

Informationsverarbeitungssysteme
Verteilte Datenschnittstelle mit Lichtwellenleitern (FDDI)
 Teil 2: Steuerungsverfahren für den Mediumzugriff des Ringes
 mit Token (MAC) (ISO 9314-2 : 1989)
 Englische Fassung EN 29 314-2 : 1993

DIN
EN 29 314
 Teil 2

Diese Norm enthält die Internationale Norm **ISO 9314-2**

Information processing systems; Fibre Distributed Data Interface (FDDI);
 Part 2: Token Ring Media Access Control (MAC); (ISO 9314-2 : 1989);
 English version EN 29 314-2 : 1993

Systèmes de traitement de l'information;
 Interface de données distribuées sur fibre (FDDI);
 Partie 2: Mécanisme d'accès au support de l'anneau à jeton (MAC);
 (ISO 9314-2 : 1989);
 Version anglaise EN 29 314-2 : 1993

Die Europäische Norm EN 29 314-2 : 1993 hat den Status einer Deutschen Norm.

Nationales Vorwort

Einführung

Entwurf war veröffentlicht als DIN 66 376 Teil 2/03.92.

Diese Norm enthält unter Berücksichtigung des DIN-Präsidialbeschlusses 13/1983 die englische Sprachfassung der Europäischen Norm EN 29 314-2. Sie ist identisch mit der Internationalen Norm ISO 9314-2, die von ISO/IEC JTC1/SC25 „Interconnection of Information Technology Equipment“ unter Mitwirkung des Deutschen Komitees erarbeitet wurde. In Deutschland zuständig ist das GUK 715.4 „Verbindung von Rechnersystemen und zugehörigen Einrichtungen“ der Deutschen Elektrotechnischen Kommission im DIN und VDE (DKE) und des Normenausschuß Informationsverarbeitungssysteme (NI) im DIN.

Um den Gebrauch der Norm zu erleichtern, enthält das Nationale Vorwort eine Einführung in diese Normenreihe und eine Fachwörterliste in Englisch-Deutsch.

Einführung in Normen für Verteilte Datenschnittstellen mit Lichtwellenleitern

Die Verteilte Datenschnittstelle mit Lichtwellenleiter (FDDI) stellt dem Anwender ein Konzept für die Realisierung einer universell verwendbaren Verbindung von Rechnersystemen und Peripherieeinheiten in einer Ringanordnung zur Verfügung. Als Übertragungsmedium werden Lichtwellenleiter verwendet. FDDI arbeitet mit einem Steuerungsverfahren mit Token (Token-Ring) nach ISO/IEC 8802-5, welches für die hier erforderlichen höheren Datenraten von bis zu 100 MBit/s modifiziert wurde. Mit FDDI können mehrere hundert Stationen, sogenannte FDDI-Knoten, über große Entfernungen verbunden werden. Das FDDI-System besteht – zur Erhöhung der Ausfallsicherheit – aus einem Doppelring paralleler Lichtwellenleiter. Die voreingestellten Werte von FDDI wurden auf der Basis von 1000 physikalischen Verbindungen mit einer gesamten Lichtwellenleiterlänge von 200 km – entsprechend 500 Stationen im Doppelring und einer gesamten Kabellänge von 100 km – berechnet.

Fortsetzung Seite 2 bis 4
 und 2 Seiten EN-Norm
 mit 72 Seiten ISO-Original

Deutsche Elektrotechnische Kommission im DIN und VDE (DKE)
 Normenausschuß Informationsverarbeitungssysteme (NI) im DIN Deutsches Institut für Normung e. V.

Die Verteilte Datenschnittstelle mit Lichtwellenleiter beschreibt eine Realisierung der beiden untersten Schichten im Basis-Referenzmodell für die Kommunikation Offener Systeme nach DIN ISO 7498¹⁾, ²⁾, die Bitübertragungsschicht (Schicht 1) und die Sicherungsschicht (Schicht 2). Es werden die Schnittstellen, Funktionen und Operationen festgelegt, die zur Sicherstellung der Zusammenarbeit von FDDI-konformen Implementierungen nötig sind.

