AERONATICAL TELECOMMUNICATIONS NETWORK PANEL

Working Group 3

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Possible (European) implementations for the Transfer of Communication service - Input for CPDLC guidance material

(Working paper)

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Summary

Within the European trials CNS/ATM-1 package based projects, it has been found that several alternatives exist to implement the Transfer of Communications (TOC). This paper presents a number of alternatives, their drawbacks, and proposed corrective actions.

It is recommended to establish guidance material indicating the preferred way to implement the TOC. It has also been found that a few additional ICAO requirements should be made in order to guarantee failure-free communications.

1. Introduction

Within Europe, the operational use of the CNS/ATM-1 package is being investigated in pre-operational validation exercises. Two major projects are considering the implementation, being the EOLIA and PETAL-II projects [1]. Although having different objectives, both projects aim to implement the European Operational Requirements (ORs) as established by EUROCONTROL's operational ODIAC task force.

A key operational ATC data link service is the Transfer of Communications / Control (TOC) service, also known as the ATC Communications Management (ACM) service. The service is quite similar to the one defined by the ICAO ADSP within the Manual of ATS data link applications (Part IV, chapter 7).

Independent analyses of the ACM service by the EOLIA and Petal-II projects led to a number of possible alternative implementations on basis of the ATN CPDLC application. All identified alternatives have their drawbacks. These alternatives, their drawbacks, and possible corrective actions, have been presented in this paper. The identified corrective actions have been presented for consideration by the ICAO ATNP working group 3.

The working group is informed of the different implementations in order to judge whether this material could also be used for input to guidance material of the ATN CPDLC application.

2. Europe□s specific requirements regarding ACM

Within Europe, the EUROCONTROL ODIAC Task Force is in charge of defining the ORs for candidate ATC data link services, for possible operational implementation within Europe. For the transfer of control / communications, the so called ATC Communications Management (ACM) ATC data link service has been defined. This service is quite similar to the one defined by the ICAO ADSP, but also requiring that:
- For each operational message (e.g. Voice Channel Instruction (VCI), WILCO, Monitoring R/T (MRT)), a Logical Acknowledgement (LACK) or ERROR message shall be returned;
- The MRT message shall only be sent once the LACK on the WILCO has been received.

The sequence of messages to be exchanged has been presented in figure 1.

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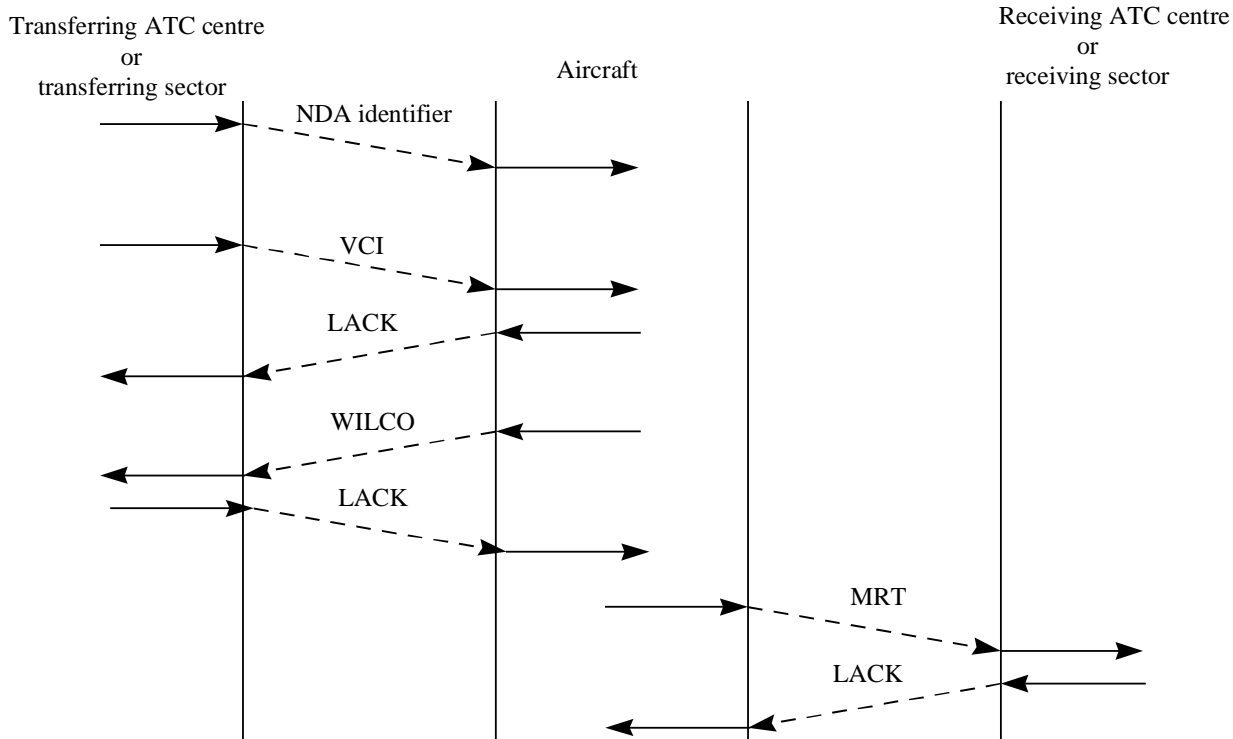
Operational Transfer of Communications Scenario

