

DIN EN 61158-4-11

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Ersatz für
DIN EN 61158-4-11:2008-09
Siehe Anwendungsbeginn

**Industrielle Kommunikationsnetze –
Feldbusse –
Teil 4-11: Protokollspezifikation des Data Link Layer
(Sicherheitsschicht) –
Typ 11-Elemente
(IEC 61158-4-11:2010);
Englische Fassung EN 61158-4-11:2012, nur auf CD-ROM**

Industrial communication networks –
Fieldbus specifications –
Part 4-11: Data-link layer protocol specification –
Type 11 elements
(IEC 61158-4-11:2010);
English version EN 61158-4-11:2012, only on CD-ROM

Réseaux de communication industriels –
Spécifications de bus de terrain –
Partie 4-11: Spécification du protocole de couche de liaison de données –
Éléments de Type 11
(CEI 61158-4-11:2010);
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DKE Deutsche Kommission Elektrotechnik Elektronik Informationstechnik im DIN und VDE

Anwendungsbeginn

Anwendungsbeginn für die von CENELEC am 2012-03-28 angenommene Europäische Norm als DIN-Norm ist 2013-01-01.

Für DIN EN 61158-4-11:2008-09 gilt eine Übergangsfrist bis zum 2015-03-28.

Nationales Vorwort

Vorausgegangener Norm-Entwurf: E DIN IEC 61158-400:2009-06.

Für dieses Dokument ist das nationale Arbeitsgremium K 956 „Feldbus“ der DKE Deutsche Kommission Elektrotechnik Elektronik Informationstechnik im DIN und VDE (www.dke.de) zuständig.

Die enthaltene IEC-Publikation wurde vom SC 65C „Industrial networks“ erarbeitet.

Das IEC-Komitee hat entschieden, dass der Inhalt dieser Publikation bis zu dem Datum (stability date) unverändert bleiben soll, das auf der IEC-Website unter „<http://webstore.iec.ch>“ zu dieser Publikation angegeben ist. Zu diesem Zeitpunkt wird entsprechend der Entscheidung des Komitees die Publikation

- bestätigt,
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- geändert.

Für den Fall einer undatierten Verweisung im normativen Text (Verweisung auf eine Norm ohne Angabe des Ausgabedatums und ohne Hinweis auf eine Abschnittsnummer, eine Tabelle, ein Bild usw.) bezieht sich die Verweisung auf die jeweils neueste gültige Ausgabe der in Bezug genommenen Norm.

Für den Fall einer datierten Verweisung im normativen Text bezieht sich die Verweisung immer auf die in Bezug genommene Ausgabe der Norm.

Der Zusammenhang der zitierten Normen mit den entsprechenden Deutschen Normen ergibt sich, soweit ein Zusammenhang besteht, grundsätzlich über die Nummer der entsprechenden IEC-Publikation. Beispiel: IEC 60068 ist als EN 60068 als Europäische Norm durch CENELEC übernommen und als DIN EN 60068 ins Deutsche Normenwerk aufgenommen.

Das Präsidium des DIN hat mit Präsidialbeschluss 1/2004 festgelegt, dass DIN-Normen, deren Inhalt sich auf internationale Arbeitsergebnisse der Informationsverarbeitung gründet, unter bestimmten Bedingungen allein in englischer Sprache veröffentlicht werden dürfen. Diese Bedingungen sind für die vorliegende Norm erfüllt.

Da sich die Benutzer der vorliegenden Norm der englischen Sprache als Fachsprache bedienen, wird die englische Fassung der EN 61158-4-11 veröffentlicht. Zu deren Abschnitt 3, der die Begriffe festlegt, wurde eine Übersetzung angefertigt und als informativer Nationaler Anhang NA der vorliegenden Norm hinzugefügt. Für viele der verwendeten Begriffe existieren keine gebräuchlichen deutschen Benennungen, da sich die deutschen Anwender in der Regel ebenfalls der englischen Benennungen bedienen. Diese Norm steht nicht in unmittelbarem Zusammenhang mit Rechtsvorschriften und ist nicht als Sicherheitsnorm anzusehen.

Einführung

Ein Feldbus ist ein digitaler serieller Datenbus für die Kommunikation zwischen Geräten der industriellen Automatisierungstechnik wie beispielsweise Messeinrichtungen, Stellgliedern, Reglern und speicherprogrammierbaren Steuerungen. Die Normen der Reihe DIN EN 61158 legen eine Anzahl von Feldbus-Protokolltypen fest. Die vorliegende Norm legt das Protokoll der Datensicherungsschicht von Typ 11 fest.

Erklärung zu Schutzrechten

Die Internationale Elektrotechnische Kommission macht darauf aufmerksam, dass ihr gegenüber erklärt wurde, dass die Übereinstimmung mit dem vorgesehenen Norm-Inhalt die Anwendung von Patenten erforderlich machen könnte. Nähere Informationen hierzu befinden sich in der „Introduction“.

Es wird darauf aufmerksam gemacht, dass Bestandteile der vorliegenden Norm Gegenstand von weiteren Patentrechten sein können. Es liegt nicht im Verantwortungsbereich der DKE, einige oder alle dieser Patentrechte zu benennen.

Der Leser der vorliegenden Norm wird jedoch gebeten, ihm bekannte derartige Patentrechte der Geschäftsstelle mitzuteilen und entsprechende Informationen zur Verfügung zu stellen.

Änderungen

Gegenüber DIN EN 61158-4-11:2008-09 wurden folgende Änderungen vorgenommen:

- a) Anpassungen in der Einleitung um Patente zur Schleifen (Loop)-Architektur hinzuzufügen
- b) Schleifen (Loop)-Architektur hinzugefügt
- c) weitere Einzelheiten:
- d) Unterabschnitt 4.4 erweitert, um in 4.4.3 die Schleifenarchitektur aufzunehmen.
- e) den Aufbau von 4.6 geändert, um die Schleifenarchitektur und weitere Datentypen aufzunehmen:
- f) in 4.6.1 einen Überblick hinzugefügt;
- g) 4.6.1.2 Zusammenfassung der Variablen der vorhandenen Sternarchitektur hinzugefügt;
- h) 4.6.1.2 Zusammenfassung der Variablen der zusätzlichen Schleifenarchitektur hinzugefügt;
- i) in 4.6.2 allgemeine Variablen, Parameter, Zähler, Timer und Warteschlangen hinzugefügt;
- j) in 4.6.3 Variablen, Parameter, Zähler, Timer und Warteschlangen für die Sternarchitektur hinzugefügt;
- k) in 4.6.3 Variablen, Parameter, Zähler, Timer und Warteschlangen für die Schleifenarchitektur hinzugefügt.
- l) alle Variablen, Parameter, Zähler, Timer und Warteschlangen alphabetisch sortiert.
- m) zur Aufnahme der Schleifenarchitektur 5.4 geändert.
- n) zur Aufnahme der Schleifenarchitektur Abschnitt 6 geändert.
- o) die in einem Bild verwendeten Symbole werden jetzt außerhalb dessen in einer Legende erklärt.
- p) zur Aufnahme der Schleifenarchitektur folgende Änderungen in Abschnitt 7:
- q) die DLE-Prozedurelemente verbleiben in 7.1, nachdem der Aufbau ohne Änderung der bestehenden Spezifikation geändert wurde;
- r) DLE-Prozedurelemente für die Schleifenarchitektur in 7.2 hinzugefügt;
- s) Serialisierer und Deserialisierer verbleiben in 7.3 nach dessen Neuaufbau;
- t) das DLL-Managementprotokoll verbleibt in 7.4 nach dessen Neuaufbau
- u) das DLL-Managementprotokoll für die Sternarchitektur verbleibt in 7.4.1 ohne Änderung,
- v) das DLL-Managementprotokoll für die Schleifenarchitektur in 7.4.2 hinzugefügt.

Frühere Ausgaben

DIN V 19245-1: 1988-01
 DIN 19245-1: 1991-04
 DIN 19245-2: 1991-04
 DIN EN 50170/1: 1997-07
 DIN EN 50170/2: 1997-07
 DIN EN 50170/3: 1997-07

DIN EN 50254: 1999-07
DIN EN 50170/A2: 2000-08
DIN EN 50170/A1: 2002-11
DIN EN 50170/A3: 2002-11
DIN EN 61158-4: 2005-05
DIN EN 61158-4-11: 2008-09

Nationaler Anhang NA (informativ)

3.3 Begriffe

3.3.1

allgemeiner Speicher

(en: **common memory**)

virtueller allgemeiner Speicher für den Feldbus Typ 11, der von den teilnehmenden Typ-11-Feldbusknoten gemeinsam genutzt wird und vorrangig für Echtzeit-Kommunikationen des zeitkritischen zyklischen Datendienstes verwendet wird

3.3.2

Daten-DLPDU

(en: **data DLPDU**)

DLPDU, die eine DLSDU von einem lokalen DLS-Benutzer an einen entfernten DLS-Benutzer überträgt

3.3.3

DLCEP-Adresse

(en: **DLCEP-address**)

DL-Adresse, die entweder

- a) einen DL-Verbindungsendpunkt von einem Peer oder
- b) einen DL-Verbindungsendpunkt von mehreren Peer-Publishern und implizit den entsprechenden Satz von Verbindungsendpunkten der DL-Subscriber kennzeichnet, wobei jeder DL-Verbindungsendpunkt innerhalb eines eindeutigen DLSAP vorhanden ist und einer entsprechenden eindeutigen DLSAP-Adresse zugeordnet ist

3.3.4

DL-Segment, Verbindungszweig, lokaler Verbindungszweig

(en: **DL-segment, link, local link**)

einzelnes DL-Subnetzwerk, in dem alle angeschlossenen DLEs direkt, d. h. ohne zwischengeschaltete DL-Weitergabe, kommunizieren können, solange alle an einem Kommunikationsvorgang teilnehmenden DLEs während der Dauer(n) der Kommunikationsversuche gleichzeitig auf das DL-Subnetzwerk reagieren können

3.3.5 ^{N1)}

DLSAP

(en: **DLSAP**)

eindeutiger Punkt, an dem eine einzelne DL-Instanz einer einzelnen Instanz auf höherer Schicht DL-Dienste bereitstellt

ANMERKUNG Diese von ISO/IEC 7498-1 abgeleitete Definition wird an dieser Stelle wiederholt, um den entscheidenden Unterschied zwischen DLSAPs und deren DL-Adressen besser verstehen zu können. (Siehe Bild 1.)

^{N1)} Nationale Fußnote: Der Begriff IEC 61158-4-11:2013, 3.3.6 ist identisch mit Begriff 3.3.5 und deshalb in der vorliegenden Übernahme dieser Internationalen Norm weggelassen.

3.3.7**DL(SAP)-Adresse****(en: DL(SAP)-address)**

entweder eine individuelle DLSAP-Adresse, die einen einzelnen DLSAP eines einzelnen DLS-Benutzers kennzeichnet, oder eine DL-Gruppenadresse, die möglicherweise mehrere DLSAPs jeweils eines einzelnen DLS-Benutzers kennzeichnet

ANMERKUNG Diese Terminologie wird gewählt, da ISO/IEC 7498-3 die Verwendung der Benennung „DLSAP-Adresse“ zur Bezeichnung von mehr als einem einzelnen DLSAP bei einem einzelnen DLS-Benutzer nicht zulässt.

