

Fieldbus specification

Part 4. Data link protocol specification

ICS 35.100: 35.200

Committees responsible for this Draft for Development

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Foreword

This Part of DD 236 has been prepared by Technical Committee, AMT/7.

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This publication contains the following parts:

Part 1	System architecture	FF-94-800	Revision 1.0
Part 2	Network management	FF-94-801	Revision 1.0
Part 3	Data link layer services subset	FF-94-821	Revision 1.0
Part 4	Data link protocol specification	FF-94-822	Revision 1.0
Part 5	Fieldbus message specification	FF-94-870	Revision 1.0
Part 6	Fieldbus access sublayer (services and protocol)	FF-94-875	Revision 1.0

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A review of this Draft for Development will be carried out not later than 2 years after its publication. Notification of the start of the review period, with a request for the submission of comments from users of this Draft for Development, will be made in an announcement in *BSI News*.

According to the replies received the responsible BSI Committee will judge whether the Draft for Development can be converted into a British Standard or what other action should be taken.

Observations which it is felt should receive attention before the official call for comments will be welcomed.

These should be sent to the Secretary of BSI Technical Committee AMT/7 at BSI, 389 Chiswick High Road, London, W4 4AL, giving the document reference and clause number and proposing, where possible, an appropriate revision of the text.

Fieldbus Foundation Fieldbus Specification Data Link Protocol Specification

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Foreword

Open Issue List		
No.	Description of Issue	Affected Documents

Resolution List		
No.	Description of Resolution	Affected Sections

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1. Scope

The purpose of this part of the Fieldbus Foundation Specifications is to define the Data Link Layer protocol. The Fieldbus Data Link protocol specifications in this document is a subset of the specifications described in the ISA draft [see the reference in section 4 of this document] for the Data Link layer Standard. This subset is selected to provide the services defined in the Fieldbus Foundation Data Link layer service document number FF-94-821. In addition, this subset includes node initialization, link initialization, address assignment, time-synchronous scheduling, and "Token-passing". This document specifies:

- a) the elements of procedure to describe the interactions between a DL-service (DLS) provider and a DLS-user for all service primitives;
- b) the structure of the Fieldbus Data Link (DL) Protocol Data Units used for the transfer of data and control information, and their representation as Physical Interface Data Units;
- c) the interactions among two or more DL-entities (DLEs) through the exchange of Fieldbus Data Link Protocol Data Units.

The base document is ISA SP50.02 - Part 3 version 4.1. The base document and this document together form the complete specifications.

1.1 Notation used to show the subset

Every section and subsection of the base document belongs to one of the following three categories for the purpose of including it in this subset:

- Included - Y: the entire section or subsection and its subsections, if any, are included in this subset,
- Included - No: the entire section or subsection and its subsections, if any, are excluded from this subset,
- Included (partially) - Y:..... only part of the section or subsection is included in this subset; the text in this document specifies what parts are excluded and what parts are included. For most sections of this category, the specifications applicable to this subset is reprinted from the base document.

1.2 Conformance to Full set

This subset of Data Link layer protocol is selected to support only the services defined in [FF-94-821]. Therefore, this subset may not interoperate completely with the devices of a bigger subset or full set of ISA SP50.02 - Part 3 version 4.1. However, it is possible, and permitted to implement a bigger subset of ISA SP50.02 - Part 3 version 4.1, such that a device with a bigger subset interoperates completely with the devices which implement only this subset.

2. Overview

This subset includes three level model of DLL [ISA DLP: section 5.1]. The higher-level is specified as elements of procedure. Only the procedures to support the services subset [FF-94-821] are part of this subset. This subset includes all three functional classes - Basic, Link Master and Bridge, specified in the [ISA DLP: section 5.6]. All functions and DLPDUs supported by these three classes as specified in ISA DLP: table 1 are part of this subset, except as specified below:

- Transmission and reception of RC DLPDU;
- Transmission and reception of Compel Acknowledge (CA) and Exchange Data (ED);
- Transmission and reception of Execute Sequence (ES);
- Transmission and reception of Wakeup (WK);
- The FDC (Fraction Duty Cycle) DLE;
- Update of Bridge routing table based on received DLPDU.

3. Architecture

The Data Link Services are provided by the Data Link Protocol which are described in this document. The relationship between the FF Specifications for Fieldbus Data Link, Fieldbus Physical Service, and other layers is illustrated in Figure 1. The interface between Data Link Layer Management Entity and the Data Link Layer and the local Network Manager Agent is not specified, because this interface is local to DLE and it does not affect InterOperability.