Note 1. The NDA identifier (identifying the receiving ATC centre) is only provided when a transfer between two data link equipped ATC centres is foreseen to take place.

Note 2. It must be noticed that a transfer of communications within the current ATC centre can still take place, after the provision of the "NDA identifier", before the actual transfer between two centres takes place.

Figure 1. Time sequence diagram showing the European Operational Requirements for ACM

3. Identified ACM implementations

3.1 Introduction

While designing the ACM service, it appeared that a number of possible CNS/ATM-1 CPDLC based implementations exists. The number even increased once it was also considered that the (European ORs conform) aircraft also have to be capable to operate in other CNS/ATM-1 package compliant areas, where the ground ATC systems have been designed without possibly having considered the specific European ORs. Moreover, the European ground ATC systems must also be capable to accommodate aircraft carrying a CNS/ATM-1 package, but not being completely conform with the European ORs. For example, it is known that some States and airlines are not in favour of LACKs. Hence, those aircraft will not request the return of a LACK once they send a downlink CPDLC message, like WILCO or MRT.

In annex A to this paper, a number of alternative scenario's has been presented, which all implement the ACM service operational requirements, using the CNS/ATM-1 CPDLC application. Scenario 1 presents an implementation where the transferring ground ATC centre provides the last Voice Channel Instruction (VCI) to an aircraft, together with the request to end the CPDLC service for that centre. It must be noted that this option is not compliant to the European requirements, because the last LACK message cannot be sent. Scenarios 2 to 4 present an implementation where the ground ATC system provides the last VCI for a given aircraft in a similar way as a VCI intended for a sector-to-sector transfer within a centre. Thus, the CPDLC-

message service is used. Once the WILCO on the VCI has been received, the ATC centre requests the end of the CPDLC service for that centre. Differences exist in the provision of the LACK, (possibly) required by the aircraft.

Before summarising the drawbacks of the alternatives, and the proposed corrective actions, some background information is provided regarding the Monitoring R/T (MRT) message.

3.2 Problem associated with the Monitoring R/T (MRT) message

The ACM service identifies three types of pilot / controller initiated messages:
1. Voice Channel Instruction (VCI)
2. WILCO / UNABLE
3. Monitoring R/T (MRT)

In case a transfer of communications is performed within an ATC centre, then all above messages will be exchanged across one and the same CPDLC link, called the current data authority (CDA) link.

