT TO [position]	*M*
UM79 CLEARED TO [position] VIA [routeClearance]	M
UM80 CLEARED [route clearance]	M
UM82 CLEARED TO DEVIATE UP TO [specifiedDistance] [direction] OF ROUTE	M
UM92 HOLD AT [position] AS PUBLISHED MAINTAIN [level]	M
UM94 TURN [direction] HEADING [degrees]	M
UM96 CONTINUE PRESENT HEADING	M
UM106 MAINTAIN [speed]	M
UM107 MAINTAIN PRESENT SPEED	M

UM108 MAINTAIN [speed] OR GREATER	M
UM109 MAINTAIN [speed] OR LESS	M
UM116 RESUME NORMAL SPEED	M
UM117 CONTACT [unitname] [frequency]	*M*
UM120 MONITOR [unitname] [frequency] **1)**	M
UM123 SQUAWK [code]	*M*
UM133 REPORT PRESENT LEVEL	M
UM148 WHEN CAN YOU ACCEPT [level]	M
UM157 CHECK STUCK MICROPHONE [frequency]	*M*
UM159 ERROR [errorInformation]	M
UM160 NEXT DATA AUTHORITY [facility]	M
UM162 SERVICE UNAVAILABLE **2)**	M
UM165 THEN	M
UM171 CLIMB AT [verticalRate] MINIMUM	M
UM172 CLIMB AT [verticalRate] MAXIMUM	M
UM173 DESCEND AT [verticalRate] MINIMUM	M
UM174 DESCEND AT [verticalRate] MAXIMUM	M
UM179 SQUAWK IDENT	*M*
UM183 [freetext]	M
UM190 FLY HEADING [degrees]	M
UM196 [freetext]	M
UM203 [freetext]	M
UM205 [freetext]	M
UM211 REQUEST FORWARDED	M
UM213 [facilitydesignation] ALTIMETER [altimeter]	M
UM215 TURN [direction] [degrees] **3)**	M
UM222 NO SPEED RESTRICTION	M
UM227 LOGICAL ACKNOWLEDGMENT	M
UM231 STATE PREFERRED LEVEL	M
UM232 STATE-TOP-OF-DESCENT	M
UM237 REQUEST AGAIN WITH NEXT UNIT	M

1) MONITOR message is not yet suitable for operational use.

2) The text *'SERVICE UNAVAILABLE' is just an ICAO intention. The text 'MESSAGE NOT SUPPORTED BY THIS ATS UNIT' is displayed in the aircraft.*

3) UM215 should be displayed as TURN [direction][degrees] DEGREES.

Operational Elements	**EUROCONTROL Specification**
DM0 WILCO	*M*
DM1 UNABLE	*M*
DM2 STANDBY	*M*
DM3 ROGER	*M*
DM4 AFFIRM	M
DM5 NEGATIVE	M
DM6 REQUEST [level]	M
DM9 REQUEST CLIMB TO [level]	O
DM10 REQUEST DECENT TO [level]	O
DM18 REQUEST [speed]	M

Operational Elements	**EUROCONTROL Specification**
DM22 REQUEST DIRECT TO [position]	*M*
DM27 REQUEST WEATHER DEVIATION UP TO [specifiedDistance] [direction] OF ROUTE	O
DM32 PRESENT LEVEL [level]	M
DM62 ERROR [errorInformation]	M
DM63 NOT CURRENT DATA AUTHORITY	M
DM65 DUE TO WEATHER	M
DM66 DUE TO AIRCRAFT PERFORMANCE	M
DM81 WE CAN ACCEPT [level] AT [time]	M
DM82 WE CANNOT ACCEPT [level]	M
DM89 MONITORING [unitname] [frequency]	M
DM98 [freetext]	M
DM99 CURRENT DATA AUTHORITY	M
DM100 LOGICAL ACKNOWLEDGMENT	M
DM106 PREFERRED LEVEL [level]	M
DM107 NOT AUTHORIZED NEXT DATA AUTHORITY	M
DM109 TOP OF DESCENT [time]	M

ANNEX C: OVERVIEW CRO SYSTEM PERFORMANCE AND PROBLEM REPORTING

C.1 Scope

EC Regulation 29/2009 [1] requires that data link system performance is regularly monitored to verify that an acceptable level of safety and conformance with the level of performance required continues to be met.