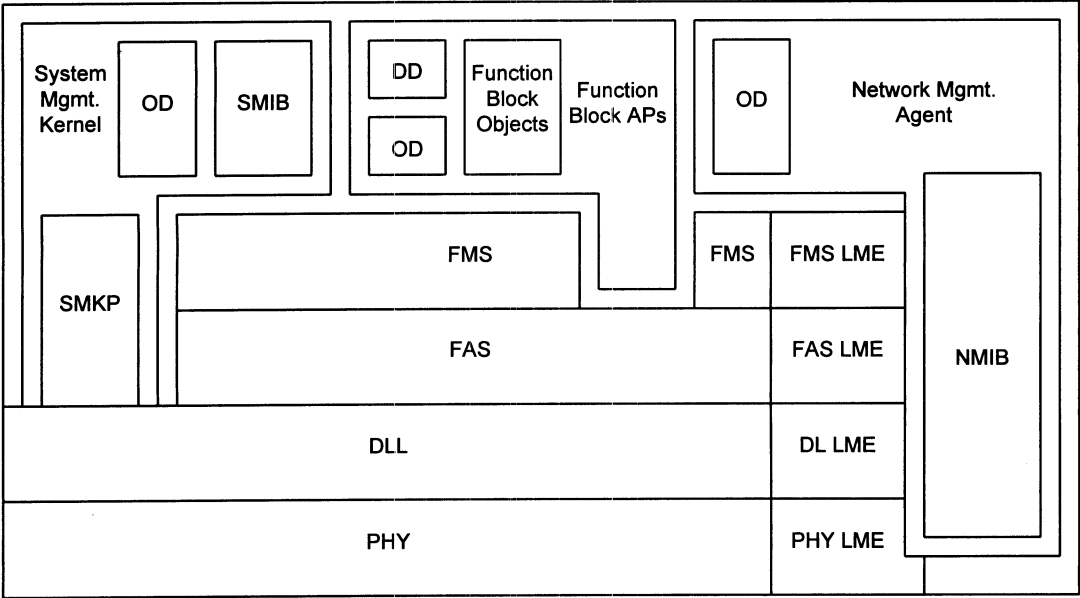


Figure 1 – Data Link Layer and the Fieldbus Foundation Architecture

4. References

[ISA SP50.02 - Part 3 version 4.1, 10 August 1995], *Digital data communications for measurement and control—Field bus for use in industrial control systems—Part 3 : Data link service definition.*

[ISA SP50.02 - Part 3 version 4.1, 26 August 1995], *Digital data communications for measurement and control—Field bus for use in industrial control systems—Part 4 : Data link protocol specification.*

[FF-95-821, PS 1.0, 1995], *Fieldbus Foundation Fieldbus Specifications—Data Link Services Subset*

4.1 Reference notation

This document specifies the subset of ISA Data Link Layer protocol by reference. The notation used is [ISA DLP: section number].

5. Overview of the DL-protocol

	Included	Included (partially)	Comments
5.1 Three-level model of the DLL (including all subsections)	Y		
5.2 Service provided by the DLL		Y	This section is the summary of service definitions. See FF-95-821 for details
5.3 DL-addresses	Y		
5.4 Service assumed from the Physical Layer (including all subsections)	Y		
5.5 Functions of the DLL (including all subsections)		Y	All types of functions specified in each subsections are included, but only to the extent necessary required by the services of FF-95-821.
5.6 Functional classes (including all subsections)	Y		