ISO 9314 besteht z.Z. aus drei Teilen, weitere sind geplant bzw. in Vorbereitung (siehe Tabelle 1).

Tabelle 1: Aufbau der Normen für FDDI

Schicht im Basis-Referenzmodell	Realisierung im FDDI		Stations- Management SMT ³⁾
Schicht 2 Sicherungsschicht	LLC	ISO 8802-2	
	MAC	ISO 9314-2 und ISO/IEC DIS 9314-5	
Schicht 1 Bitübertragungsschicht	PHY	ISO 9314-1	
	PMD	ISO/IEC 9314-3 SMF-PMD ISO/IEC CD 9314-4	

ISO 9314-1 legt das mediumunabhängige Protokoll (PHY) für die Bitübertragungsschicht fest, welche sich bei FDDI aus zwei Teilschichten (PHY und PMD) zusammensetzt. ISO 9314-2 behandelt das Steuerungsverfahren für den Mediumzugriff (MAC), welches in der unteren Teilschicht der ebenfalls zweigeteilten Sicherungsschicht (MAC und LLC) enthalten ist. (Für das Steuerungsverfahren im Übermittlungsabschnitt (LLC) gilt ISO 8802-2.) Mediumspezifische Festlegungen für die Bitübertragungsschicht werden in ISO/IEC 9314-3 für den Fall beschrieben, daß Mehrmoden-Lichtwellenleiter (PMD) eingesetzt werden. ISO/IEC CD 9314-4³⁾ enthält mediumspezifische Festlegungen für die Bitübertragungsschicht, welche die Verwendung von Einmoden-Lichtwellenleitern (SMF-PMD) erlauben, und kann alternativ zu ISO/IEC 9314-3 benutzt werden. ISO/IEC DIS 9314-5 beschreibt eine Hybride Ringsteuerung (HRC), die neben der Übertragung von asynchronen und synchronen Daten auch ein Protokoll zum Transfer von isochronen Daten bietet. In einer weiteren, geplanten Norm der Reihe wird das Stations-Management (SMT) festgelegt, welches die Dienste der verschiedenen Schichten eines FDDI-Netzes (Ring-Konfigurierung, Leistungsüberwachung usw.) steuert und verwaltet.

Erläuterungen zu Anwendungsbereich und Zweck

Diese Norm der Reihe „Verteilte Datenschnittstelle mit Lichtwellenleitern (FDDI)“ beschreibt das in der unteren Teilschicht der Sicherungsschicht angeordnete Steuerungsverfahren für den Mediumzugriff (MAC).

Die Steuerung für den Mediumzugriff stellt den deterministischen und nach gerechten Kriterien gewährten Zugriff einer Station auf das Medium sicher. Ihre Hauptaufgabe besteht in der Zustellung der Datenübertragungsblöcke, deren Einfügung, Wiederholung und Entfernung eingeschlossen. Sie sorgt für das Erkennen der Adresse sowie die Erzeugung und Verifikation der Blockprüfzeichenfolge.

Aufbau dieser Norm

Abschnitt 1 beschreibt den Zweck dieser Norm, Abschnitt 2 enthält die Verweisungen auf andere Internationale Normen, Abschnitt 3 definiert die in dieser Norm verwendeten Begriffe, Abschnitt 4 beinhaltet weitere Vereinbarungen zum Gebrauch einzelner Begriffe und Abkürzungen. Abschnitt 5 führt in die FDDI-Topologie ein. Die von der MAC unterstützten Dienste werden in Abschnitt 6 beschrieben. Abschnitt 7 behandelt die Steuersymbole, die Protokolldateneinheiten einschließlich der darin enthaltenen Felder, die Zeitgeber sowie die Überwachung der übertragenen Datenblöcke. Abschnitt 8 behandelt die für den Betrieb von MAC in einer FDDI-Station relevanten Gesichtspunkte. Er beschreibt den Aufbau und die Struktur der MAC und erläutert die Funktionsweise der MAC-Sende- sowie MAC-Empfangseinheit. Anhang A informiert über hierarchische Strukturierung der Adressierung für lokal verwaltete Adressen, Hinweise zur Blockprüfzeichenfolge werden in Anhang B gegeben.