The Central Reporting Office (CRO), established within EUROCONTROL's Network Management Directorate, functions as focal point for:

- Monitoring system performance;
- Investigating system-level problems;
- Facilitating the sharing of knowledge among the data link community.

To perform its functions, the CRO will routinely need data from both the ACSPs and the ANSPs as well as problem reports from all stakeholders. It will create a set of regular performance monitoring reports and a shared knowledge of problem resolutions via the problem reporting database as well as more generic descriptions of common problems/resolutions on the Link wiki.

C.2 Performance monitoring

A set of reports, agreed between each ANSP and each National Safety Authority, allow the ANSPs to monitor the quality of service as required under the EC Regulation No 29/2009. The set of reports from ANSPs contains performance data at:

a) CPDLC-and CM application to be created monthly.
b) at application- or ATN transport layer to verify general system health on regular or ad-hoc basis.

In addition, the CRO receives data in relation to VDLM2 communication primarily from ACSPs for capacity planning and problem investigation and also receives some complementary data from ANSPs.

The CRO regularly publishes ATM network level performance monitoring reports on the CRO wiki (http://www.eurocontrol.int/link2000/wiki/index.php/Main_Page). The reports, created at ANSP or Aircraft Operator level are restricted to the relevant user and EUROCONTROL.

C.3 Problem Reporting, investigation and resolution

Link stakeholders are expected to perform their own investigations of any problems found. The CRO provides a database system for reporting problems and investigates those that cannot be resolved locally (e.g. by the ANSP for a problem reported by an Air Traffic Controller).

In order to promote knowledge sharing across the Link2000+ community, all system problems should be recorded in the CRO problem reporting database (https://www.eurocontrol.int/ticketingservices/secure/Dashboard.jspa) and be made accessible to all registered users.

The CRO core team will identify any commonly occurring problem in a generic way and publish them on the LINK2000+ wiki as means of information sharing.

For more details on the CRO functions, refer to the LINK2000+ website: http://www.eurocontrol.int/services/link-2000-programme.

ANNEX D: SERVICE PROVISION TO FANS 1/A(+) AND BILINGUAL AIRCRAFT

Some ANSPs (NATS, MUAC, NAV-P, IAA) have accommodated their ground systems to allow the provision of CPDLC services to FANS 1/A aircraft and FANS 1/A+ aircraft.

ANSPs (NATS, NAV-P, IAA) at the NAT/EUR Continental boundary allow seamless transfer to bilingual aircraft, equipped as integrated FANS 1/A+ and ATN-B1 stacks.

Note 1: FANS 1/A+ aircraft have implemented the Latency Time Monitor (LTM) mechanism to satisfy ED120 safety requirement SR-ACL-13 for profile changing messages, while FANS 1/A aircraft exclude this.

Note 2: For details on FANS 1/A(+) aircraft, refer to GOLD-Ed 2.0 [11]

The EUROCAE ED154A document [5] provides Interoperability requirements for:

a) ATN-B1 ground systems, allowing the accommodation of FANS 1/A+ aircraft;

b) Ground- and aircraft systems (FANS 1/A+ or ATN-B1), allowing the seamless transfer of bilingual aircraft, equipped as integrated FANS 1/A+ and ATN-B1 stacks.

FANS 1/A (+) Aircraft

Safety analysis has demonstrated that the absence of some safety-critical properties of FANS 1/A(+) aircraft implementations require some additional mitigations. The Table below lists the differences with reference to ATN-B1 implementations and provides system- and procedural mitigations, when providing CPDLC services to FANS 1/A(+) aircraft.

Difference	Mitigation
No downlink of DM99 CURRENT DATA AUTHORITY	After the controller has assumed the flight, the ATSU should: Either, generate an internal CDA message and then uplinks free text message UM169 containing ICAO facility designation, facility name and facility function (as for ATN-B1 aircraft). Or, Uplink a free text 'Welcome' message UM169, requiring the flight crew to respond with ROGER *Example: BAW126 WELCOME TO LONDON RESPOND CPDLC ROGER*
No Flight Identification in message application checksum	Some ATSUs may prepend the Flight Identification, using free text message UM169, to each uplink message.
No distinction between FANS 1/A and FANS 1/A+ aircraft in logon request or FPL	The ATSU does not uplink free text message UM169 to a FANS 1/A+ aircraft, instructing the pilot to set Latency Time Monitor (40s), but relies on ground timer tts (120s). Upon time-out of ground-timer tts: Either, The ATSU should automatically generate a commanded termination (reason code 5) which will terminate CPDLC with that aircraft for the duration of the flight for which the ATSU is CDA, and, The controller should return to voice, instructing the flight crew to disconnect CPDLC for the duration of the flight for which the ATSU is CDA. Or, The controller should return to voice to clarify the situation. If no message is received, the controller should instruct the flight crew to disconnect CPDLC for the duration of the flight for which the ATSU is CDA.