3.3.8**(individuelle) DLSAP-Adresse****(en: (individual) DLSAP-address)**

DL-Adresse, die nur einen DLSAP innerhalb des erweiterten Verbindungszweiges kennzeichnet

ANMERKUNG Eine einzelne DL-Instanz kann mehrere DLSAP-Adressen, die einem einzelnen DLSAP zugeordnet sind, besitzen.

3.3.9**erweiterter Verbindungszweig****(en: extended link)**

DL-Subnetzwerk, das aus der maximalen Menge von Verbindungszweigen besteht, die über DL-Relais-Instanzen geschaltet werden können, wobei ein einziger DL-Namensraum (DL-Adressraum) gemeinsam genutzt wird; in diesem Subnetzwerk können alle angeschlossenen DL-Instanzen miteinander entweder direkt oder mithilfe einer oder mehrerer der zwischengeschalteten DL-Relais-Instanzen kommunizieren.

ANMERKUNG Ein erweiterter Verbindungszweig besteht möglicherweise aus nur einem einzelnen Verbindungszweig.

3.3.10**FCS-Fehler****(en: FCS error)**

Fehler, der auftritt, wenn der berechnete Wert der Blockprüfzeichenfolge nach Empfang aller Oktette in einer DLPDU nicht mit dem erwarteten Rest übereinstimmt

3.3.11**Rahmen****(en: frame)**

abwertendes Synonym für DLPDU

3.3.12**DL-Gruppenadresse****(en: group DL-address)**

DL-Adresse, die möglicherweise mehr als einen DLSAP innerhalb des erweiterten Verbindungszweiges kennzeichnet. Eine einzelne DL-Instanz kann mehrere DL-Gruppenadressen, die einem einzelnen DLSAP zugeordnet sind, besitzen. Eine einzelne DL-Instanz kann auch eine einzelne DL-Gruppenadresse, die mehr als einem DLSAP zugeordnet ist, besitzen

3.3.13**zyklische Hochgeschwindigkeitsdaten****(en: high-speed cyclic data)**

Daten, die mithilfe von zyklischer Hochgeschwindigkeits-Datenübertragung übermittelt werden

3.3.14**zyklische Hochgeschwindigkeits-Datenübertragung****(en: high-speed cyclic data transmission)**

höchste Priorität des zeitkritischen zyklischen Datendienstes

3.3.15

implizites Token (en: **implicit token**)

Mechanismus, der das Recht zur Übertragung steuert

ANMERKUNG Über das Medium wird keine eigentliche Token-Nachricht übertragen. Jeder Knoten verfolgt den Knoten, von dem er annimmt, dass dieser derzeit das Recht zur Übertragung hat. Das Recht zur Übertragung wird von Knoten zu Knoten weitergegeben, wobei der Knoten, der zuletzt übertragen hat, aufgezeichnet wird. Damit ein fehlender Knoten im Kreislauf übersprungen werden kann, wird ein Zeitfenster verwendet.

3.3.16

zyklische Niedriggeschwindigkeitsdaten (en: **low-speed cyclic data**)

Daten, die mithilfe von zyklischer Niedriggeschwindigkeits-Datenübertragung übermittelt werden

3.3.17

zyklische Niedriggeschwindigkeits-Datenübertragung (en: **low-speed cyclic data transmission**)

niedrigste Priorität des zeitkritischen zyklischen Datendienstes

3.3.18

zyklische Mediengeschwindigkeitsdaten (en: **medium-speed cyclic data**)

Daten, die mithilfe von zyklischer Mediengeschwindigkeits-Datenübertragung übermittelt werden

3.3.19

zyklische Mediengeschwindigkeits-Datenübertragung (en: **medium-speed cyclic data transmission**)

zweithöchste Priorität des zeitkritischen zyklischen Datendienstes

3.3.20

Multi-Peer-DLC (en: **multi-peer DLC**)

zentralisierte DL-Verbindung mit mehreren Endpunkten, die eine DL-Duplex-Übertragung zwischen einem einzelnen definierten DLS-Benutzer, auch bekannt als Publisher oder veröffentlichender DLS-Benutzer, und einer Menge von Peers, die jedoch nicht definierten DLS-Benutzern entsprechen, die in ihrer Gesamtheit als Subscriber oder abonnierende DLS-Benutzer bekannt sind, anbietet. Der veröffentlichende DLS-Benutzer kann Daten an die abonnierenden DLS-Benutzer als Gruppe (jedoch nicht einzeln) senden, und die abonnierenden DLS-Benutzer können Daten an den veröffentlichenden DLS-Benutzer (jedoch sich nicht gegenseitig) senden.

3.3.21

Mehrpunktverbindung (en: **multipoint connection**)

Verbindung von einem Knoten zu vielen Knoten

ANMERKUNG Durch Mehrpunktverbindungen kann der Datentransfer von einem einzelnen Publisher von vielen Subscriber-Knoten empfangen werden.

3.3.22

Knoten (en: **node**)

einzelne DL-Instanz, wie sie auf einem lokalen Verbindungszweig existiert

3.3.23

DL-Adresse des Knotens (en: **node DL-address**)

DL-Adresse, die die (einzelne) DL-Instanz kennzeichnet, die einem einzelnen Knoten auf einem spezifischen lokalen Verbindungszweig zugeordnet ist

3.3.24**Knoten-ID****(en: node-id)**

primäre Kennung aus zwei Oktetten für die DLE auf dem lokalen Verbindungszweig, deren Werte beschränkt sind

ANMERKUNG Ein zulässiger Wert liegt zwischen 1 und 255. Der Wert 0 wird speziell für den SYN-Knoten, der den SYN-Rahmen ausgibt, verwendet.

3.3.25**empfangender DLS-Benutzer****(en: receiving DLS-user)**

Benutzer der DL-Dienste, der als Empfänger von DL-Benutzerdaten agiert

ANMERKUNG Ein Benutzer der DL-Dienste kann gleichzeitig sendender und empfangender DLS-Benutzer sein.

3.3.26**sendender DLS-Benutzer****(en: sending DLS-user)**

Benutzer der DL-Dienste, der als Quelle von DL-Benutzerdaten agiert

3.3.27**Zeitfenster****(en: slot-time)**

512-Bit-Zeit des physikalischen Signalisierungssymbols, festgelegt in ISO/IEC 8802-3, Abschnitt 29

3.3.28**sporadischer Nachrichtendatendienst****(en: sporadic message data service)**

aperiodischer Nachrichtentransfer, der auf Anforderung eines DLS-Benutzers zur Übertragung einer oder mehrerer Nachrichten sporadisch auftritt; der regelmäßige Ethernet-Nachrichtenrahmen nach ISO/IEC 8802-2 wird mithilfe dieses Nachrichtentransfers übertragen

3.3.29**SYN-Knoten****(en: SYN node)**

Knoten, der den SYN-Rahmen überträgt

3.3.30**zeitkritischer zyklischer Datendienst****(en: time-critical cyclic data service)**

zyklischer Datentransfer mit drei gleichzeitigen Stufen der Datenübertragung, wobei jede Datenübertragungsstufe der Datenpriorität und der Datenübertragungsdauer für eine Echtzeit-Übertragung entspricht und die Datenübertragungsdauer sowie das Gesamtdatenvolumen für jede Stufe in der Entwurfsphase und entsprechend den Anwendungsanforderungen festgelegt werden kann

3.3.31**Token****(en: token)**

Recht zur Übertragung auf dem lokalen Verbindungszweig

– Leerseite –

**Industrial communication networks -
Fieldbus specifications -
Part 4-11: Data-link layer protocol specification -
Type 11 elements
(IEC 61158-4-11:2010)**

Réseaux de communication industriels -
Spécifications de bus de terrain -
Partie 4-11: Spécification du protocole de
couche de liaison de données -
Éléments de Type 11
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Industrielle Kommunikationsnetze -
Feldbusse -
Teil 4-11: Protokollspezifikation des
Data Link Layer (Sicherheitsschicht) -
Typ 11-Elemente
(IEC 61158-4-11:2010)

This European Standard was approved by CENELEC on 2012-03-28. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CENELEC member.

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CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

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Foreword

The text of document 65C/605/FDIS, future edition 2 of IEC 61158-4-11, prepared by SC 65C, "Industrial networks", of IEC/TC 65, "Industrial-process measurement, control and automation" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN 61158-4-11:2012.

The following dates are fixed:

- latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2012-12-28
- latest date by which the national standards conflicting with the document have to be withdrawn (dow) 2015-03-28

This document supersedes EN 61158-4-11:2008.

EN 61158-4-11:2012 includes the following significant technical changes with respect to EN 61158-4-11:2008:

- Introduction has been modified to add the patents related to the loop-architecture
- Addition of loop (ring) -architecture
- More details:
 - Subclause 4.4 is extended to cover the loop-architecture as 4.4.3.
 - Subclause 4.6; structure has changed in order to include the loop-architecture, and the data types of variables have been added:
 - 4.6.1 Overview;
 - 4.6.1.2 Summary of variables of existing star-architecture;
 - 4.6.1.3 Summary of variables of additional loop-architecture;
 - 4.6.2 Type 11 common variables, parameters, counters, timers and queues;
 - 4.6.3 Star-architecture specific variables, parameters, counters, timers and queues;
 - 4.6.4 Loop-architecture specific variables, parameters, counters, timers and queues.
 - All variables, parameters, counters, timers and queues are rearranged in alphabetical order.
 - Subclause 5.4 is modified to cover the loop-architecture.
 - Clause 6 is modified to cover the loop-architecture.
 - Explanations of symbols referenced in each figure are modified to appear in the form of Key out of each figure object.
 - Clause 7 is changed in the structure for inclusion and extension of the loop architecture as follows:
 - DLE elements of procedure for existing star-architecture are maintained in 7.1 after restructuring with no change to the existing specification;
 - DLE elements of procedure for loop-architecture are added in 7.2;
 - Serializer and deserializer is maintained in 7.3 after restructuring;
 - DLL management protocol is in 7.4 after restructuring, and
 - DLL management protocol for star-architecture is maintained in 7.4.1 without change,
 - DLL management protocol for loop-architecture is added in 7.4.2.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CENELEC [and/or CEN] shall not be held responsible for identifying any or all such patent rights.

Endorsement notice

The text of the International Standard IEC 61158-4-11:2010 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following note has to be added for the standard indicated:

IEC/TR 61158-1:2010 NOTE Harmonized as CLC/TR 61158-1:2010 (not modified).

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INTRODUCTION

This part of IEC 61158 is one of a series produced to facilitate the interconnection of automation system components. It is related to other standards in the set as defined by the “three-layer” fieldbus reference model described in IEC/TR 61158-1.

The data-link protocol provides the data-link service by making use of the services available from the physical layer. The primary aim of this standard is to provide a set of rules for communication expressed in terms of the procedures to be carried out by peer data-link entities (DLEs) at the time of communication. These rules for communication are intended to provide a sound basis for development in order to serve a variety of purposes:

- a) as a guide for implementors and designers;
- b) for use in the testing and procurement of equipment;
- c) as part of an agreement for the admittance of systems into the open systems environment;
- d) as a refinement to the understanding of time-critical communications within OSI.

This standard is concerned, in particular, with the communication and interworking of sensors, effectors and other automation devices. By using this standard together with other standards positioned within the OSI or fieldbus reference models, otherwise incompatible systems may work together in any combination.

NOTE Use of some of the associated protocol types is restricted by their intellectual-property-right holders. In all cases, the commitment to limited release of intellectual-property-rights made by the holders of those rights permits a particular data-link layer protocol type to be used with physical layer and application layer protocols in Type combinations as specified explicitly in the profile parts. Use of the various protocol types in other combinations may require permission from their respective intellectual-property-right holders.