5.1 Local parameters, variables, counters, timers and queues

5.1.1 Parameters, variables, counters, timers and queues to support the Basic class

	Included	Included (partially)	Comments
5.7.1.1 V(ST) slot-time	Y		
5.7.1.2 V(PhLO) per-DLPDU-PhL-overhead	Y		
5.7.1.3 V(MRD) maximum-response-delay	Y		
5.7.1.4 V(IRRd) immediate-response-recovery-delay	Y		
5.7.1.5 V(MRC) maximum-retry-count		Y	Number of retries is always 0 for this subset.
5.7.1.6 V(NRC) network-repeat-count		Y	Number of retries is always 0 for this subset.
5.7.1.7 V(NDL) network-DLPDU-lifetime		Y	Network-DLPDU-lifetime is always 0 for this subset.
5.7.1.8 V(TN) this-node	Y		
5.7.1.9 V(TL) this-link	Y		
5.7.1.10 V(MEP) DL-MAC-address-embedding-prefix		Y	This variable is not used by the protocol.
5.7.1.11 C(RD) remaining-duration counter	Y		
5.7.1.12 V(MID) minimum-inter-PDU-delay	Y		
5.7.1.13 T(IRRd) immediate-response-recovery-delay monitor	Y		
5.7.1.14 V(RA) reply-address	Y		
5.7.1.15 V(OTA) outstanding-transaction-array	No		Not required, because V(MRC) = 0
5.7.1.16 V(LTI) last-transaction-index	No		Not required, because V(MRC) = 0
5.7.1.17 Q(US) unscheduled-service queue		Y	References to user requests per clause a.1), a.3) and a.4) only; clauses a.2), b) and c) do not apply to this subset.
5.7.1.18 V(RID) random identifier	Y		
5.7.1.19 C(NT) node-time counter	Y		
5.7.1.20 V(NTO) node-time-offset	Y		
5.7.1.21 V(TSL) time-source-link	Y		
5.7.1.22 V(TQ) time-quality	Y		
5.7.1.23 V(MD) measured-delay	Y		
5.7.1.24 V(LN) LAS-node	Y		
5.7.1.25 V(TSC) time-synchronization-class	Y		
5.7.1.26 T(TDP) time-distribution-period monitor	Y		

5.1.2 Parameters and timers to support a DLS-user's request

	Included	Included (partially)	Comments
5.7.2.2 $P_U(SDU)$ DLSDU request parameter	Y		
5.7.2.3 $P_U(MCD)$ maximum-confirm-delay parameter	Y		
5.7.2.4 $T_U(MCD)$ maximum-confirm-delay monitor	Y		

5.1.3 Queues to support DL-address-based DL-scheduling

	Included	Included (partially)	Comments
5.7.3.1 $Q_A(UR)$ user-request queue	Y		

5.1.4 Variables and timers to support a DLCEP

	Included	Included (partially)	Comments
5.7.4.1 $V_C(ST)$ DLCEP state	Y		
5.7.4.2 $V_C(NP)$ negotiated DLCEP parameters	Y		
5.7.4.3 $V_C(N)$ next sequence number to assign to a DLSDU	Y		
5.7.4.4 $V_C(R)$ maximum non-transmittable DLSDU sequence number	No		Not required for DLCEP data delivery features of this subset
5.7.4.5 $V_C(A)$ maximum acknowledged DLSDU sequence number		Y	Only for CLASSICAL and DISORDERED Peer DLC
5.7.4.6 $V_C(M)$ maximum transmitted DLSDU sequence number	Y		
5.7.4.7 $V_C(MS)$ maximum transmitted DLSDU segment number	No		Max DLSDU size is restricted to one segment
5.7.4.8 $V_{C,K}(SS)$ segments to send		Y	Number of segments is always one; only for CLASSICAL and DISORDERED Peer DLC
5.7.4.9 $T_{C,K}(SS)$ sent-segments monitor	Y		
5.7.4.9.1 $T_C(SS)$ simplified sent-segments monitor	Y		
5.7.4.10 $V_C(L)$ last-reported DLSDU sequence number	Y		
5.7.4.11 $V_C(H)$ highest-detected DLSDU sequence number	Y		
5.7.4.12 $V_C(HS)$ highest-detected segment number of the highest-detected DLSDU sequence number		Y	Max DLSDU size is restricted to one segment
5.7.4.13 $V_{C,K}(MRS)$ missing received segments		Y	Number of segments is always one; only for CLASSICAL and DISORDERED Peer DLC
5.7.4.14 $V_{C,K}(RRS)$ retransmission-request required segments		Y	Number of segments is always one; only for CLASSICAL and DISORDERED Peer DLC
5.7.4.15 $T_{C,K}(RRS)$ retransmission request monitor	No		Not required for DLCEP data delivery features of this subset
5.7.4.16 $T_C(RAS)$ residual activity stimulus	Y		
5.7.4.17 $T_C(RAM)$ residual activity monitor	Y		
5.7.4.18 $V_C(TNA)$ DL-time of last network access	Y		
5.7.4.19 $V_B(TW)$ DL-time of last buffer write	Y		
5.7.4.20 $V_B(TP)$ DL-time of production	No		Time-of-production is not included in this subset.
5.7.4.21 $V_B(TS)$ Timeliness-status of buffer write	Y		