¹⁾ DIN ISO 7498/04.91 enthält den Text von ISO 7498 : 1984 sowie der internationalen Änderungen ISO 7498 : 1984/Add.1:1987 und ISO 7498 : 1984/Cor.1 : 1988 in englischer Sprache.

²⁾ Das Europäische Komitee für Normung (CEN) hat 1988 den Text von ISO 7498 : 1984 sowie der internationalen Änderung ISO 7498 : 1984/Add.1 : 1987 als EN 27498 angenommen.

³⁾ Internationale Norm geplant bzw. in Vorbereitung

Zusammenhang mit nationalen Normen

Nachfolgend wird den im Nationalen Vorwort sowie im Abschnitt 2 genannten Internationalen Normen/Norm-Entwürfen die jeweils entsprechende Europäische Norm bzw. Deutsche Norm gegenübergestellt:

ISO/IEC	EN	DIN
ISO 9314-1	EN 29 314-1	DIN EN 29 314 Teil 1 Informationsverarbeitungssysteme; Verteilte Datenschnittstelle mit Lichtwellenleitern (FDDI); Teil 1: Protokoll für die Bitübertragungsschicht (PHY); (ISO 9314-1:1989); Englische Fassung EN 29 314-1:1993
ISO/IEC 9314-3	EN 29 314-3	DIN EN 29 314 Teil 3 Informationsverarbeitungssysteme; Verteilte Datenschnittstelle mit Lichtwellenleitern (FDDI); Teil 3: Mediumspezifische Festlegungen für die Bitübertragungsschicht (PMD); (ISO/IEC 9314-3:1990); Englische Fassung EN 29 314-3:1993
ISO/IEC CD 9314-4	–	DIN 66 376 Teil 4 (z.Z. Entwurf) Informationsverarbeitungssysteme; Verteilte Datenschnittstelle mit Lichtwellenleitern (FDDI); Teil 4: Mediumspezifische Physikalische Schicht mit Monomodalen-Lichtwellenleiter (SMF-PMD); Identisch mit ISO/IEC CD 9314-4
ISO/IEC DIS 9314-5	–	DIN 66 376 Teil 5 (z.Z. Entwurf) Informationsverarbeitungssysteme; Faser-optische dezentrale Datenschnittstelle (FDDI); Teil 5: Hybride Ringsteuerung (HRC); Identisch mit ISO/IEC DIS 9314-5:1991
ISO 7498	EN 27 498	DIN ISO 7498 Informationsverarbeitung; Kommunikation offener Systeme; Basis-Referenzmodell; Identisch mit ISO 7498:1984 (Stand 1988)
ISO 8802-2	–	DIN 66 325 Teil 2 Lokale und Regionale Netze; LLC; Identisch mit ISO 8802-2:1989 (Stand 1992)
ISO/IEC 8802-5	–	DIN ISO 8802 Teil 5 (z.Z. Entwurf) Lokale Netze; Ring mit Sendeberechtigungsmarke
–	–	DIN 44 300 Teil 5 Informationsverarbeitung; Begriffe; Aufbau digitaler Rechensysteme
–	–	DIN 44 300 Teil 8 Informationsverarbeitung; Begriffe; Verarbeitungsfunktionen
–	–	DIN 44 300 Teil 9 Informationsverarbeitung; Begriffe; Verarbeitungsabläufe
–	–	DIN 44 302 Informationsverarbeitung; Datenübertragung, Datenübermittlung; Begriffe

Fachwörterliste

Die Wahl deutscher Benennungen erfolgte – soweit möglich – nach DIN 44 300 Teil 5, DIN 44 300 Teil 8, DIN 44 300 Teil 9 und DIN 44 302.