The International Electrotechnical Commission (IEC) draws attention to the fact that it is claimed that compliance with this document may involve the use of patents concerning Type 11 elements and possibly other types given in the subclause 4.2, 4.4, 4.5, 5.4, 6.2 to 6.10, 7.1 and 7.2 as follows:

US 4,930,121 [TO] Network system using token-passing bus with multiple priority levels

US 5,414,813 [TO] Direct transfer from a receive buffer to a host in a token-passing type network data transmission system

US 6,711,131 [TO] Data transmitting apparatus, network interface apparatus, and data transmitting system

PCT/JP2007/55292 [TO] Double ring network system, communication control method thereof, transmission station, and communication control program of double ring network system

JP 3,461,954 [TO] Data transmission system

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INDUSTRIAL COMMUNICATION NETWORKS – FIELDBUS SPECIFICATIONS –

Part 4-11: Data-link layer protocol specification – Type 11 elements

1 Scope

1.1 General

The data-link layer provides basic time-critical messaging communications between devices in an automation environment.

This protocol provides communication opportunities to all participating data-link entities

- a) in a synchronously-starting cyclic manner, according to a pre-established schedule, and
- b) in a cyclic or acyclic asynchronous manner, as requested each cycle by each of those data-link entities.

Thus this protocol can be characterized as one which provides cyclic and acyclic access asynchronously but with a synchronous restart of each cycle.

1.2 Specifications

This standard specifies

- a) procedures for the timely transfer of data and control information from one data-link user entity to a peer user entity, and among the data-link entities forming the distributed data-link service provider;
- b) procedures for giving communications opportunities to all participating DL-entities, sequentially and in a cyclic manner for deterministic and synchronized transfer at cyclic intervals up to one millisecond;
- c) procedures for giving communication opportunities available for time-critical data transmission together with non-time-critical data transmission without prejudice to the time-critical data transmission;
- d) procedures for giving cyclic and acyclic communication opportunities for time-critical data transmission with prioritized access;
- e) procedures for giving communication opportunities based on standard ISO/IEC 8802-3 medium access control, with provisions for nodes to be added or removed during normal operation;
- f) the structure of the fieldbus DLPDUs used for the transfer of data and control information by the protocol of this standard, and their representation as physical interface data units.

1.3 Procedures

The procedures are defined in terms of

- a) the interactions between peer DL-entities (DLEs) through the exchange of fieldbus DLPDUs;
- b) the interactions between a DL-service (DLS) provider and a DLS-user in the same system through the exchange of DLS primitives;
- c) the interactions between a DLS-provider and a Ph-service provider in the same system through the exchange of Ph-service primitives.

1.4 Applicability

These procedures are applicable to instances of communication between systems which support time-critical communications services within the data-link layer of the OSI or fieldbus reference models, and which require the ability to interconnect in an open systems interconnection environment.

Profiles provide a simple multi-attribute means of summarizing an implementation's capabilities, and thus its applicability to various time-critical communications needs.

1.5 Conformance

This standard also specifies conformance requirements for systems implementing these procedures. This standard does not contain tests to demonstrate compliance with such requirements.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 61158-3-11:2007, *Industrial communication networks – Fieldbus specifications – Part 3-11: Data-link layer service definition – Type 11 elements*

IEC 61158-5-11:2007, *Industrial communication networks – Fieldbus specifications – Part 5-11: Application layer service definition – Type 11 elements*

IEC 61158-6-11:2007, *Industrial communication networks – Fieldbus specifications – Part 6-11: Application layer protocol specification – Type 11 elements*

ISO/IEC 7498-1, *Information technology – Open Systems Interconnection – Basic Reference Model: The Basic Model*

ISO/IEC 7498-3, *Information technology – Open Systems Interconnection – Basic Reference Model: Naming and addressing*

ISO/IEC 8802-3:2000, *Information technology – Telecommunications and information exchange between systems – Local and metropolitan area networks – Specific requirements – Part 3: Carrier sense multiple access with collision detection (CSMA/CD) access method and Physical Layer specifications*

ISO/IEC 10731, *Information technology – Open Systems Interconnection – Basic Reference Model – Conventions for the definition of OSI services*

3 Terms, definitions, symbols and abbreviations

For the purposes of this document, the following terms, definitions, symbols and abbreviations apply.

3.1 Reference model terms and definitions

This standard is based in part on the concepts developed in ISO/IEC 7498-1 and ISO/IEC 7498-3, and makes use of the following terms defined therein.

3.1.1	called-DL-address	[ISO/IEC 7498-3]
3.1.2	calling-DL-address	[ISO/IEC 7498-3]
3.1.3	centralized multi-end-point-connection	[ISO/IEC 7498-1]
3.1.4	correspondent (N)-entities	[ISO/IEC 7498-1]
	correspondent DL-entities (N=2)	
	correspondent Ph-entities (N=1)	
3.1.5	demultiplexing	[ISO/IEC 7498-1]

3.1.6	DL-address	[ISO/IEC 7498-3]
3.1.7	DL-address-mapping	[ISO/IEC 7498-1]
3.1.8	DL-connection	[ISO/IEC 7498-1]
3.1.9	DL-connection-end-point	[ISO/IEC 7498-1]
3.1.10	DL-connection-end-point-identifier	[ISO/IEC 7498-1]
3.1.11	DL-connection-mode transmission	[ISO/IEC 7498-1]
3.1.12	DL-connectionless-mode transmission	[ISO/IEC 7498-1]
3.1.13	DL-data-sink	[ISO/IEC 7498-1]
3.1.14	DL-data-source	[ISO/IEC 7498-1]
3.1.15	DL-duplex-transmission	[ISO/IEC 7498-1]
3.1.16	DL-facility	[ISO/IEC 7498-1]
3.1.17	DL-local-view	[ISO/IEC 7498-3]
3.1.18	DL-name	[ISO/IEC 7498-3]
3.1.19	DL-protocol	[ISO/IEC 7498-1]
3.1.20	DL-protocol-connection-identifier	[ISO/IEC 7498-1]
3.1.21	DL-protocol-control-information	[ISO/IEC 7498-1]
3.1.22	DL-protocol-data-unit	[ISO/IEC 7498-1]
3.1.23	DL-protocol-version-identifier	[ISO/IEC 7498-1]
3.1.24	DL-relay	[ISO/IEC 7498-1]
3.1.25	DL-service-connection-identifier	[ISO/IEC 7498-1]
3.1.26	DL-service-data-unit	[ISO/IEC 7498-1]
3.1.27	DL-simplex-transmission	[ISO/IEC 7498-1]
3.1.28	DL-subsystem	[ISO/IEC 7498-1]
3.1.29	DL-user-data	[ISO/IEC 7498-1]
3.1.30	flow control	[ISO/IEC 7498-1]
3.1.31	layer-management	[ISO/IEC 7498-1]
3.1.32	multiplexing	[ISO/IEC 7498-3]
3.1.33	naming-(addressing)-authority	[ISO/IEC 7498-3]
3.1.34	naming-(addressing)-domain	[ISO/IEC 7498-3]
3.1.35	naming-(addressing)-subdomain	[ISO/IEC 7498-3]
3.1.36	(N)-entity	[ISO/IEC 7498-1]
	DL-entity	
	Ph-entity	

3.1.37	(N)-interface-data-unit DL-service-data-unit (N=2) Ph-interface-data-unit (N=1)	[ISO/IEC 7498-1]
3.1.38	(N)-layer DL-layer (N=2) Ph-layer (N=1)	[ISO/IEC 7498-1]
3.1.39	(N)-service DL-service (N=2) Ph-service (N=1)	[ISO/IEC 7498-1]
3.1.40	(N)-service-access-point DL-service-access-point (N=2) Ph-service-access-point (N=1)	[ISO/IEC 7498-1]
3.1.41	(N)-service-access-point-address DL-service-access-point-address (N=2) Ph-service-access-point-address (N=1)	[ISO/IEC 7498-1]
3.1.42	peer-entities	[ISO/IEC 7498-1]
3.1.43	Ph-interface-control-information	[ISO/IEC 7498-1]
3.1.44	Ph-interface-data	[ISO/IEC 7498-1]
3.1.45	primitive name	[ISO/IEC 7498-3]
3.1.46	reassembling	[ISO/IEC 7498-1]
3.1.47	recombining	[ISO/IEC 7498-1]
3.1.48	reset	[ISO/IEC 7498-1]
3.1.49	responding-DL-address	[ISO/IEC 7498-3]
3.1.50	routing	[ISO/IEC 7498-1]
3.1.51	segmenting	[ISO/IEC 7498-1]
3.1.52	sequencing	[ISO/IEC 7498-1]
3.1.53	splitting	[ISO/IEC 7498-1]
3.1.54	synonymous name	[ISO/IEC 7498-3]
3.1.55	systems-management	[ISO/IEC 7498-1]

3.2 Service convention terms and definitions

This standard also makes use of the following terms defined in ISO/IEC 10731 as they apply to the data-link layer:

- 3.2.1 acceptor
- 3.2.2 asymmetrical service
- 3.2.3 confirm (primitive);
requestor.deliver (primitive)
- 3.2.4 deliver (primitive)
- 3.2.5 DL-confirmed-facility
- 3.2.6 DL-facility
- 3.2.7 DL-local-view
- 3.2.8 DL-mandatory-facility
- 3.2.9 DL-non-confirmed-facility
- 3.2.10 DL-provider-initiated-facility
- 3.2.11 DL-provider-optional-facility
- 3.2.12 DL-service-primitive;
primitive
- 3.2.13 DL-service-provider
- 3.2.14 DL-service-user
- 3.2.15 DL-user-optional-facility
- 3.2.16 indication (primitive)
acceptor.deliver (primitive)
- 3.2.17 multi-peer
- 3.2.18 request (primitive);
requestor.submit (primitive)
- 3.2.19 requestor
- 3.2.20 response (primitive);
acceptor.submit (primitive)
- 3.2.21 submit (primitive)
- 3.2.22 symmetrical service

3.3 Terms and definitions

3.3.1

common memory

virtual common memory over Type 11 fieldbus, which is shared by participating Type 11 fieldbus nodes and is primarily used for real-time communications by the time-critical cyclic data service

3.3.2

data DLPDU

DLPDU that carries a DLSDU from a local DLS-user to a remote DLS-user

3.3.3

DLCEP-address

DL-address which designates either

- a) one peer DL-connection-end-point, or
- b) one multi-peer publisher DL-connection-end-point and implicitly the corresponding set of subscriber DL-connection-end-points where each DL-connection-end-point exists within a distinct DLSAP and is associated with a corresponding distinct DLSAP-address