5.1.5 Variables and timers to support the Link Master class

	Included	Included (partially)	Comments
5.7.5.1 V(DTA) delegation-address	Y		
5.7.5.2 V(LL) local-link live-list	Y		
5.7.5.3 V(TCL) token-circulation list	Y		
5.7.5.4 V(ENRL) expected-non-response list	No		Fraction Duty Cycle DLE is not included in this subset.
5.7.5.5 V(MST) maximum-scheduled-traffic	No		LAS does not construct the schedule for this subset.
5.7.5.6 V(MSO) maximum-scheduling-overhead	Y		
5.7.5.7 V(DMDT) default-minimum-token-delegation-time	Y		
5.7.5.8 V(DTHT) default-token-holding-time	Y		
5.7.5.9 V(LTHT) link-maintenance-token-holding-time	Y		
5.7.5.10 V(MTHA) maximum-token-holding-time-array	Y		
5.7.5.11 V(TTRT) target-token-rotation-time	Y		
5.7.5.12 V(ATRT) actual-token-rotation-time	Y		
5.7.5.13 V(RTHA) remaining-token-holding-time-array	Y		
5.7.5.14 V(NTHN) next-token-holding-node	Y		
5.7.5.15 V(FUN) first-unpolled-node	Y		
5.7.5.16 V(NUN) number-of-consecutive-unpolled-nodes	Y		
5.7.5.17 P(TRD) token-recovery-delay	Y		
5.7.5.18 V(TDP) time-distribution-period	Y		

5.1.6 Variables and timers to support the Bridge class

	Included	Included (partially)	Comments
5.7.6.1 V(ML) maximum-link	Y		

6. Common DLPDU structure, encoding and elements of procedure

All sub-sections of ISA DLP: section 6 are included in this subset..

7. DLPDU-specific structure, encoding and elements of procedure

This section specifies the low-level of path-access-and scheduling functions by describing the protocol for all types of DLPDUs. The DLPDUs shown in table 7.1 are included in this subset. The subsections “7.x.4.3 Additional actions required of a Bridge class DLE” apply only for forwarding the DLPDU. The bridge function of this subset does not include updating its routing tables based on the received DLPDU.

DLPDU class	frame control	DL-addresses			parameters	user data
		destination	source	2nd source		
EC 1	1111 LF00	[HL.]N.S	[HL.]N.S	[HL.]N.S	EC-p	o-DLSDU
EC 2	1110 LF00		[HL.]N.S	[HL.]N.S	EC-p	o-DLSDU
DC 1	0111 LF00	[HL.]N.S	[HL.]N.S		DC-p	o-DLSDU
DC 2	0110 LF00		[HL.]N.S		DC-p	o-DLSDU
CD 1	1111 LFPP	[HL.]N.S	[HL.]N.S		—	—
CD 2	1011 LFPP	[HL.]N.S	—		—	—
DT 1	1101 LFPP	[HL.]N.S	[HL.]N.S		SD-p	o-DLSDU
DT 2	1001 LFPP	[HL.]N.S	—		SD-p	o-DLSDU
DT 3	0101 LFPP		[HL.]N.S		SD-p	o-DLSDU
DT 5	0101 OF00		[PDA]		SD-p	o-DLSDU
SR	0001 OF11	[PSA]	N		o-SR-p	—
CT	0001 OF00	—	—		—	—
TD	0001 OF01	—	N		TD-p	—
RQ	1100 OF00	N.0	N.0		RQ-p	—
RR	1101 OF00	N.0	N.0		RR-p	—
PN	0010 0110	N	—		PN-p	—
PR	0010 0111	—	—		—	SPDU
PT	0011 OFPP	N	—		DD-p	—
RT	0011 OF00	—	[DTH]		—	—
RI	0010 0000	—	[DTH]		DD-p	—
CL	0000 0001	—	N		—	—
TL	0000 0110	N	—		—	SPDU
Idle	0001 OF10	—	—		—	o-DLSDU

LEGEND:

L indicates the length of the associated DL-addresses (0 = SHORT, 1 = LONG)

F indicates final use of a token, or that a sequence should be finished rather than restarted