Englisch	Deutsch	Englisch	Deutsch
abort	abbrechen	loopback	Rückschleifen (des Datensignals zu Prüfzwecken)
acquisition time, signal	Signalerkennungsintervall	mandatory	verpflichtend (abgekürzt: M)
adjacent	benachbart	media access control	Steuerung für Mediumzugriff
align	ausrichten	medium	Medium
antecedent	vorausgehend	modifier	Ergänzung
assert	Signalzustand WAHR herbeiführen, wird hier mit logisch EINS realisiert	monitor	überwachen
		negotiate	verhandeln
assign	zuweisen	node	Knoten
attachment	Anschluß	octet	Byte
beacon	Warnsignal	optional	optional, wahlfrei (abgekürzt: O)
broadcast	Rundaufruf	outbound	auswärts gerichtet, abgehend
burst (transmission)	Bündel(-übertragung)	peer	Partner-, gleichrangig
capture (token)	(Token) festhalten	power budget	Leistungsbilanz
claim (token)	(um Token) bewerben	preamble	Vorspann
clock	Takt	preempt(ive)	vorbesetzen, vorrangig
completion	Beendigung	primitive	Element
confirm	bestätigen	propagation delay	Laufzeit
connector	Steckverbinder	quiet	keine Aktivität
consecutive	aufeinanderfolgend	receiver	Empfänger
contiguous	zusammenhängend	reissuance	Wiederholung
control(ler)	Steuerung	remaining time	Restzeit
data assurance service	Datensicherungsdienst	remnant	Rest
data link layer	Sicherungsschicht	repeat	Zwischenverstärkung
deassert	Signalzustand FALSCH herbeiführen, wird hier mit logisch NULL realisiert	request	Anforderung, anfordern
		requester	Anforderer
		reset	rücksetzen
default	Vorgabe(wert)	ring latency	Ring-Umlaufzeit
delay	(Zeit-)Verzögerung	scheduling	Zeitsteuerung
delimiter	Begrenzer	service	Dienst
delineation	Darstellung, Beschreibung	service provider	Diensterbringer
discard	löschen, wegwerfen	service user	Dienstbenutzer
downstream station	nachfolgende Station	spurious	falsch, gelegentlich
driver	Sender	state	Zustand
elapsed time	abgelaufene Zeit	state diagram	Zustandsdiagramm
elasticity buffer	Anpassungspuffer	station management	Stations-Management
eligible	ausgewählt	status	Zustand
entity	Instanz	stream	Datenstrom
exit	verlassen	strip	abtrennen
fault	Fehler	sustained	Dauer-
fibre, optical	Lichtwellenleiter	target time	Sollzeit
frame	Datenübertragungs-Block	target value	Sollwert
halt	Aktivität angehalten	time-sliced	im Zeitmultiplex
hang condition	Blockierungszustand	timing allowance	Zeitvorgabe
idle	Bereitschaft, keine Aktivität	token	Token
implementer defined	implementierungsabhängig	token lateness	verspätetes Eintreffen des Token
inbound	einwärts gerichtet, ankommend	token-ring	Token-Ring
indication	Anzeige	transfer	übertragen, Übertragung
indicator	Anzeiger	transfer rate	Transfergeschwindigkeit
interoperability	Fähigkeit zum Zusammenarbeiten	transition	Zustandsübertragung
isochronous	isochron	two-tier	zweistufig
jabber	Dauerbelegung	upstream station	vorausgehende Station
jitter	Jitter, Zittern	violation	Verstoß, Verletzung
layer	Schicht (im OSI-Referenzmodell)		
logical link control	Steuerung im Übermittlungsabschnitt		

Zitierte Normen

- in der Englischen Fassung: Siehe Abschnitt 2
- in nationalen Zusätzen: Siehe Nationales Vorwort

Weitere Normen und Unterlagen

Beiblatt 1 zu DIN 44 302 Informationsverarbeitung; Datenübertragung, Datenübermittlung; Fachwörter

Internationale Patentklassifikation

G 02 B 006/10 G 06 F 013/42

DK 681.3.01 : 621.39 : 666.189.21 : 666.22

Deskriptoren: Datenverarbeitung, Informationsaustausch, Verbindung von Netzen, Lichtwellenleiter, Rechnerschnittstelle, Übermittlungsprozedur