3.3.4

DL-segment, link, local link

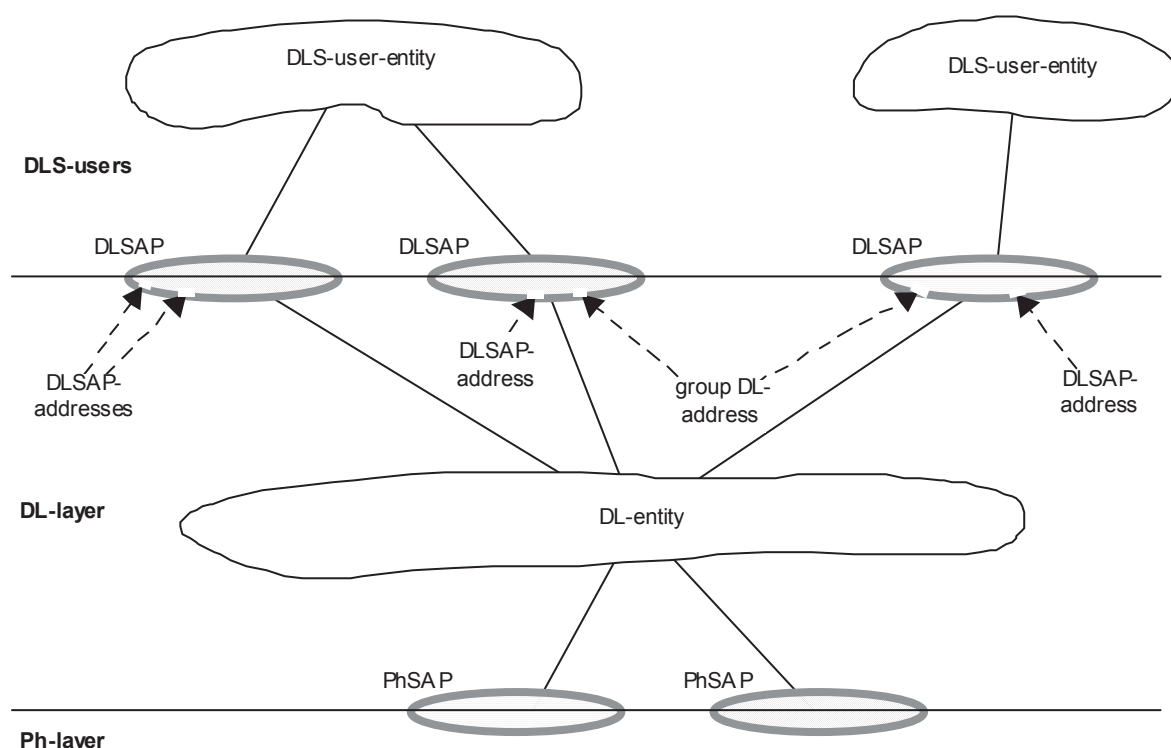
single DL-subnetwork in which any of the connected DLEs may communicate directly, without any intervening DL-relaying, whenever all of those DLEs that are participating in an instance of communication are simultaneously attentive to the DL-subnetwork during the period(s) of attempted communication

3.3.5

DLSAP

distinctive point at which DL-services are provided by a single DL-entity to a single higher-layer entity

NOTE This definition, derived from ISO/IEC 7498-1, is repeated here to facilitate understanding of the critical distinction between DLSAPs and their DL-addresses. (See Figure 1)



NOTE 1 DLSAPs and PhSAPs are depicted as ovals spanning the boundary between two adjacent layers.

NOTE 2 DL-addresses are depicted as designating small gaps (points of access) in the DLL portion of a DLSAP.

NOTE 3 A single DL-entity may have multiple DLSAP-addresses and group DL-addresses associated with a single DLSAP.

Figure 1 – Relationships of DLSAPs, DLSAP-addresses and group DL-addresses

3.3.6

DLSAP

distinctive point at which DL-services are provided by a single DL-entity to a single higher-layer entity

NOTE This definition, derived from ISO/IEC 7498-1, is repeated here to facilitate understanding of the critical distinction between DLSAPs and their DL-addresses. (See Figure 1)

3.3.7

DL(SAP)-address

either an individual DLSAP-address, designating a single DLSAP of a single DLS-user, or a group DL-address potentially designating multiple DLSAPs, each of a single DLS-user

NOTE This terminology is chosen because ISO/IEC 7498-3 does not permit the use of the term DLSAP-address to designate more than a single DLSAP at a single DLS-user.

3.3.8 **(individual) DLSAP-address**

DL-address that designates only one DLSAP within the extended link

NOTE A single DL-entity may have multiple DLSAP-addresses associated with a single DLSAP.

3.3.9 **extended link**

DL-subnetwork, consisting of the maximal set of links interconnected by DL-relays, sharing a single DL-name (DL-address) space, in which any of the connected DL-entities may communicate, one with another, either directly or with the assistance of one or more of those intervening DL-relay entities

NOTE An extended link may be composed of just a single link.

3.3.10 **FCS error**

error that occurs when the computed frame check sequence value after reception of all the octets in a DLPDU does not match the expected residual

3.3.11 **frame**

denigrated synonym for DLPDU

3.3.12 **group DL-address**

DL-address that potentially designates more than one DLSAP within the extended link. A single DL-entity may have multiple group DL-addresses associated with a single DLSAP. A single DL-entity also may have a single group DL-address associated with more than one DLSAP

3.3.13 **high-speed cyclic data**

data conveyed by means of high-speed cyclic data transmission

3.3.14 **high-speed cyclic data transmission**

highest priority of time-critical cyclic data service

3.3.15 **implicit token**

mechanism that governs the right to transmit

NOTE No actual token message is transmitted on the medium. Each node keeps track of the node that it believes currently holds the right to transmit. The right to transmit is passed from node to node by keeping the node that last transmitted. A slot time is used to allow a missing node to be skipped in the rotation.

3.3.16 **low-speed cyclic data**

data conveyed by means of low-speed cyclic data transmission

3.3.17 **low-speed cyclic data transmission**

lowest priority of time-critical cyclic data service

3.3.18 **medium-speed cyclic data**

data conveyed by means of medium-speed cyclic data transmission

3.3.19
medium-speed cyclic data transmission
second-highest priority of time-critical cyclic data service

3.3.20
multi-peer DLC
centralized multi-end-point DL-connection offering DL-duplex-transmission between a single distinguished DLS-user known as the publisher or publishing DLS-user, and a set of peer but undistinguished DLS-users known collectively as the subscribers or subscribing DLS-users. The publishing DLS-user can send to the subscribing DLS-users as a group (but not individually), and the subscribing DLS-users can send to the publishing DLS-user (but not to each other)

3.3.21
multipoint connection
connection from one node to many nodes

NOTE Multipoint connections allows data transfer from a single publisher to be received by many subscriber nodes.

3.3.22
node
single DL-entity as it appears on one local link

3.3.23
node DL-address
DL-address which designates the (single) DL-entity associated with a single node on a specific local link

3.3.24
node-id
two-octet primary identifier for the DLE on the local link, whose values are constrained

NOTE A permissible value is from 1 to 255. A value 0 is specifically used for SYN node, which emits SYN frame.

3.3.25
receiving DLS-user
DL-service user that acts as a recipient of DL-user-data

NOTE A DL-service user can be concurrently both a sending and receiving DLS-user.

3.3.26
sending DLS-user
DL-service user that acts as a source of DL-user-data

3.3.27
slot-time
512-bit time of the physical signaling symbol specified in the ISO/IEC 8802-3, Clause 29

3.3.28
sporadic message data service
aperiodic message transfer which sporadically occurs upon DLS-user requesting one or more message to transfer, and regular ISO/IEC 8802-3 Ethernet message frame is transferred by means of this message transfer

3.3.29
SYN node
node transmitting SYN frame

3.3.30
time-critical cyclic data service
cyclic data transfer with three levels of data transmission at the same time, of which each data transmission level is according to the data priority and the data transmission period for real-time delivery, and of which data

transmission period and total data volume for each level can be specified in designing phase and on application needs

3.3.31

token

right to transmit on the local link

3.4 Symbols and abbreviations

ACM	Access control machine
CLM	Claim frame
CMP	Transmission complete frame
CTRC	Cyclic-transmission TX/RX control
COM	Command frame
DT	Cyclic data frame
CW	Control word (as parameter of SYN DLPDU)
DT-CMP	DT with transmission complete frame
FC	Frame control field
LL	Live list (as parameter of SYN DLPDU)
PhIDU	Ph-interface-data-unit
PM	Periodic mode (as parameter of SYN DLPDU)
PN	Transmission permits node number (as parameter of SYN DLPDU)
Pri	Priority field
RAS	RAS frame
REC	In-ring request frame
RMC	Redundancy medium control
RMSEL	Redundant medium selection
RN	Recipient node number
SN	Source node number field
ST	Slot time (as parameter of SYN DLPDU)
SYN	Synchronization frame
Th	High-speed transmission period (as transmission period)
Tm	Medium-speed transmission period (as transmission period)
Ts	Sporadic-speed transmission period (as transmission period)
TI	Low-speed transmission period (as transmission period)

4 Overview of the DL-protocol

4.1 General

This standard meets the industrial automation market objective of providing predictable time deterministic and reliable time-critical data transfer and means, which allow co-existence with non-time-critical data transfer over the ISO/IEC 8802-3 series communications medium, for support of cooperation and synchronization between automation processes on field devices in a real-time application system. The term "time-critical" is used to represent the presence of a time-window, within which one or more specified actions are required to be completed with some defined level of certainty.

4.1.1 Field of applications

In industrial control systems, several kinds of field devices such as Drives, Sensors and Actuators, Programmable controllers, Distributed Control Systems and Human Machine Interface devices are required to be connected with control networks. The process control data and the state data is transferred among these field devices in the system and the communications between these field devices requires simplicity in application programming and to be executed with adequate response time. In most industrial automation systems such as food, water, sewage, paper and steel, including a rolling mill, the control network is required to provide time-critical response capability for their application, as required in ISO/TR 13283 for time-critical communications architectures.

Plant production may be compromised due to errors, which could be introduced to the control system if the network does not provide a time-critical response. Therefore the following characteristics are required for a time-critical control network:

- deterministic response time between the control device nodes;
- ability to share process data seamlessly across the control system.

This protocol is applicable to such an industrial automation environment, in which time-critical communications is primarily required. The term "time-critical" is used to represent the presence of a time window, within which one or more specified actions are required to be completed with some defined level of certainty. Failure to complete specified actions within the time-window risks failure of the applications requesting the actions, with attendant risk to equipment, plant and possibly human life.

4.2 Overview of the medium access control

The Type 11 fieldbus has a deterministic medium access control in order to avoid collisions that occur when a number of the nodes send data frames simultaneously, and to provide the opportunity of sending data to each node in a sequential order and within a predetermined time period. Figure 2 shows the basic principle of medium access control of the Type 11 fieldbus.

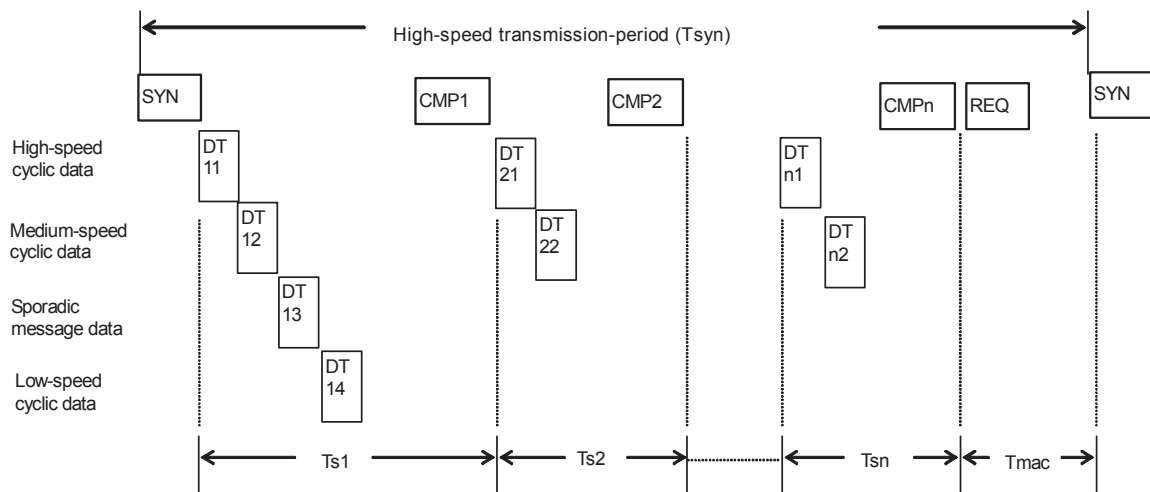


Figure 2 – Basic principle of medium access control

At the start time of every high-speed-transmission-period (T_{syn}), the SYN frame is broadcasted to all nodes. Receiving the SYN frame, the node with sequential number 1 starts sending its data frames, and after that broadcasts its CMP frame in order to indicate the completion of its data frames transmission. The Nth node can send out its data frames after receiving the CMP frame from the (N-1) node. After all the nodes send their data frames, the time period to solicit new nodes begins. The REQ frame is used for a new node requesting inclusion to the Type 11 fieldbus network. The sequential number is assigned to a new node at the time approval to join is granted.