PP specifies the priority of the DLPDU and any passed token

shading indicates a logically non-existent field

— indicates a logically existent field whose contents are required to be null

[HL.]N.S is a four-octet LONG DL-address (HLNS) when L = 1

or a two-octet SHORT DL-address (NS) with HL=00 implied when L = 0

N is a one-octet NODE DL-address

N.0 is the two-octet SHORT DL-address form of a one-octet NODE DL-address

[PDA] is the implied DL-address equal to the explicit destination DL-address of the immediately prior DLPDU on the link, which must have been a CD DLPDU

[PSA] is the implied DL-address equal to the implied or explicit source DL-address of the immediately prior DLPDU on the link

o- indicates optional field contents

xx-p indicates xx-class DLPDU parameters

DLSDU is a DL Service Data Unit

SPDU is a Support Protocol Data Unit

Table 1 – Summary structure of DLPDUs included in this subset

	Included	Included (partially)	Comments
7.1 Establish Connection (EC) DLPDU	Y		
7.2 Disconnect Connection (DC) DLPDU	Y		
7.3 Reset Connection (RC) DLPDU	No		DLC Reset is not part of the services included in this subset.
7.4 Compel Acknowledgment (CA) DLPDU	No		Acknowledgment from the remote DLE is not required for the services included in this subset.
7.5 Compel Data (CD) DLPDU		Y	See the text for details.
7.6 Exchange Data (ED) DLPDU	No		DL-Unitdata Exchange service is not included in this subset., and it is not necessary to support two way data exchange for connection-oriented data transfer.
7.7 Data (DT) DLPDU		Y	See the text for details.
7.8 Status Response (SR) DLPDU		Y	See the text for details.
7.9 Compel Time (CT) DLPDU	Y		
7.10 Time Distribution (TD) DLPDU	Y		
7.11 Round-Trip-Delay Query (RQ) DLPDU		Y	Only local LAS, 0400 ₁₆ , as destination address is included.
7.12 Round-Trip-Delay Reply (RR) DLPDU		Y	Only the LAS DLE is required to send RR DLPDU for this subset.
7.13 Probe Node DL-address (PN) DLPDU	Y		
7.14 Probe Response (PR) DLPDU	Y		
7.15 Pass Token (PT) DLPDU		Y	See the text for details.
7.16 Execute Sequence (ES) DLPDU	No		The schedule is executed only by the LAS.
7.17 Return Token (RT) DLPDU	Y		
7.18 Request Interval (RI) DLPDU	Y		
7.19 Claim LAS (CL) DLPDU	Y		
7.20 Transfer LAS (TL) DLPDU		Y	See the text for details.
7.21 Wakeup (WK) DLPDU	No		Fraction Duty Cycle (FDC) DLE is not included in this subset.
7.22 Idle (IDLE) DLPDU	Y		
7.23 Spare DLPDUs	Y		
7.24 Reserved (can't use) DLPDUs	Y		

7.5 Compel Data (CD) DLPDU

In ISA DLP: section 7.5, the COMPEL DATA (CD) DLPDU is used by a DLE to request the transfer of user data from another DLE and the destination address of a CD can be DLCEP or DLSAP. In this subset, CD is used only by the LAS or by a subscriber to request the transfer of user data from a publishing DLCEP.

	Included	Included (partially)	Comments
7.5.1 Structure of the CD DLPDUs		Y	No SD-parameter
7.5.2 Content of the CD DLPDU		Y	Only DLCEP-address as destination
7.5.2.1 Content of the CD DLPDU when specifying a destination DLSAP-address	No		
7.5.2.2 Content of the CD DLPDU when specifying a destination DLCEP-address		Y	Only publisher's DLCEP-address as destination is included. See text for details
7.5.3 Sending the CD DLPDU		Y	Destination is not DLSAP-address, there is no immediate retry. See text for details.
7.5.4 Receiving the CD DLPDU		Y	Only publisher's DLCEP-address as destination is included, there is no immediate retry. CD with peer 's DLCEP-address as destination address is ignored by the receiving DLE. See text for details.
7.5.4.1 Actions required of all DLEs		Y	(a), (b) are not included; (c) and (d) apply only to publisher; (e) is included. See text for details.
7.5.4.2 Additional actions required of a Link-Master class or Bridge class DLE	Y		
7.5.4.3 Additional actions required of a Bridge class DLE		Y	There is no immediate retry. See text for details.
7.5.4.4 Additional actions required of the current LAS DLE	Y		

7.5.1 Structure of the CD DLPDUs

All formats, but with null SD-parameter are included in this subset.