For a centre-to-centre transfer (see also figure 1), the messages 1) and 2) will be exchanged between the transferring ATC centre and so over the existing, active CPDLC link (i.e. CDA link). The MRT message needs to be send to the next (receiving) ATC centre (i.e. next data authority).
> It must be considered that the SARPs do not allow the submission of a CPDLC message to the **next** (i.e. receiving) data authority when a CDA link still exists. So, the aircraft has to wait till the next data authority becomes the current one. This will happen once the CPDLC link with the transferring ATC centre has been released.

Considering the above two cases, the question arises: How does the aircraft know that the transfer of communications is related to a transfer within a given ATC centre, or between two centres? Consequently, how does the aircraft know that it should not send the MRT message to the current ATC centre?

In theory, this problem could be solved by stating that a transfer of communications requested upon the provision of the Next Data Authority (NDA) identifier to the aircraft, the aircraft always has to expect a transfer to another centre. However, it may be possible that due to technical implementation reasons the NDA identifier is already provided to the aircraft, and that still a transfer of communications within the current ATC centre needs to be performed. This could especially be the case for centres controlling high air-traffic density airspaces.

The MRT message will normally contain the same *unit name* as indicated by the VCI message. For information, the SARPs definition of the unit name has been given in annex B. A system can only relate the MRT message with a CDA / NDA identifier in case the *FacilityDesignation* parameter has been chosen within the VCI. Otherwise, it is likely to be impossible to correlate the VCI with the CDA or NDA, which is identified by the *FacilityDesignation* parameter.

Given the current definition of the *Unit Name*, no guarantee can be given that an MRT message is **not** sent to the **current (i.e. transferring)** data authority, instead of the intended **next (i.e. receiving)** data authority if the CPDLC link with the transferring ATC centre is still open for message exchanges at the moment the aircraft is allowed to submit a MRT message.

3.3 Overview of drawbacks and possible corrective actions

The following table presents the different scenario's, as identified in annex A, together with their drawbacks and the way to solve them. The proposed corrective actions are subject for input to the CPLDC guidance material and possibly the CPDLC application SARPs as well.

| Scenario	Typical aspect	Drawback	Possible corrective action
1	VCI is being put in CPDLC-end.req.	• The ground is not able to issue any other message (unless the air responds with a CPDLC-end.rsp (reject)). • No LACK / ERROR on a WILCO can be returned to the aircraft. Incompliance with European requirements.	Not possible when VCI is put in CPDLC-end.req
2	Last LACK is put in CPDLC-end.req.	This scenario only works correct, if the aircraft requests a LACK to be returned for the WILCO. If no LACK is requested, a possibility exists that the MRT message will be sent to the transferring ATC centre.	A LACK request to a WILCO referring to a VCI has to become mandatory, and the MRT message is only allowed to be sent upon receipt of this LACK (which is conform to the European OR).
3	Last LACK, requested by aircraft, is put in CPDLC-message.req.	It cannot be guaranteed that the MRT message is not sent to the wrong ground ATC centre	• The ground CPLDC user has to choose the FacilityDesignation parameter within the *Unit name* of the last VCI. This allows correlation with the identifier of the next data authority (NDA identifier), if available. • The airborne CPDLC user is required to correlate the *UnitName* with the NDA identifier, if available, before it is being transmitted. When equivalent with the NDA identifier, the airborne CPDLC user shall postpone the submission of the MRT message, until the NDA link has become the CDA link.
4	The aircraft does not request the LACK.	A high risk exists that the MRT message is sent to the wrong ground ATC centre (being the transferring ATC centre).	See corrective action for scenario 3.

4. Recommendations

The ATNP/WG3 is invited to notice the existence of alternative implementations for the Transfer Of Communications/ Control (for short TOC or ACM) service.

Unfortunately, none of these alternatives is perfect. Some of them may even risk unintended operational communications, as a message can go to a destination for which it is not intended. Therefore, the ATNP WG3 is recommended to consider the alternatives, and to use one (or some of) them as a basis for input to the draft CPDLC guidance material.