Each node can hold the transmission right for a preset time and shall send its CMP frame to transfer the transmission right to the next node within the preset time. The data to be sent and the data to be held over are determined by priority.

Transmission includes Time-critical cyclic data and sporadic Ethernet message transmission. Cyclic data transmission is divided into High-, Medium- and Low-speed data transmission (see Note). Each node sends the High-speed cyclic data frames on each occasion when it obtains the transmission right. The data of lower priorities, that is the Medium-speed cyclic data, the sporadic Ethernet message data and the Low-speed cyclic data (see Note) respectively, is sent or not sent depending on the circumstances. The holding time of the transmission right of each node is determined by the settings of the High-speed cyclic, the Medium-speed cyclic, the sporadic Ethernet message and the Low-speed cyclic data transmission periods and by the volume of transmission data for each node. After sending all the High-speed cyclic data, the node sends the Medium-speed cyclic data. If the holding time of the transmission right ends during sending the Medium-speed cyclic data, the transmission of the Medium-speed cyclic data is interrupted, and the CMP frame is sent. The n th node obtains the transmission right again during the next High-speed data transmission period, during which time all the High-speed cyclic data and the remainder of the previous Medium-speed cyclic data is sent. Tmac is the period for a new node sending out REQ frame to enter the network.

NOTE Low-speed data transmission and Low-speed cyclic data are available for star-architecture.

4.3 Service assumed from the PhL

4.3.1 General

This subclause describes the assumed Physical Service (PhS) and the constraints on use by the Type 11 DLE. The Physical Service is assumed to provide the following service primitives specified by ISO/IEC 8802-3, Clause 6.

4.3.2 Assumed primitives of PhS

The PhS is assumed to provide the following two categories of primitives to the Type 11 DL-protocol.

- a) Service primitives for transmitting and receiving frames to / from other peer DLEs.
- b) Service primitives that provide information needed by the local DLE to perform the media access functions.

The assumed primitives of PhS are grouped into these two categories:

- c) Transfer of Data to all other peer DLE
 - 1) PLS_DATA request
 - 2) PLS_DATA indication
- d) Media access management by local DLE
 - 1) PLS_CARRIER indication
 - 2) PLS_SIGNAL indication
 - 3) PLS_DATA_VALID indication

The interaction of the PhS primitives to the DLE is shown in Figure 3.

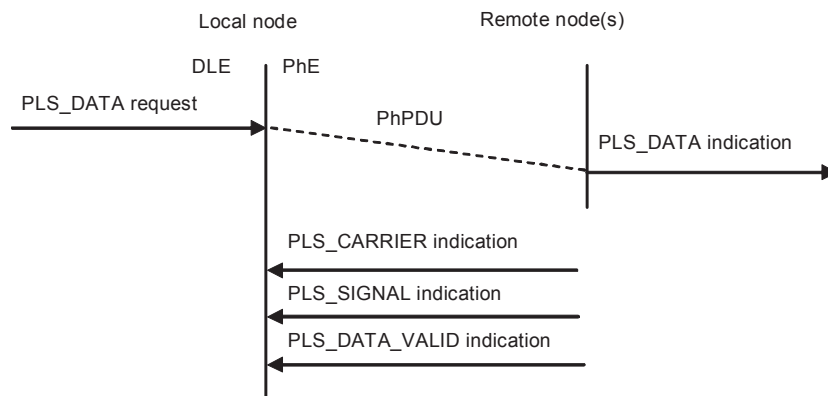


Figure 3 – Interaction of PhS primitives to DLE

4.4 DLL architecture

4.4.1 Overview

The Type 11 fieldbus DLL is modeled as a combination of control components of Access Control Machine (ACM), Cyclic transmission TX/RX Control (CTRC), Sporadic TX/RX Control (STRC), Redundancy Medium Control (RMC), Serializer, Deserializer and DLL management interface.

The Access Control Machine as the primary control component provides the function for deterministic medium access control cooperating with the Cyclic-transmission TX/RX Control, the Sporadic TX/RX Control and the Redundancy Medium Control for reliable and efficient support of higher-level connection-mode and connectionless data transfer services. Specifically the Access Control Machine has the primary responsibility for

- a) assuring that the local node detects and fully utilizes its assigned access time period;
- b) assuring that the local node does not interfere with the transmissions of other nodes, especially of the node transmitting the SYN frame;
- c) detecting network disruption, and initiating the SYN frame transmission for restoration of the network disruption from after prescribed time duration in which the SYN frame is not heard;
- d) assuring a new node adding to and removing from the network.

The DLL management interface provides DLL management functions. PhL framing and delimiters are managed by DLL functions for serializing and deserializing M_symbol requests and indications.

4.4.2 Star-architecture

The Data-link layer is comprised of the components listed in Table 1. The internal arrangement of these components, and their interfaces, are shown in Figure 4. The arrowheads illustrate the primary direction of flow of data and control.

Table 1 – Data-link layer components of star-architecture

Components	Description
Access control machine (ACM)	Deterministic medium access control and scheduling the opportunities to sending out the DLPDUs, control for adding and removing nodes, restoration from disruption. Assembles and transmits the DLPDUs to the TX framer through the RMC, receives and disassembles the DLPDUs with the control information from the RMC, and determines the timing and duration of the transmissions. Signals the RMC to sending out the DLPDUs for control and diagnosis of the Type 11 fieldbus. Buffers and dispatches in time the DLPDUs received between the DLS-user and the RMC
Cyclic transmission TX/RX control (CTRC)	Buffers and dispatches in time DLSDU received for the time-critical cyclic data transfer between the DLS-user and the ACM
Sporadic TX/RX control (STRC)	Buffers and dispatches in time DLSDU received for the Sporadic message data between DLS-user and the ACM
Redundancy medium control (RMC)	Receives the DLPDUs from the ACM and breaks them down into octet symbol requests to the Octet serializer, assembles received octets from the Octet deserializer into DLPDUs and submits them to the ACM. Selects one of two outputs of the Octet deserializers through the RX framers for medium redundancy
TX/RX framer	Receives the octet symbols from the RMC, detects and indicates the start timing of a DLPDU to the Octet serializer, passes received octets from the Octet deserializer and indicates the start timing of a DLPDU to the RMC
Octet serializer	Receives octet symbols, encodes and serializes them, and sends them as M_symbols to the PhL. It is also responsible for generating the FCS
Octet deserializer	Receives M_symbols from the PhL, converts M_symbols into octets and sends them to the RX framer. It is also responsible for checking the FCS
DLL management interface	Holds the station management variables that belong to the DLL, and manages synchronized changes of the link parameters

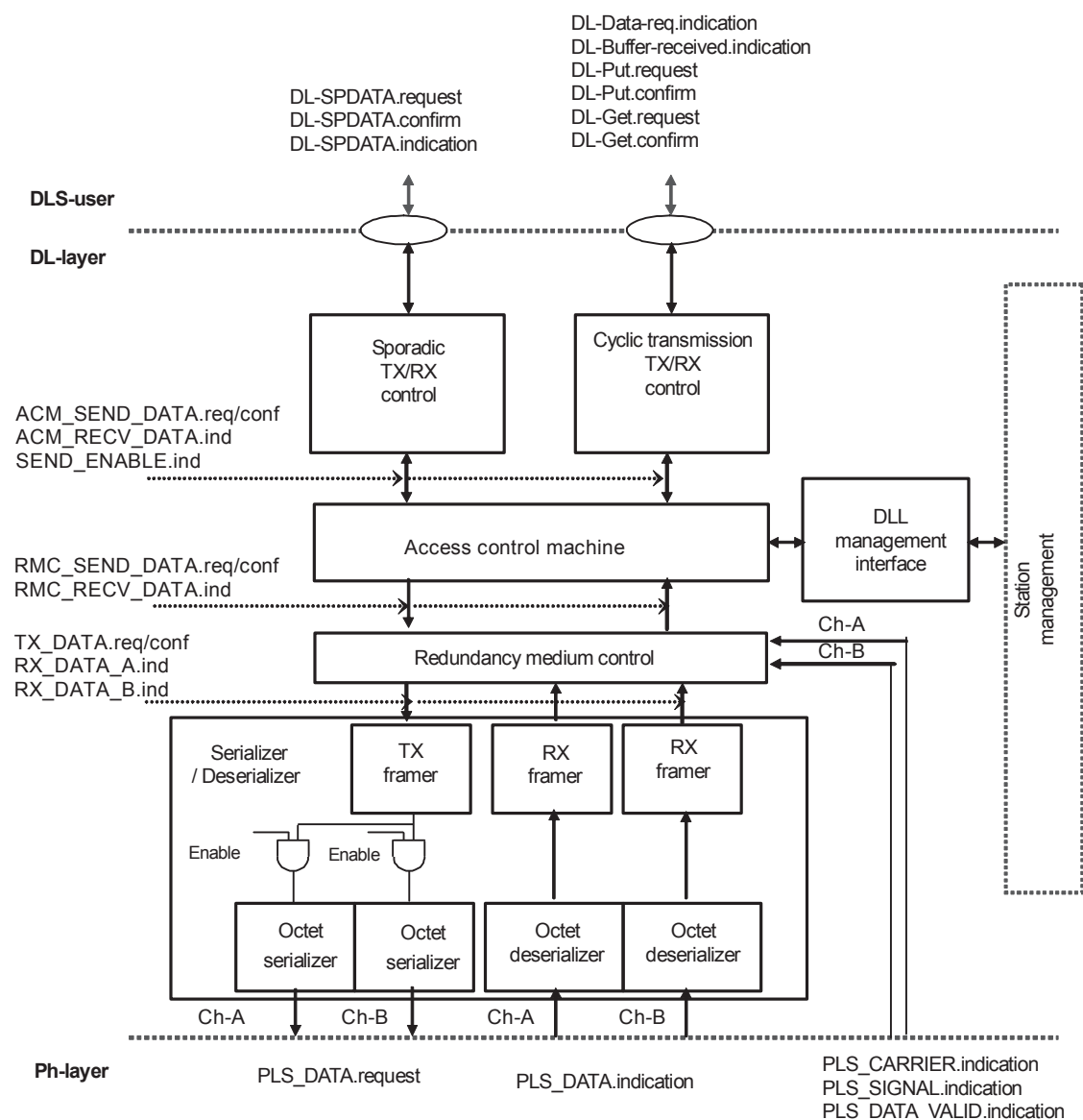


Figure 4 – Data-link layer internal architecture of star-architecture

4.4.3 Loop-architecture

The Data-link layer is comprised of the components listed in Table 2. The internal arrangement of these components, and their interfaces, are shown in Figure 5. The arrowheads illustrate the primary direction of flow of data and control.