7.5.2 Content of the CD DLPDU

The destination address shall be DLCEP-address. The source address, if present shall be subscriber's DL-address.

7.5.2.1 Content of the CD DLPDU when specifying a destination DLSAP-address

This section does not apply.

7.5.2.2 Content of the CD DLPDU when specifying a destination DLCEP-address

When the first address is a DLCEP-address, as in [7.5.2(b)] and [7.5.2(c)], then

- a) this DLPDU shall request state information from the addressed DLCEP, and shall request that DLS-user data be included in the reply DLPDU, and
- b) the second address, if present, shall be a subscriber DLCEP's calling-DLSAP-address of the same DLC as the destination publisher DLCEP-address; and
- c) the SD-parameters field shall not be present; and
- d) the user data shall be null.

NOTE 3 Formats 1L and 1S are used for subscriber-to-publisher [7.5.2(c)] communications when the DLPDU-authentication attribute is SOURCE. Formats 2L and 2S are used for subscriber-to-publisher communications when the DLPDU-authentication attribute is ORDINARY.

7.5.3 Sending the CD DLPDU

A CD DLPDU may be selected for transmission on the link when

- a) the sending DLE holds a scheduler token or delegated token which is the dominant token on the local link, and
- b) the remaining allocated duration of token usage, C(RD), permits completion of the transactions prior to expiration of the token, where the transaction consists of sending the CD DLPDU that requires an immediate reply, and awaiting a worst-case SR DLPDU or worst-case permitted DT reply DLPDU containing DLS-user data.

If the DLE holds a delegated token, and no additional use of that token after sending this DLPDU and awaiting its immediate reply is needed at that time, then the DLE may set the final-token-use subfield of the CD DLPDU to the value FINAL; else that subfield shall have the value NOT-FINAL.

Each explicit DL-address in the CD DLPDU shall be delocalized [6.2.2] before transmission.

After sending a CD DLPDU, the sending DLE shall monitor the local link for a period of immediate-response-recovery-delay slot-times, $V(\text{IRRD}) \times V(\text{ST})$ octet-durations, waiting for a reply.

- i) If a PhL-indication [5.4.3] reporting DATA is received, then the DLE shall
 - stop further monitoring,
 - then wait for receipt of the PhL-indication reporting END-OF-DATA-AND-ACTIVITY or END-OF-ACTIVITY, and
 - then proceed as in (iv) or (v), as appropriate.
- ii) If (i) does not apply, and the monitoring period expires, then
 - A) If the bus is not active at that moment (that is, the last-received PhL-indication reported END-OF-ACTIVITY), then the DLE shall proceed as in (iii).
 - B) If (A) does not apply, implying that the link is still active at that moment (that is, the last-received PhL-indication reported START-OF-ACTIVITY), then the DLE shall monitor the local link for a period of one additional slot-time, $V(\text{ST})$ octet-durations, waiting for a PhL-indication:
 - a) If a PhL-indication reporting DATA is received, then the DLE shall proceed as in (i).
 - b) If a PhL-indication reporting END-OF-ACTIVITY is received, then the DLE shall stop further monitoring and proceed as in (iii).
 - c) If neither (a) nor (b) apply, and the monitoring period expires before a PhL-indication is received, then the DLE shall
 - wait for receipt of the PhL-indication reporting END-OF-DATA-AND-ACTIVITY or END-OF-ACTIVITY, and
 - then proceed as in (iv) or (v), as appropriate.
- iii) If (ii.A) or (ii.B.b) applied, then the sending DLE shall
 - report the failure to detect a valid reply to local DL-management, and
 - if the final-token-use subfield of the CD DLPDU specified NOT-FINAL, then the DLE shall start the next transmission within immediate-response-recovery-delay plus one slot-times, $(V(\text{IRRD}) + 1) \times V(\text{ST})$ octet-durations, of the end of transmission of the CD DLPDU.
- iv) If (i) or (ii.B.a) or (ii.B.c) applied and link activity did not result in a DLPDU, then the sending DLE shall
 - report the failure to detect a valid reply to local DL-management, and
 - if the final-token-use subfield of the CD DLPDU specified NOT-FINAL, then the DLE shall start the next transmission within maximum-reply-delay slot-times, $V(\text{MRD}) \times V(\text{ST})$ octet-durations, of the beginning of the current period of link non-activity.
- v) If the link activity resulted in a DLPDU, and if the received DLPDU was not either
 - a DT DLPDU without a destination DL-address, or

- an SR DLPDU,
then any held token shall be dropped and local DL-management shall be notified of the event.