It is recommended that the ATNP WG3 either:
- Mandates the use of the *FacilityDesignation* parameter in the last VCI for a given centre, and requires the air CPDLC user to correlate the *UnitName* with the NDA identifier, if available, before submitting the MRT message; or
- Modifies the definition of the *UnitName* such that the *FacilityDesignation* parameter will always be provided (instead of having the choice to provide the *FacilityName*), and requires the air CPDLC user to correlate the *UnitName* with the NDA identifier, if available, before submitting the MRT message; or
- Endorses the ACM service implementation, in which an aircraft always requests a LACK on the WILCO, where that LACK will be required to be placed within the CPDLC-end.req message field, and where the MRT message will not be sent before the LACK has been received, as the ICAO recommended practice.

Annex A   Presentation of ACM CNS/ATM-1 package based implementation scenarios
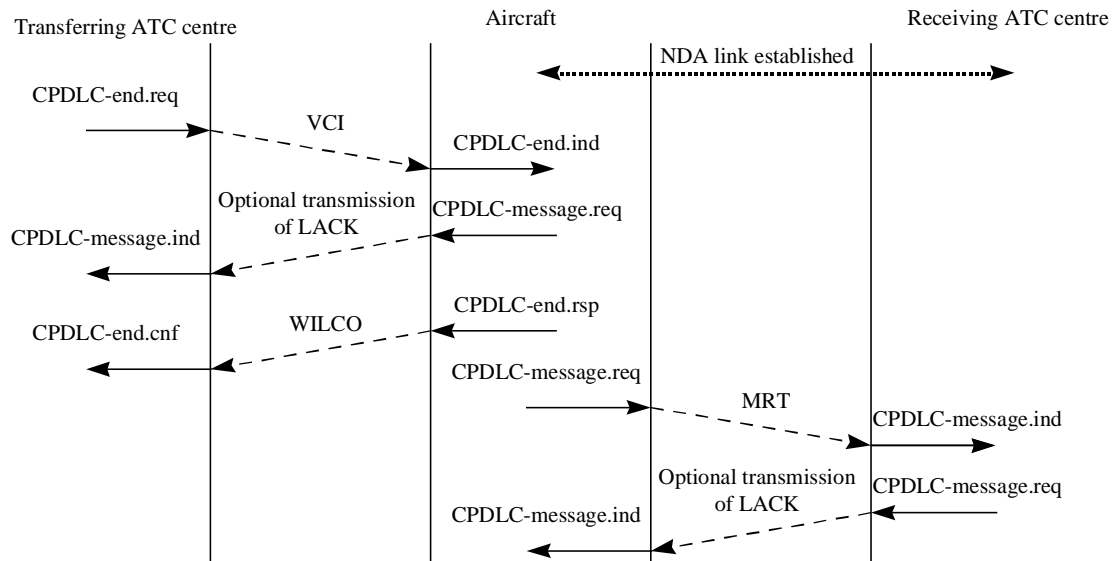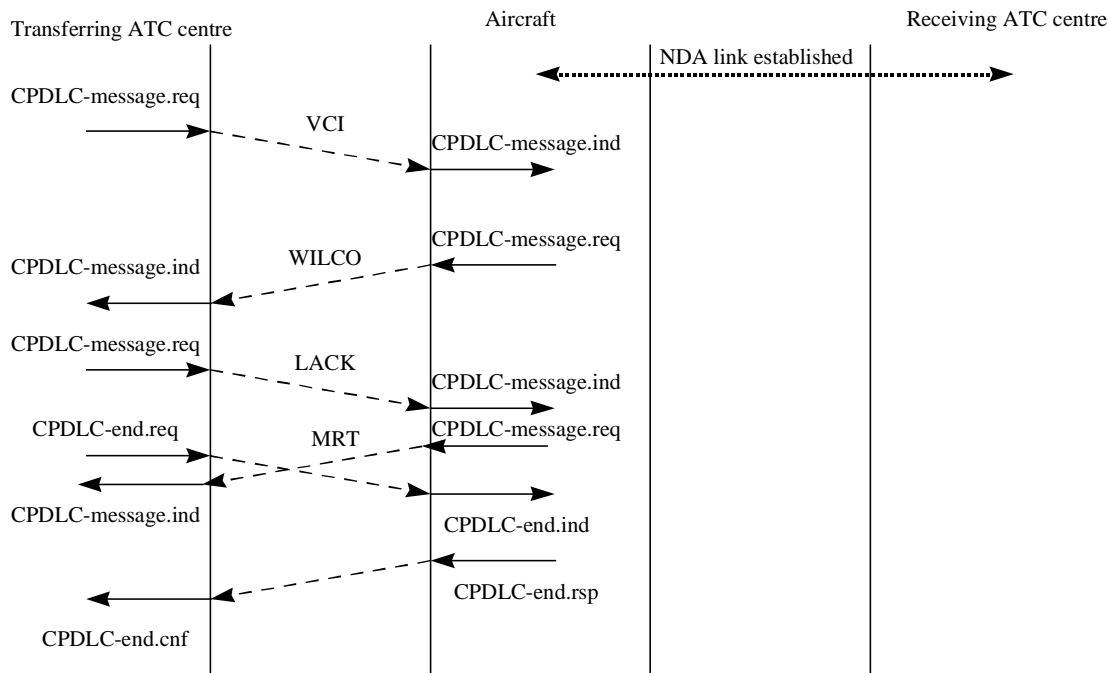