Deutsche Fassung

Informationsverarbeitungssysteme

Verteilte Datenschnittstelle mit Lichtwellenleitern (FDDI)

Teil 2: Steuerungsverfahren für den Mediumzugriff des Ringes mit Token (MAC)
(ISO 9314-2 : 1989)

Information processing systems – Fibre
Distributed Data Interface (FDDI) –
Part 2: Token Ring Media Access Control
(MAC) (ISO 9314-2 : 1989)

Systèmes de traitement de l'information –
Interface de données distribuées sur fibre
(FDDI) – Partie 2: Mécanisme d'accès au
support de l'anneau à jeton (MAC)
(ISO 9314-2 : 1989)

Diese Europäische Norm wurde von CEN am 1993-10-20 angenommen.

Die CEN-Mitglieder sind gehalten, die CEN/CENELEC-Geschäftsordnung zu erfüllen, in der die Bedingungen festgelegt sind, unter denen dieser Europäischen Norm ohne jede Änderung der Status einer nationalen Norm zu geben ist.

Auf dem letzten Stand befindliche Listen dieser nationalen Normen mit ihren bibliographischen Angaben sind beim Zentralsekretariat oder bei jedem CEN-Mitglied auf Anfrage erhältlich.

Die Europäischen Normen bestehen in drei offiziellen Fassungen (Deutsch, Englisch, Französisch). Eine Fassung in einer anderen Sprache, die von einem CEN-Mitglied in eigener Verantwortung durch Übersetzung in seine Landessprache gemacht und dem Zentralsekretariat mitgeteilt worden ist, hat den gleichen Status wie die offiziellen Fassungen.

CEN-Mitglieder sind die nationalen Normungsinstitute von Belgien, Dänemark, Deutschland, Finnland, Frankreich, Griechenland, Irland, Island, Italien, Luxemburg, Niederlande, Norwegen, Österreich, Portugal, Schweden, Schweiz, Spanien und dem Vereinigten Königreich.

CEN

EUROPÄISCHES KOMITEE FÜR NORMUNG
European Committee for Standardization
Comité Européen de Normalisation

Zentralsekretariat: rue de Stassart 36, B-1050 Brüssel

Vorwort

Auf Vorschlag des Zentralsekretariats von CEN hatte das Technische Büro entschieden, die Internationale Norm:

“Informationsverarbeitungssysteme – Verteilte Datenschnittstelle mit Lichtwellenleitern (FDDI) – Teil 2: Steuerungsverfahren für den Mediumzugriff des Ringes mit Token (MAC) (ISO 9314-2 : 1989)”

zur formellen Abstimmung vorzulegen.

Das Ergebnis der formellen Abstimmung war positiv.

Zur Zeit besteht dieses Dokument nur in Englisch.

Diese Europäische Norm muß den Status einer nationalen Norm erhalten, entweder durch Veröffentlichung eines identischen Textes oder durch Anerkennung bis April 1994, und etwaige entgegenstehende nationale Normen müssen bis April 1994 zurückgezogen werden.

Entsprechend der CEN/CENELEC-Geschäftsordnung sind folgende Länder gehalten, diese Europäische Norm zu übernehmen: Belgien, Dänemark, Deutschland, Finnland, Frankreich, Griechenland, Irland, Island, Italien, Luxemburg, Niederlande, Norwegen, Österreich, Portugal, Schweden, Schweiz, Spanien und das Vereinigte Königreich.

Anerkennungsnotiz

Der Text der Internationalen Norm ISO 9314-2 : 1989 wurde von CEN ohne jegliche Änderung als Europäische Norm angenommen.

INTERNATIONAL STANDARD

ISO
9314-2

First edition
1989-05-01

Information processing systems — Fibre Distributed Data Interface (FDDI) —

Part 2 : Token Ring Media Access Control (MAC)

*Systèmes de traitement de l'information — Interface de données distribuées sur
fibre (FDDI) —*

Partie 2 : Mécanisme d'accès au support de l'anneau à jeton (MAC)



Reference number
ISO 9314-2 : 1989 (E)

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work.

Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council. They are approved in accordance with ISO procedures requiring at least 75 % approval by the member bodies voting.

International Standard ISO 9314-2 was prepared by Technical Committee ISO/TC 97, *Information processing systems*.

ISO 9314 consists of the following parts, under the general title *Information processing systems — Fibre Distributed Data Interface (FDDI)* —

- *Part 1: Token Ring Physical Layer Protocol (PHY)*
- *Part 2: Token Ring Media Access Control (MAC)*
- *Part 3: Token Ring Physical Layer, Medium Dependent (PMD)*

Introduction

This part of ISO 9314 on the FDDI media access control is intended for use in a high-performance multistation network. This protocol is designed to be effective at 100 Mbit/s using a Token ring architecture and fibre optics as the transmission medium over distances of several kilometres in extent.

Information processing systems - Fibre Distributed Data Interface (FDDI) -

Part 2: Token Ring Media Access Control (MAC)

1 Scope

This part of ISO 9314 specifies the Media Access Control (MAC), the lower sublayer of the Data Link Layer (DLL), for Fibre Distributed Data Interface (FDDI).

FDDI provides a high-bandwidth (100 Mbit/s), general-purpose interconnection among computers and peripheral equipment using fibre optics as the transmission medium in a ring configuration. FDDI can be configured to support a sustained transfer rate of approximately 80 Mbit/s (10 Mbyte/s). It may not meet the response time requirements of all unbuffered high speed devices. FDDI establishes the connection among many stations distributed over distances of several kilometres in extent. Default values for the FDDI were calculated to accommodate rings of up to 1 000 physical links and a total fibre path length of 200 km (typically corresponding to 500 stations and 100 km of dual fibre cable).

FDDI consists of

- (a) A Physical Layer (PL), which provides the medium, connectors, optical bypassing, and driver/receiver requirements. PL also defines encode/decode and clock requirements as required for framing the data for transmission on the medium or to the higher layers of the FDDI. For purposes of this part of 9314, references to the PL are made in terms of the Physical Layer entity designated PHY.
- (b) A Data Link Layer (DLL), which is divided into two sublayers:
 - (1) A Media Access Control (MAC) which provides fair and deterministic access to the medium, address recognition, and generation and verification of frame check sequences. Its primary function is the delivery of frames, including frame insertion, repetition, and removal. The definition of MAC is contained in this part of ISO 9314.
 - (2) A Logical Link Control (LLC) which provides a common protocol to provide the required data assurance services between MAC and the Network Layer.
- (c) A Station Management (SMT)¹⁾ which provides the control necessary at the station level to manage the processes under way in the various FDDI layers such that a station may work co-operatively on a ring. SMT provides services such as control of station initialization, configuration management, fault isolation and recovery, and scheduling procedures.

¹⁾ SMT will form the subject of a future part of ISO 9314.

The MAC definition contained herein is designed to be as independent as possible from both the physical medium and the speed of operation. Concepts employed in ISO 8802-5, dealing with Token Ring MAC operation have been modified to accommodate the higher FDDI speeds, while retaining a similar set of services and facilities.

ISO 9314 specifies the interfaces, functions, and operations necessary to ensure interoperability between conforming FDDI implementations. This part of ISO 9314 provides a functional description. Conforming implementations may employ any design technique that does not violate interoperability.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 9314. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this part of ISO 9314 are encouraged to investigate the possibility of applying the most recent editions of the standards listed below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 8802-2: ----¹⁾, *Information processing systems - Local Area Networks - Part 2: Logical Link Control (LLC)*.

ISO 8802-5: ----¹⁾, *Information processing systems - Local Area Networks - Part 5: Token Ring Access Method and Physical Layer specification*.

ISO 9314-1: 1989, *Information processing systems - Fibre Distributed Data Interface (FDDI) - Part 1: Token Ring Physical Layer Protocol (PHY)*.

ISO 9314-3: ----¹⁾, *Information processing systems - Fibre Distributed Data Interface (FDDI) - Part 3: Token Ring Physical Layer, Medium Dependent (PMD)*.