NOTE 1: The received DLPDU is processed as specified in [7.7.4] and [7.8.4].

NOTE 2: These DL-management reports may take the form of incrementing a DL-management error counter.

7.5.4 Receiving the CD DLPDU

Each DL-address in the DLPDU shall be delocalized [6.2.2] upon reception.

A received CD DLPDU shall be treated as follows by the receiving DLE:

7.5.4.1 Actions required of all DLEs

NOTE 1: The clause (c) is included only for publisher DLCEP. For this subset, CD addressed to peer DLCEP is ignored.

- c) If the destination DL-address specified by the DLPDU designates an active DLCEP-address of a DLC for which the receiving DLE
 - is a publisher, and the DLL priority of the DLCEP is not equal to the priority specified in the received DLPDU, then the receiving DLE shall initiate a reply within a period of maximum-response-delay slot-times, $V(MRD) \times V(ST)$ octet-durations, of receipt of the CD DLPDU. The reply DLPDU shall be a DT DLPDU in the format negotiated for the DLC for the selected direction of transmission, and shall contain SD-parameters appropriate to the sending DLCEP, but shall not contain DLS-user-data.
 - is a peer, then the receiving DLE shall ignore the received DLPDU.
- d) If (c) does not apply, and the destination DL-address specified by the DLPDU designates an active DLCEP-address of a DLC for which the receiving DLE is a publisher, then
 - 2) The receiving DLE shall initiate a reply within a period of maximum-response-delay slot-times, $V(MRD) \times V(ST)$ octet-durations, of receipt of the CD DLPDU. The reply DLPDU shall be a DT DLPDU in the format negotiated for the DLC for the selected direction of transmission, shall contain SD-parameters appropriate to the sending DLCEP, and shall contain DLS-user-data if any was available and waiting for transmission or retransmission from the DLCEP.
- e) If the destination DL-address specified by the DLPDU designates an active DLCEP-address of a DLC for which the receiving DLE is a subscriber, then
 - 2) The receiving DLE shall record the destination DL-address from the received CD DLPDU in $V(RA)$ for subsequent association with the expected immediate reply DT DLPDU, which should be the next DLPDU received.
 - 3) The receiving DLE shall initiate a timer with a duration of immediate-response-recovery-delay slot-times, $V(IRRDR) \times V(ST)$ octet-durations.
 - i) If a PhL-indication [5.4.3] reporting DATA is received, then the DLE shall stop further monitoring and wait for receipt of the PhL-indication reporting END-OF-DATA-AND-ACTIVITY or END-OF-ACTIVITY and proceed as in (v).
 - ii) If the monitoring period expires, and the bus is not active at the end of this monitoring period, then the DLE shall stop further monitoring and proceed as in (iv).
 - iii) If the monitoring period expires, and the bus is active at the end of this monitoring period, then the DLE shall wait for receipt of the PhL-indication reporting END-OF-DATA-AND-ACTIVITY or END-OF-ACTIVITY, and then proceed as in (iv) or (v) as appropriate.
 - iv) If the monitoring did not result in a DLPDU as in (ii) or possibly in (iii), then the DLE shall invalidate $V(RA)$;
 - v) If the link activity resulted in a DLPDU as in (i) or possibly in (iii), and if the received DLPDU was a DT DLPDU whose source DL-address is implicitly or explicitly the destination DLCEP-address specified by the CD DLPDU, then the recorded address $V(RA)$ shall be assumed to be the implied source address of that CD DLPDU. Otherwise the recorded address $V(RA)$ shall be invalidated.

7.5.4.3 Additional actions required of a Bridge class DLE

- i) If the destination DL-address specified in the DLPDU is one which the bridge should forward but which the bridge DLE itself would not otherwise receive, then the bridge shall form and send an SR DLPDU,
 - within a period of maximum-response-delay slot-times, $V(MRD) \times V(ST)$ octet-durations, of receipt of the CD DLPDU,
 - with status indicating whether or not the bridge was able to buffer the received DLPDU.
- ii) If the destination DL-address specified in the DLPDU is one which the bridge should forward, and the bridge was able to receive and buffer the DLPDU without error, then the received DLPDU shall be forwarded with modification of the frame-control field in the forwarded DLPDU as appropriate [6.1.1.3].