Scenario 1

VCI is transferred using CPDLC-end service. The SARPs prohibit that the aircraft requests the return of a LACK message referring to the WILCO. It is clear that the MRT will always go to the receiving ATC centre.
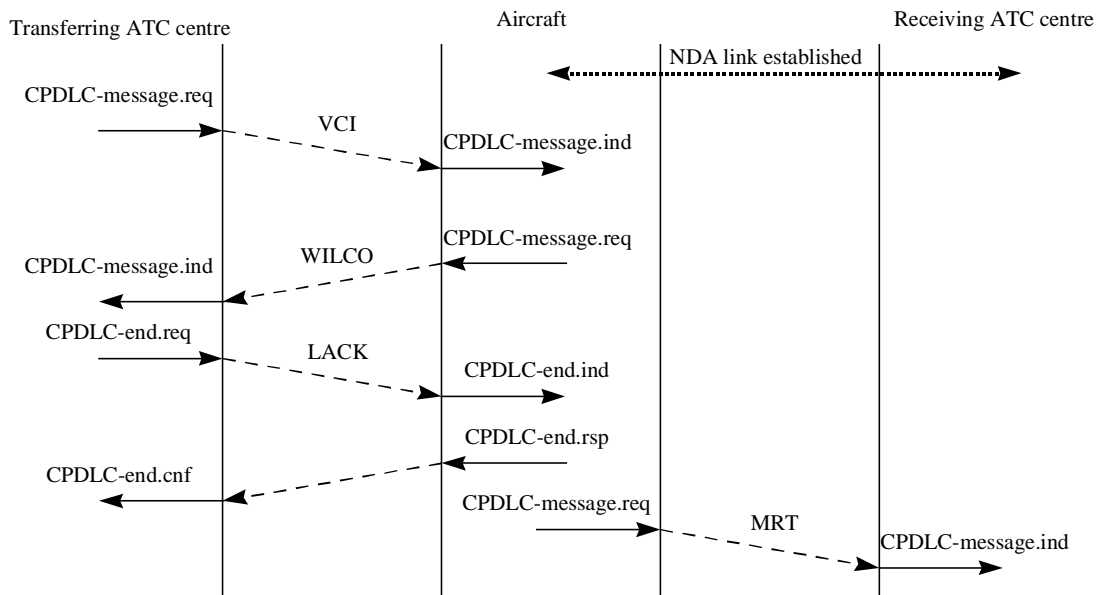
Scenario 2

VCI is transferred using CPDLC-message service. The SARPs now allow the aircraft to request the return of a LACK message referring to the WILCO. Here, the LACK is requested.
If the LACK on the WILCO is transferred using the CPDLC-end service, instead of the CPDLC-message.service, then it is ensured that the MRT message will go to the receiving ATC centre.