Table 2 – Data-link layer components of loop-architecture

Components	Description
Access control machine (ACM)	Deterministic medium access control and scheduling the opportunities to sending out the DLPDUs, control for adding and removing nodes, restoration from disruption. Assembles and transmits the DLPDUs to the TX framer through the RMC, receives and disassembles the DLPDUs with the control information from the RMC, and determines the timing and duration of the transmissions. Signals the RMC to sending out the DLPDUs for control and diagnosis of the Type 11 fieldbus. Buffers and dispatches in time the DLPDUs received between the DLS-user and the RMC
Cyclic transmission TX/RX control (CTRC)	Buffers and dispatches in time DLSDU received for the time-critical cyclic data transfer between the DLS-user and the ACM
Sporadic TX/RX control (STRC)	Buffers and dispatches in time DLSDU received for the Sporadic message data between DLS-user and the ACM
Redundancy medium control (RMC)	Receives the DLPDUs from the ACM and breaks them down into the octet-symbol requests to the TX-framer, assembles received-octets from the RX-framers into the DLPDUs, selects one of two outputs from the RX-framers and submits them to the ACM. Receives the signal from the ACM and activates the transmission of the DLPDU frames for control and diagnosis of the Type 11 fieldbus
TX/RX framer	TX framer receives the octet-symbols from the RMC, detects and indicates the start timing of a DLPDU to the Octet-serializer, forwards received-octets from the Octet-deserializer connected to a Ring-port to other Octet-serializer connected to other Ring-port. RX framer passes received-octets from the Octet-deserializer and indicates the start-delimiter of a DLPDU to the RMC
Octet serializer	Receives octet symbols, encodes and serializes them, and sends them as M_symbols to the PhL. It is also responsible for generating the FCS
Octet deserializer	Receives M_symbols from the PhL, converts M_symbols into octets and sends them to the RX framer and the TX framer. It is also responsible for checking the FCS
DLL management interface	Holds the station management variables that belong to the DLL, and manages synchronized changes of the link parameters

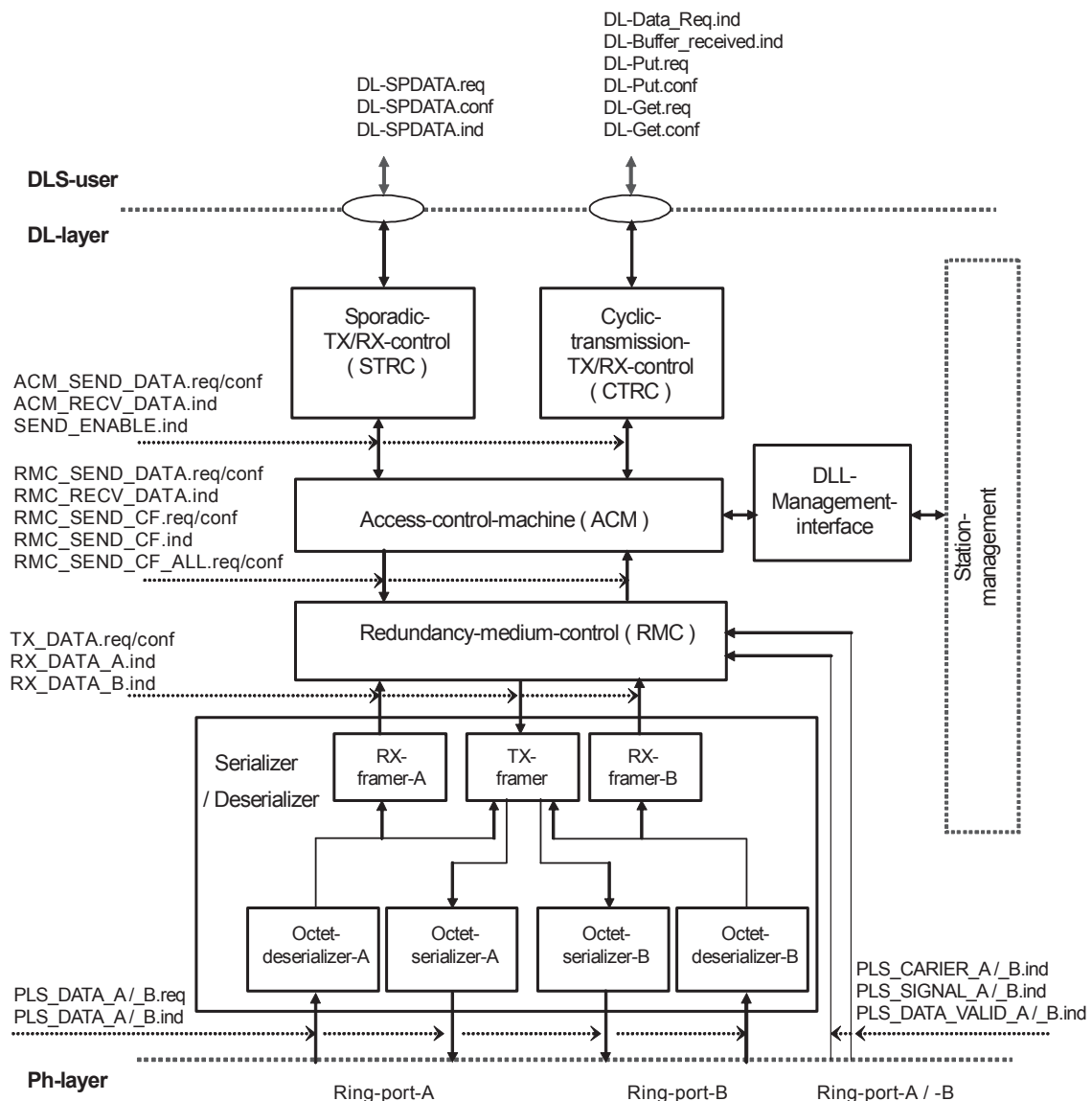


Figure 5 – Data-link layer internal architecture of loop-architecture

4.5 Access control machine and schedule support functions

The ACM functions schedule all communications between the DLEs participating in the Type 11 fieldbus, and the timing of this communications is controlled as to

- fulfill the specific medium access control to give all the DLEs the opportunities to send out two kinds of class of Time-critical cyclic data and Sporadic message data in timely, prioritized and deterministic fashion, and to detect network disruption and to initiate the restoration in appropriate time, further to add and remove nodes on line;
- provide multiple levels of Time-critical data transfer opportunities of sending data to node in sequential order and within each pre-specified time period, and that the data transfer of each level is performed within the pre-specified time duration (token holding time) and whether the data transfer of lower levels to be carried out or to be held over to later cyclic time period depends on the level and the occasion though the top level of the data transfer is always carried out at every occasion; on the other hand the whole volume of the data transfer of lower levels is transferred within each pre-specified time period;

- c) provide sporadic message data transfer opportunities of sending out to node that the request to transfer is happened sporadically by the DLS-user, and the data transfer is performed in pre-specified time period of the corresponding level of priority and is based on regular ISO/IEC 8802-3 applications.

Accurate scheduling timing is very important to support many control and data collection tasks in the applications domain of this protocol.

4.6 Local parameters, variables, counters, timers and queues

4.6.1 Overview

4.6.1.1 General

This specification uses DLS-user request parameters P(...) and local variables V(...) as a means of clarifying the effect of certain actions and the conditions under which those actions are valid, local timers T(...) as a means of monitoring actions of the distributed DLS-provider and of ensuring a local DLE response to the absence of those actions, and local counters C(...) for performing rate measurement functions. It also uses local queues Q(...) as a means of ordering certain activities, of clarifying the effects of certain actions, and of clarifying the conditions under which those activities are valid.

Unless otherwise specified, at the moment of their creation or of DLE activation:

- a) all variables shall be initialized to their default value, or to their minimum permitted value if no default is specified;
- b) all counters shall be initialized to zero;
- c) all timers shall be initialized to inactive;
- d) all queues shall be initialized to empty.

DL-management may change the values of configuration variables.

4.6.1.2 Summary of variables, parameters, counters, timers for star-architecture

Table 3 and Table 4 summarize the variables and their usage.

NOTE The data types used in the data link variables, parameters, state machines are specified in IEC 61158-5-11, Clause 5. The most significant bit of the most significant octet is always used as the most significant bit of the binary number. The bits of each octet are numbered 0 to 7, where bit 0 is the least significant bit of the octet. Each octet is transferred to the Ph layer low-bit first and multiple octets is transferred low-order octet first (little endian format).

Table 3 – DLE-variables and permissible values of star-architecture

Variable-name	Description	Permissible values	Data type
BW	Length of TCC data word in a DLPDU	The default value is 128 (octets). See 4.6.2.7	UINT
DR	Data-rate	The default value is 100 (Mbps). See 4.6.2.11	UINT
HT _h	Maximum observational time period for detecting the continuous high-speed transmission cycle disrupted	2 to 216-1 (in unit of 1 ms). The default value is 3 x V(Th). See 4.6.2.12	UDINT
HT _l	Maximum observational time period for detecting the continuous low-speed transmission cycle disrupted	2 to 216-1 (in unit of 1 ms). The default value is 3 x V(Th). See 4.6.3.5	UDINT
HT _m	Maximum observational time period for detecting the continuous medium-speed transmission cycle disrupted	2 to 216-1 (in unit of 1 ms). The default value is 3 x V(Th). See 4.6.2.14	UDINT
IA	Individual address of this node	Individual 48-bit address identical to ISO/IEC 8802-3. See 4.6.2.16	USINT[6]
IGP	Time interval from the end of a previous frame to the start of the consecutive frame sent by a node	The default value is 24 (0.96 µs in unit of 0,04µs). See 4.6.2.17	UDINT
IP	IP address of this node	32-bit address identical to IPv4. See 4.6.2.18	USINT[4]
MD	Maximum distance on the connection path between any 2 nodes	1 to 100 (km). The default value is 8. See 4.6.2.21	UINT
MDD	Maximum difference of the distance of two redundant physical mediums on the connection path between any 2 nodes	0 to 2 000 (in m). The default value is 500. See 4.6.3.7.	UINT
MGA	Multicast group address	Multicast 48-bit address identical to ISO/IEC 8802-3, for logically associated Type 11 fieldbus nodes. The default value is 0x01-0x00-0x5e-0x50-0x00-0x01. See 4.6.2.22	USINT[6]
MN	Maximum node number	254 (default value). See 4.6.2.23	USINT
MPD	Maximum difference of the signal delay time propagating over two redundant physical mediums on the connection path between any 2 nodes	1 to 0x7c (in units of 0,04 µs). The default value is 0x7c (≈5 µs). See 4.6.3.8	UDINT
MRT	Maximum number of the repeater units on the connection path between any 2 nodes	0 to 7. The default value is 3. See 4.6.2.24	UINT
MTHT	Maximum-token-hold-time for high-speed cyclic data transmission	1 to 216-1 (octet times). The default value is 0x30B4 (≈900 µs). See 4.6.2.25	UDINT
PB _h	List of up to 2 048 data buffers using for sending out high-speed TCC data	1 to 2048. See 4.6.2.28	UINT
PB _l	List of up to 2 048 data buffers using for sending out low-speed TCC data	1 to 2048. See 4.6.3.10	UINT
PB _m	List of up to 2 048 data buffers using for sending out medium-speed time-critical cycle data	1 to 2048. See 4.6.2.29	UINT
RCS	Receive-channel switching control for receiving frames. Designates the switching control for receiving frames out of one of two receive-channel A and B corresponding to each of the redundant media A and B	“Automatic”, “Force A”, “Force B” “Automatic”: Automatically switch to the proper receive-channel. “Force A”, “Force B”: Force to switch Receive-channel A or B respectively. The default is “Automatic”. See Table 10, Table 12, 4.6.3.12, 4.6.3.12	BOOL
RMGP	Maximum time-interval for one receive-channel, which has already completed one frame received and has waited for IGP time, to wait for the completion of a frame to be received on the other receive-channel in order to detect the other receive-channel disrupted	250 (in units of 0,04 µs). The value 250 represents 10 µs. See 4.6.3.14	UDINT