It is a protocol error for a bridge DLE which will forward the received CD DLPDU to not send an SR reply DLPDU when a reply is required.

NOTE: At most one bridge DLE on the local link should be forwarding the received CD DLPDU.

7.7 DATA (DT) DLPDU

A DATA (DT) DLPDU is used to transfer a limited amount of transparent user data from one DLS-user to one or more other DLS-users; to acknowledge the transfer of such data; and to assist in the synchronization of DLCEPs and of DLS-users.

It is also used by a DLE to send an SPDU to one or more other DLEs.

	Included	Included (partially)	Comments
7.7.1 Structure of the DT DLPDUs		Y	Format 4 is not included.
7.7.2 Content of the DT DLPDU		Y	See subsections and the text for details.
7.7.2.1 Content of the DT DLPDU when specifying a destination DL(SAP)-address		Y	Clause (d) is not included.
7.7.2.2 Content of the DT DLPDU when specifying a destination or source DLCEP-address		Y	Subscriber to publisher DT DLPDU is not included.
7.7.3 Sending the DT DLPDU		Y	See subsections and the text for details.
7.7.3.1 Transmission when the reply token is dominant		Y	Only CD DLPDU with publisher's DLCEP-address as destination address is included.
7.7.3.2 Transmission when the delegated token is dominant	Y		
7.7.3.3 Transmission when the scheduler token is dominant	Y		
7.7.4 Receiving the DT DLPDU		Y	See subsections and the text for details.
7.7.4.1 Actions required of all DLEs		Y	See subsections and the text for details.
7.7.4.1.1 Actions required when the reply token was not dominant at start-of-reception		Y	Clause (b) is not included. In clause (c), subscriber to publisher DT DLPDU is not included.
7.7.4.1.2 Actions required when the reply token was dominant at start-of-reception and the receiving DLE sent the CD DLPDU which created the reply token		Y	Clauses (a), (b) and (c) are not included.
7.7.4.1.3 Actions required when the reply token was dominant at start-of-reception and the receiving DLE did not send the CD DLPDU which created the reply token		Y	Only CD DLPDU with publisher's DLCEP-address as destination address is included.
7.7.4.2 Additional actions required of a Link-Master class or Bridge class DLE	Y		
7.7.4.3 Additional actions required of a Bridge class DLE	Y		
7.7.4.3.1 Actions required when the reply token was dominant at start-of-reception and the receiving bridge DLE forwarded, but did not originate, the CD DLPDU which created the reply token	No		This is not included, because it applies only if the destination of CD DLPDU was DLSAP-address.
7.7.4.4 Additional actions required of the current LAS DLE	Y		

7.7.1 Structure of the DT DLPDUs

All formats, except format 4 of DT DLPDU are included in this subset.

7.7.2 Content of the DT DLPDU

The frame control field shall be encoded as specified in table 10.

Either the DL-addresses shall be

- the first a group DL-address and the second a DLSAP-address, or
- all DLSAP-addresses, or
- all DLCEP-addresses, or

7.7.2.1 Content of the DT DLPDU when specifying a destination DL(SAP)-address

When the first address is a group DL-address as in [7.7.2(a)], then

- If the DLPDU format is format 1L or 1S, then
 - the DLPDU is being used to implement the unitdata transfer service, and
 - the DL(SAP)-role for the destination DLSAP-address shall be GROUP; and
 - the DL(SAP)-role for the source DLSAP-address shall be BASIC; and
 - the SD-parameters field shall be null; and
 - the user data shall be a single DLSDU whose size is limited to the maximum size for the priority specified in [7.7.1.1(b)], and shall not be null.

- No other DLPDU format may be used.

When the addresses are DLSAP-addresses as in [7.7.2(b)], then

- If the DLPDU format is format 1L or 1S, then
 - this DLPDU is being used to implement the unitdata transfer service, and
 - the DL(SAP)-role for the destination DLSAP-address shall be BASIC; and
 - the DL(SAP)-role for the source DLSAP-address shall be BASIC; and
 - the SD-parameters field shall be null; and
 - the user data shall be a single DLSDU whose size is limited to the maximum size for the priority specified in [7.7.1.1(b)], and shall not be null.