3 Definitions

For the purposes of this part of ISO 9314, the following definitions apply:

3.1 asynchronous: A class of data transmission service whereby all requests for service contend for a pool of dynamically allocated ring bandwidth and response time.

3.2 capture: The act of removing a Token from the ring for the purpose of Frame transmission.

3.3 claim token: A process whereby one or more stations bid for the right to initialize the ring.

3.4 entity: An active functional agent within an Open System Interconnection (OSI) layer or sublayer, including both operational and management functions.

3.5 fibre optics: The technology whereby optical signals from light-generating transmitters are propagated through optical fibre waveguides to light-detecting receivers.

¹⁾ To be published.

3.6 frame: A PDU transmitted between co-operating MAC entities on a ring, consisting of a variable number of octets and control symbols.

3.7 Media Access Control (MAC): The Data Link Layer responsible for scheduling and routing data transmissions on a shared medium Local Area Network (e.g., an FDDI ring).

3.8 nonrestricted token: A Token denoting the normal mode of asynchronous bandwidth allocation, wherein the available bandwidth is time-sliced among all requesters.

3.9 octet: A data unit composed of eight ordered bits (a pair of data symbols).

3.10 Physical (PHY): The Physical Layer responsible for delivering a symbol stream produced by an upstream MAC Transmitter to the logically adjacent downstream MAC Receiver in an FDDI ring.

3.11 physical connection: The full-duplex physical layer association between adjacent physical layer entities (in concentrators, repeaters, or stations) in an FDDI ring.

3.12 primitive: An element of the service interface presented by an entity.

3.13 Protocol Data Unit (PDU): The unit of data transfer between communicating peer layer entities. It may contain control information, address information, data (e.g., an SDU from a higher layer entity), or any combination of the three. The FDDI MAC PDUs are Tokens and Frames.

3.14 receive: The action of a station in accepting a Token, Frame, or other symbol sequence from the incoming medium.

3.15 repeat: The action of a station in receiving a Token or Frame from the adjacent upstream station and simultaneously sending it to the adjacent downstream station. The FDDI MAC may repeat received PDUs (Tokens and Frames), but does not repeat the received symbol stream between PDUs. While repeating a Frame, MAC may copy the data contents and modify the control indicators as appropriate.

3.16 restricted token: A Token denoting a special mode of asynchronous bandwidth allocation, wherein the bandwidth available for the asynchronous class of service is dedicated to a single extended dialogue between specific requesters.

3.17 ring: Two or more stations connected by a physical medium wherein information is passed sequentially between active stations, each station in turn examining or copying and repeating the information, finally returning it to the originating station.

3.18 Service Data Unit (SDU): The unit of data transfer between a service user and a service provider.

3.19 services: A set of functions provided by one OSI layer sublayer entity, for use by a higher layer or sublayer entity or by management entities.

3.20 station: An addressable logical and physical attachment in a ring, capable of transmitting, receiving, and repeating information. An FDDI station has one or more PHY entities, one or more MAC entities, and one SMT entity.

3.21 Station Management (SMT): The supervisory entity within an FDDI station that monitors and controls the various FDDI entities including PMD, MAC, and PHY.

3.22 symbol: The smallest signalling element used by MAC, i.e., the PHY SDU. The symbol set consists of 16 data symbols and 8 control symbols. Each symbol maps to a specific sequence of five code bits as transmitted by the Physical Layer.

3.23 synchronous: A class of data transmission service whereby each requester is preallocated a maximum bandwidth and guaranteed a response time not to exceed a specific delay.

3.24 token: An explicit indication of the right to transmit on a shared medium. On a Token Ring, the Token circulates sequentially through the stations in the ring. At any time, it may be held by zero or one station. FDDI uses two classes of Tokens: restricted and nonrestricted.

3.25 transmit: The action of a station in generating a Token, Frame, or other symbol sequence and placing it on the outgoing medium.

4 Conventions and abbreviations

4.1 Conventions

The terms SMT, MAC, LLC, and PHY, when used without modifiers, refer specifically to the local entities. The term LLC unless otherwise qualified refers to any local user of MAC data services, other than SMT, including ISO 8802-2.