Variable -name	Description	Permissible values	Data type
ST	The slot-time is the fundamentally observational time unit, used in the DLME for observing to initiate action such as re-initialization in sending out the CLM frame, and also used in the DLME for observing the CMP frame sent by the corresponding node, and in case that the node failed to send out, used in the DLME for initiating action just as the CMP frame is received	1 to 255 (in units of physical symbol times for 512 bits, identical to ISO/IEC 8802-3). The default value is 20 (=100 µs). See Table 14, 4.6.2.38	USINT
SCMP	Medium-access-control-time for substitute CMP	1 to 255 (in unit of physical symbol times for 512 bits, identical to ISO/IEC 8802-3). The default value is 20 (=100 µs). See 4.6.2.31	USINT
SCMPL	Permissible repetitive count within which the node can behave like that the node received the CMP frame even though the corresponding node had failed to send out the CMP frame. The node determines the corresponding node is out of service if the count is over	1 to 16. The default value is 3. See 4.6.2.33	USINT
SENA SENB	Send enable control for sending frames out of the transmitter-A or -B	"True" / "Enable" or "False" / "Disable" The default value is "True" / "Enable". See 4.6.3.16	BOOL
Th	High-speed transmission period	1 to 160 (in units of 0,1 ms). See Table 15, 4.6.2.39	USINT[3]
TI	Low-speed transmission period	100 to 10 000 (in unit of 1 ms). See Table 18, 4.6.3.17	UINT
TISPD	Time-interval cyclically processed for Sporadic message data service	1 to 1 000 (in unit of 1 ms). The default value is 100. See Table 17, 4.6.2.40, 4.6.2.41	UINT
Tm	Medium-speed transmission period	10 to 1 000 (in unit of 1 ms). The default value is 100. See Table 16, 4.6.2.42	UINT
TMAC	Maximum observation time period for the SYN node to solicit new nodes into the Type 11 fieldbus	1 to 100 (in units of 0.1 ms). The default value is 100. See 4.6.2.43, 4.6.2.44	USINT
Tsl	DLE number able to send out next slot	1 to 255. See 4.6.2.46	USINT
TSYN	Target-periodic-time from SYN frame arrival to SYN frame arrival	1 to 160 (in units of 0,1 ms). See 4.6.2.47	UDINT
TTRT0	Target-token-rotation-time for access class 0	1 to 216-1 (octet time). The default value is P(TSYN). See 4.6.3.18	UDINT
TTRT1	Target-token-rotation-time for access class 1	1 to 216-1 (octet time). The default value is P(TSYN). See 4.6.2.48	UDINT
TTRT2	Target-token-rotation-time for access class 2	1 to 216-1 (octet time). The default value is P(TSYN). See 4.6.2.49	UDINT
TN	Node identifier number of the node. The initial value is 0 on power-up or reset	1 to 255. See 4.6.2.45	USINT

Table 4 – Observable variables and their value ranges of star-architecture

Variable -name	Description	Range of value	Data type
AIGPA AIGPB	IGP monitor over the receive-channel A and B	0 to 24, continuously decrementing. The value 24 represents 0.96 μ s. See 4.6.3.1	UDINT
ARMGP	The observed time period for one receive-channel, which has already completed one frame received and has waited for IGP time (0,96 μ s), to wait the completion of a frame received on the other receive-channel in order to detect the other receive-channel disrupted	0 to 250, continuously decrementing. The value 250 represents 10 μ s. See 4.6.3.2	UDINT
ASCMP	Collection of counters of total number of nodes. Each counter corresponding to a node indicates observed repetitive count that the corresponding node failed to send out the CMP frame and the other node can behave like that the CMP frame received without error. The node determines the corresponding node is out of service when the count reaches the pre-specified number. The number counted is indicated and is incremented coincidentally at each DLME	1 to 16. The default value is equal to the value of SCMPL, which is 3. See 4.6.2.1	USINT
ATHT	The observed time period of the MTHT	0 to MTHT, continuously decrementing. See 4.6.2.2	UDINT
ATSYN	The observed time period from SYN frame arrival to SYN frame arrival	1 to 216 (octet times). See 4.6.2.3	UDINT
ATTRT0	The observed time period of the TTRT0	1 to 216-1, continuously decrementing. See 4.6.3.3	UDINT
ATTRT1	The observed time period of the TTRT1	1 to 216-1, continuously decrementing. See 4.6.2.4	UDINT
ATTRT2	The observed time period of the TTRT2	1 to 216-1, continuously decrementing. See 4.6.2.5	UDINT
CDh	Cumulative count of transmitted high-speed-cyclic data frames	0 to 232-1. See 4.6.2.8	UDINT
CDHblk	Information data status of the data buffer with the identifier number "blk", indicating the corresponding TCC data being active (healthy) or inactive (unhealthy)	True: active. False: inactive. See 4.6.2.9	BOOL
CDl	Cumulative count of transmitted low-speed-cyclic data frames	0 to 232-1. See 4.6.3.4	UDINT
CDm	Cumulative count of transmitted medium-speed-cyclic data frames	0 to 232-1. See 4.6.2.10	UDINT
LL	Live list indicating whether the corresponding node, at this moment, is connected to and running in the Type 11 fieldbus domain in the received SYN frame. The Live list is a set of 256 Booleans, represented in 32 octets, in which each bit corresponds to a node in the Type 11 fieldbus domain and indicates the current status of that node	256-bit set of Booleans True: node is connected and working. False: node is not connected or not working. See 4.6.2.19	USINT[16]
LN	Extracted number from LL at each node and used by each node to decide whether the node is able to send the data frame out over the medium	1 to 255. See 4.6.2.20	USINT
NCDA, NCDB	Cumulative count of No-Carrier detected on the receive-channel A or B	0 to 232-1. See 4.6.3.9	UDINT
NONC	Permissible repetitive count of no CMP frame received by the SYN node within the corresponding consecutive Tsyn cycles, that is 256 times by SCMPL, in order to detect no other node except the SYN node in the Type 11 fieldbus domain	1 to 16. The default value is 3. See 4.6.2.26, 4.6.2.27	USINT

Variable -name	Description	Range of value	Data type
REA, REB	Cumulative count of DLPDUs received in error on the receive-channel A or B. REA is incremented when an error is detected on receive-channel A while receive-channel B is error-free. REB corresponds, but with interchanged channel roles.	0 to 232-1. See 4.6.3.13	UDINT
ROKA, ROKB	Cumulative count of DLPDU-received without error on the receive-channel A or B	0 to 232-1. See 4.6.3.15	UDINT
SL	The observed time period of the SL	0 to V(SL). See 4.6.2.35, 4.6.2.36	USINT
SD	Cumulative count of transmitted sporadic data frames	0 to 232-1. See 4.6.2.34	UDINT

4.6.1.3 Summary of variables, parameters, counters, timers for loop-architecture

Table 5 and Table 6 summarise the variables and their usage. The data types used in the data link variables, parameters, state machines are specified in IEC 61158-5-11, Clause 5.

NOTE The data types used in the data link variables, parameters, state machines are specified in IEC 61158-5-11, Clause 5. The most significant bit of the most significant octet is always used as the most significant bit of the binary number. The bits of each octet are numbered 0 to 7, where bit 0 is the least significant bit of the octet. Each octet is transferred to the Ph layer low-bit first and multiple octets is transferred low-order octet first (little endian format).

Table 5 – DLE variables and permissible values of loop-architecture

Variable -name	Description	Permissible values	Data type
BW	Length of TCC data word in a DLPDU	16 to 128. The default value is 64. See 4.6.2.7	UINT
DR	Data-rate	The default value is 100 (Mbps). See 4.6.2.11	UINT
FWEAB FWEBA	Forwarding control for receiving frame enable to each direction to/from Ring-port-A and -B. FWEAB controls forwarding frames receiving from Ring-port-A to Ring-port-B. On the other hand, FWEBA controls forwarding frames receiving from Ring-port-B to Ring-port-A	“Enable” or “Disable”. “Enable”: permit forwarding frames receiving from one Ring-port to other Ring-port. “Disable”: prohibit forwarding frames between Ring-ports. The default value is “Disable”. See 6.9.3, 4.6.4.3	BOOL
HTh	Maximum observational time period for detecting the continuous high-speed transmission cycle disrupted	2 to 216-1 (in unit of 1 ms). The default value is 3 x V(Th). See 4.6.2.12	UDINT
HTI	Maximum observational time period for detecting the continuous low-speed transmission cycle disrupted	2 to 216-1 (in unit of 1 ms). The default value is 3 x V(Th). See 4.6.3.5	UDINT
HTm	Maximum observational time period for detecting the continuous medium-speed transmission cycle disrupted	2 to 216-1 (in unit of 1 ms). The default value is 3 x V(Th). See 4.6.2.14	UDINT
IA	Individual address of this node	Individual 48-bit address identical to ISO/IEC 8802-3. See 4.6.2.16	SWORD[6]
IGP	Time interval from the end of a previous frame to the start of the consecutive frame sent by a node	The default value is 24 (0.96 µs in unit of 0,04µs). See 4.6.2.17	UDINT
IP	IP address of this node	32-bit address identical to IPv4. See 4.6.2.18	USINT[4]
MD	Maximum distance on the connection path between any 2 nodes	1 to 20 (km). The default value is 4. See 4.6.2.21	UINT
MDAD	Maximum distance between adjacent node	1 to 2 (km). The default value is 1. See 4.6.4.6	UINT