Note. For ease, the optional LACKs on the VCI and MRT have not been shown.

Transferring ATC centre   Aircraft   Receiving ATC centre

NDA link established

CPDLC-message.req

VCI

CPDLC-message.ind

CPDLC-message.req

CPDLC-message.ind   WILCO

CPDLC-message.req   LACK

CPDLC-message.ind

CPDLC-end.req   MRT   CPDLC-message.req

CPDLC-message.ind
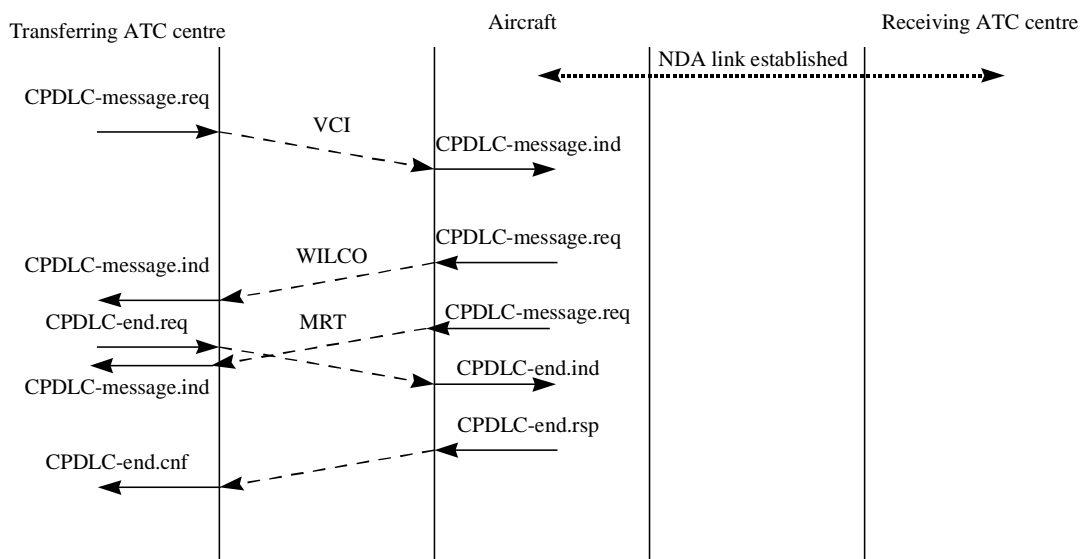
CPDLC-end.ind

CPDLC-end.rsp

CPDLC-end.cnf

Scenario 3

VCI is transferred using CPDLC-message service. The SARPs now allow the aircraft to request the return
of a LACK message referring to the WILCO. If the LACK on the WILCO is transferred using a CPDLC-message.req,
instead of a CPDLC-end.req, then it cannot be ensured that the MRT message will go to the receiving ATC centre.
A risk exists that the MRT message willl go to the transferring ATC centre.

Transferring ATC centre   Aircraft   Receiving ATC centre

NDA link established

CPDLC-message.req

VCI

CPDLC-message.ind

CPDLC-message.req

CPDLC-message.ind   WILCO

CPDLC-end.req   MRT   CPDLC-message.req

CPDLC-end.ind

CPDLC-message.ind

CPDLC-end.rsp

CPDLC-end.cnf

Scenario 4

VCI is transferred using CPDLC-message service. The SARPs now allow the aircraft to request the return
of a LACK message referring to the WILCO. However, if no LACK on the WILCO is requested ,
then it cannot be ensured that the MRT message will go to the Receiving ATC centre.
A high risk (much higher than within scenario 3) exists that the MRT message willl go to the transferring ATC centre.

Annex B   The SARPs ASN.1 definition of the Unit Name

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```
UnitName ::= SEQUENCE
        {
        facilityId              FacilityIdentification,
        facilityFunction        FacilityFunction
        }

FacilityIdentification ::= CHOICE
        {
        facilityDesignation     [0]     FacilityDesignator,
        facilityName            [1]     FacilityName
        }
```

…