Bilingual Aircraft

Two types of dual FANS 1/A+ and ATN aircraft implementations exist, requiring different procedures:

a) Integrated FANS and ATN

At initial logon, in NAT airspace, a bilingual aircraft sets itself automatically in 'FANS' mode, while in Continental European airspace, the aircraft sets itself automatically in 'ATN' mode.

Note: Upon initial logon, the aircraft system checks whether a CM-address can be found. If so, the aircraft sets the DL functions in ATN mode. If not, the aircraft sets the DL functions in FANS mode.

For flights, crossing the boundary of the NAT/EUR Continental region, seamless DL transfer between the ACCs at the NAT/EUR Continental airspace (NATS, NAV-P, IAA) is possible, provided the interoperability requirements as specified in ED-154A/Chapter 4 [9] are implemented.

AOs and ANSPs do not require other procedures than those specified in GOLD ED 2.0 [15] and the LINK2000+ Operational guidances.

b) Independent FANS and ATN

When departing, before initial logon, the flight crew needs to manually set the DL functions either in FANS or ATN mode, followed by a manual logon by the flight crew to the first ACC. It is not possible to use the applications at the same time.

For flight, crossing the boundary of the NAT/EUR Continental region, no seamless DL transfer between the NAT ACC and EUR Continental ACC is possible.

When the aircraft is flying into the EUR Continental region or departs from an airport within the EUR Continental region, the flight crew must manually set the DL functions into ATN mode, followed by a manual logon to the ATN-based ACC.
Likewise, when the aircraft is flying into a Non-EUR Continental region or departs from an airport outside the EUR Continental region, the flight crew must manually set the DL functions into FANS mode, followed by a manual logon to the FANS-based ACC.

Both CPDLC applications make use of the same attention getters.

The display of messages on the HMI is slightly different between independent ATN-B1 and FANS 1/A systems as is presented in the table below. As may be concluded, the differences are not significant and should be easily understood by the flight crew. The differences should not cause confusion or interpretation issues, provided flight crews are trained in both FANS 1/A and ATN B1 system operation.

Uplink Message Number (UM#)	**FANS 1/A Message Element and Display Format**	**ATN Message Element and Display Format**
20	CLIMB TO AND MAINTAIN [altitude]	CLIMB TO [level]
23	DESCEND TO AND MAINTAIN [altitude]	DESCEND TO [level]
96	FLY PRESENT HEADING	CONTINUE PRESENT HEADING
133	CONFIRM ALTITUDE	REPORT PRESENT LEVEL
162	SERVICE UNAVAILABLE	MESSAGE NOT SUPPORTED BY THIS ATS UNIT

APPENDIX A: LIST OF CONTRIBUTORS

Chairman:	
Søren Dissing	EUROCONTROL (HQ)
Secretary:	
Willem Brondsema	EUROCONTROL (HQ)

Members:

Bolander, Sylvie	DSNA/DTI
Breting, Lisa	NAVIAIR
Carlsson, Goran	SAS
Carretero, Fortunato	NAV-Portugal
Daems, Daniel	EUROCONTROL (MUAC)
Dehn, Doris	EUROCONTROL (HQ)
Diez, David	AENA - Madrid
Gelabert, Jordi	AENA - Barcelona ACC
Gheorghe, Augustin	EUROCONTROL (HQ)
Lesch, Jörg	DFS – ACC Karlsruhe
Lezerat, Olivier	Airbus
Manzano, Jordi	Air-Europa
Milan, Korab	ANSP-CZ
Monteil, Olivier	DSNA/DO Marseille
Most, Christine	EUROCONTROL (IANS)
McGuffin, Tom	Honeywell
Ozé, Stefan	EUROCONTROL (CRDS-Budapest)
Schuen-Medwed, Renée	EUROCONTROL (CRDS-Budapest)
Skov, Finn	NAVIAIR (Denmark)
Stuhlsatz, Volker	EUROCONTROL (MUAC)
Teyssandier, Olivier	DSNA/DO
Villwock, Hartmut	DFS-Langen
Vogel, David	Skyguide