Variable -name	Description	Permissible values	Data type
MGA	Multicast group address	Multicast 48-bit address identical to ISO/IEC 8802-3, for logically associated Type 11 fieldbus nodes. The default value is 0x01-0x00-0x5e-0x50-0x00-0x01. See 4.6.2.22	USINT[6]
MN	Maximum node number	254 (default value). See 4.6.2.23	USINT
MRT	Maximum number of the repeater units on the connection path between any 2 nodes	0 to 252. The default value is 30. See 4.6.2.24	USINT
MHTT	Maximum-token-hold-time for high-speed cyclic data transmission	1 to 216-1 (octet times). The default value is 0x30B4 (=900 µs). See 4.6.2.25	UDINT
PBh	List of up to 2 048 data buffers using for sending out high-speed TCC data	1 to 2048. See 4.6.2.28	UINT
PBm	List of up to 2 048 data buffers using for sending out medium-speed time-critical cycle data	1 to 2048. See 4.6.2.29	UINT
PSA PSB	Port state control for blocking or non-blocking frame receiving from the Ring-port-A or -B	"Blocked" or "Non-blocked". The default value is "Blocked". See Table 26, 4.6.4.12	BOOL
RENA RENB	Receive enable control for receiving frames from the Ring-port-A or -B.	"Enable" or "Disable". The default value is "Enable". See Table 27, 4.6.4.14	BOOL
ST	The slot-time is the fundamentally observational time unit, used in the DLME for observing to initiate action such as re-initialization in sending out the CLM frame, and also used in the DLME for observing the CMP frame sent by the corresponding node, and in case that the node failed to send out, used in the DLME for initiating action just as the CMP frame is received	1 to 255 (in units of physical symbol times for 512 bits, identical to ISO/IEC 8802-3). The default value is 20 (=100 µs). See Table 14, 4.6.2.38	USINT
SCMP	Medium-access-control-time for substitute CMP	1 to 255 (in unit of physical symbol times for 512 bits, identical to ISO/IEC 8802-3). The default value is 20 (=100 µs). See 4.6.2.31	USINT
SCMPL	Permissible repetitive count within which the node can behave like that the node received the CMP frame even though the corresponding node had failed to send out the CMP frame. The node determines the corresponding node is out of service if the count is over	1 to 16. The default value is 3. See 4.6.2.33	USINT
SENA SENB	Send enable control for sending frames out of the Ring-port-A or -B	"True" / "Enable" or "False" / "Disable". The default value is "True" / "Enable". See Table 24, 4.6.4.16	BOOL
Th	High-speed transmission period	1 to 160 (in units of 0,1 ms). See Table 15, 4.6.2.39	USINT[3]
TISPD	Time-interval cyclically processed for Sporadic message data service	1 to 1 000 (in unit of 1 ms). The default value is 100. See Table 17, 4.6.2.40, 4.6.2.41	UINT
Tm	Medium-speed transmission period	10 to 1 000 (in unit of 1 ms). The default value is 100. See Table 16, 4.6.2.42	UINT
TMAC	Maximum observation time period for the SYN node to solicit new nodes into the Type 11 fieldbus	1 to 100 (in units of 0.1 ms). The default value is 100. See 4.6.2.43, 4.6.2.44	USINT
Tsl	DLE number able to send out next slot	1 to 255. See 4.6.2.46	USINT
TSYN	Target-periodic-time from SYN frame arrival to SYN frame arrival	1 to 160 (in units of 0,1 ms). See 4.6.2.47	UDINT
TTRT1	Target-token-rotation-time for access class 1	1 to 216-1 (octet time). The default value is P(TSYN). See 4.6.2.48.	UDINT
TTRT2	Target-token-rotation-time for access class 2	1 to 216-1 (octet time) The default value is P(TSYN). See 4.6.2.49	UDINT

Variable -name	Description	Permissible values	Data type
TN	Node identifier number of the node. The initial value is 0 on power-up or reset	1 to 255. See 4.6.2.45	USINT

Table 6 – Observable variables and their value ranges of loop-architecture

Variable -name	Description	Range of value	Data type
ANA ANB	Node number of adjacent node neighboring Ring-port-A or -B	1 to 254. See 4.6.4.1	USINT
ASCMP	Collection of counters of total number of nodes. Each counter corresponding to a node indicates observed repetitive count that the corresponding node failed to send out the CMP frame and the other node can behave like that the CMP frame received without error. The node determines the corresponding node is out of service when the count reaches the pre-specified number. The number counted is indicated and is incremented coincidentally at each DLME	1 to 16. The default value is equal to the value of SCMP, which is 3. See 4.6.2.1	USINT
ATHT	The observed time period of the MTHT	0 to MTHT, continuously decrementing. See 4.6.2.2	UDINT
ATSYN	The observed time period from SYN frame arrival to SYN frame arrival	1 to 216 (octet times). See 4.6.2.3	UDINT
ATTRT1	The observed time period of the TTRT1	1 to 216-1, continuously decrementing. See 4.6.2.4	UDINT
ATTRT2	The observed time period of the TTRT2	1 to 216-1, continuously decrementing. See 4.6.2.5	UDINT
CDh	Cumulative count of transmitted high-speed-cyclic data frames	0 to 232-1. See 4.6.2.8	UDINT
CDHblk	Information data status of the data buffer with the identifier number "blk", indicating the corresponding TCC data being active (healthy) or inactive (unhealthy)	True: active. False: inactive. See 4.6.2.9	BOOL
CDm	Cumulative count of transmitted medium-speed-cyclic data frames	0 to 232-1. See 4.6.2.10	UDINT
CREA CREB	Observed repetitive count for the abnormal reception error detected during receiving incoming frame from the Ring-port-A or -B respectively. The count is decreased by each abnormal reception detection repetitively but reset to the initial value when the abnormal reception is cleared. When reached to 0, abnormal reception error is detected	0 to 15. The default value is 2. See 4.6.4.2	USINT
LINKA LINKB	Link state indicating the condition of physical link connection at Ring-port-A or -B	"Abnormal" or "Normal". See 4.6.4.4	BOOL
LSYN	Node number of the node in current master state	1 to 254. See 4.6.4.5	USINT
LL	Live list indicating whether the corresponding node, at this moment, is connected to and running in the Type 11 fieldbus domain in the received SYN frame. The Live list is a set of 256 Booleans, represented in 32 octets, in which each bit corresponds to a node in the Type 11 fieldbus domain and indicates the current status of that node	256-bit set of Booleans. True: node is connected and working. False: node is not connected or not working. See 4.6.2.19	USINT[16]
LN	Extracted number from LL at each node and used by each node to decide whether the node is able to send the data frame out over the medium	1 to 255. See 4.6.2.20	USINT
NCDA, NCDB	Cumulative count of No-Carrier detected on the Ring-port-A or B	0 to 232-1. See 4.6.3.9	UDINT

Variable -name	Description	Range of value	Data type
NONC	Permissible repetitive count of no CMP frame received by the SYN node within the corresponding consecutive Tsyn cycles, that is 256 times by SCMPL, in order to detect no other node except the SYN node in the Type 11 fieldbus domain	1 to 16. The default value is 3. See 4.6.2.26, 4.6.2.27	USINT
NOS	Node operation state indicating the operation condition of a node in normal or open state	"Normal" or "Open". The default value is "Open". See 4.6.4.8	BOOL
NRFA NRFB	Observed time period in which no frame received from Ring-port-A or -B after from other Ring-port-B or -A respectively, a frame has been received	0 to 15 (in unit of Th time). The default value is 2. See 4.6.4.9	USINT
NS	Node state indicating the node condition operating as master or slave	"Master" or "Slave". The default value is "Slave". See 4.6.4.10	BOOL
PP	Primary port indicating the Ring-port-A or -B through which SYN or CLM received first since this node is power-up, or in the system start-up, or in the system initialization	"Ring-port-A" or "Ring-port-B". The default value is "Ring-port-A". See Table 25, 4.6.4.11	BOOL
REA, REB	Cumulative count of DLPDUs received in error on the Ring-port-A or -B. REA is incremented when an error is detected on the Ring-port-A while the Ring-port-B respectively is error-free. REB corresponds, but with interchanged channel roles	0 to 232-1. See 4.6.4.13	UDINT
ROKA, ROKB	Cumulative count of DLPDU-received without error on the Ring-port-A or -B	0 to 232-1. See 4.6.4.15	UDINT
SL	The observed time period of the SL	0 to V(SL). See 4.6.2.35, 4.6.2.36	USINT
SD	Cumulative count of transmitted sporadic data frames	0 to 232-1. See 4.6.2.34	UDINT

4.6.2 Type 11 common variables, parameters, counters, timers and queues

4.6.2.1 C(ASCMP) : ASCMP count

A collection of counters, each of which indicates the number of observed repetitive count that the corresponding node failed to send out the CMP frame and the other node can behave like that the CMP frame received without error. The number of C(ASCMP) is incremented coincidentally at each node in Type 11 fieldbus. The value is in the range of 1 to V(SCMPL) and the default value is 3.

4.6.2.2 T(ATHT) : MHT monitor

T(ATHT) is used by the DLE to measure the time elapsed of MHT. The value is decremented in the range of P(MHT) to 0.

4.6.2.3 T(ATSYN) : TSYN monitor

T(ATSYN) is used by the DLE to monitor the time period from SYN frame arrival to SYN frame arrival. The value is indicated in octet time by the data signaling rate.

4.6.2.4 T(ATRT1) : TTRT1 monitor

T(ATRT1) is used by the DLE to monitor the time period of TTRT1. The value is decremented in the range of 216-1 to 1, of which unit is in octet time by the data-signaling rate.

4.6.2.5 T(ATRT2) : TTRT2 monitor

T(ATRT2) is used by the DLE to monitor the time period of TTRT2. The value is decremented in the range of 216-1 to 1, of which unit is in octet time by the data-signaling rate.

4.6.2.6 Q(BF_{blk}) : Data buffer used for sending and receiving a DLPDU for time-critical cyclic data DLPDU

The total number of buffers is equivalent of the total number of DLCEP. Each buffer with the identifier "blk" number corresponds to a DLCEP with the identifier number "identifier".

4.6.2.7 V(BW), P(BW) : Length of time-critical cyclic data word in a DLPDU

This variable holds and designates the length of the Time-critical cyclic data word in a DLPDU.

The possible value of the length in octet is as follows:

- a) star-architecture: The default value is 128.
- b) loop-architecture: 16 to 128. The default value is 64.

4.6.2.8 C(CDh) : Cumulative count of high-speed-cyclic data frame sent

C(CDh) indicates the number of cumulative count of high-speed-cyclic data frame sent on the medium. C(CDh) is a roll-over binary counter of 32-bit length.

4.6.2.9 V(CDH_{blk}) Information data status of the data buffer with identifier number "blk"

This variable indicates the status of the corresponding time-critical cyclic data being active (healthy) or inactive (unhealthy). The value "True" indicates active, and the value "False" indicates inactive.

4.6.2.10 C(CDm) : Cumulative count of medium-speed-cyclic data frame sent

C(CDm) indicates the number of cumulative count of medium-speed-cyclic data frame sent on the medium. C(CDm) is a roll-over binary counter of 32 bits length.

4.6.2.11 V(DR) : Data-rate

The value of this variable indicates the data signaling rate in Mbps. The value is 100.

4.6.2.12 V(HTh), P(HTh) : Maximum observational time period for detecting the continuous high-speed transmission cycle disrupted

This variable holds and designates the value of maximum observational time period for detecting the continuous High-speed transmission cycle disrupted. The value of this variable is in the range of 2 to 2¹⁶-1, of which the unit is 1 ms. The default value is 3 x V(Th).

4.6.2.13 T(HTh) : HTh monitor

T(HTh) is used by the DLE to measure the HTh time elapsed to detect the continuous High-speed transmission cycle failed. The value is decremented in the range of V(HTh) to 1.

4.6.2.14 V(HTm), P(HTm) : Maximum observational time period for detecting the continuous medium-speed transmission cycle disrupted

This variable holds and designates the value of maximum observational time period for detecting the continuous Medium-speed transmission cycle disrupted. The value of this variable is in the range of 2 to 2¹⁶-1, of which the unit is 1ms. The default value is 3 x V(Th).

4.6.2.15 T(HTm) : HTm monitor

T(HTm) is used by the DLE to measure the HTm time elapsed to detect the continuous Medium-speed transmission cycle disrupted. The value is decremented in the range of V(HTm) to 1.