Low lines (e.g., `requested_service_class`) are used as a convenience to mark the name of signals, functions, etc., that might otherwise be misinterpreted as independent individual words if they were to appear in text.

The use of a period (e.g., `MA_UNITDATA.request`) is equivalent to the use of low lines except that a period is used as an aid to distinguish modifier words appended to an antecedent expression.

4.1.1 Addressing

my short address (MSA): 16-bit Individual Address of this station (0 = Null).

my long address (MLA): 48-bit Individual Address of this station (0 = Null). If a station does not implement 48-bit addressing then `MLA=0`.

short addresses: Set of 16-bit station Addresses including MSA if not Null, the 16-bit Broadcast Address (all ones), and any other 16-bit Group Addresses recognized by this station.

long addresses: Set of 48-bit Station Addresses including MLA if not Null, the 48-bit Broadcast Address (all ones), and any other 48-bit Group Addresses recognized by this station.

If a station does not implement 48-bit addressing, then `MLA = 0`.

When claiming the Token (i.e., the transmitter is in Claim Token state), if the station transmits with 16-bit addressing, then `MLA = 0`; conversely, if the station transmits with 48-bit addressing, then `MSA = 0`.

4.1.2 Timing values and timers:

All timing values are expressed as the unsigned two complements of the target, or remaining, time in octets, i.e., the numerically greater magnitude represents the shortest time remaining. This definition is for reference purposes only and does not prescribe the implementation, except where these timing values appear in Protocol Data Units on the ring. These timing values are not all used simultaneously in the state machines; consequently, the implementation need not materialize them when they are not needed.

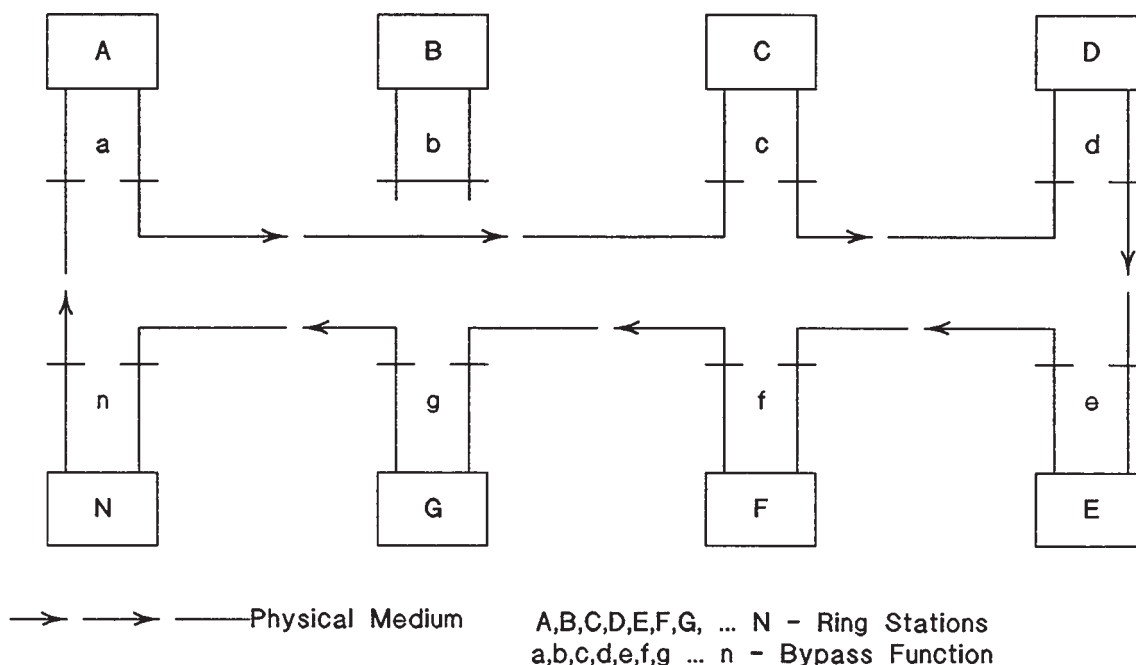
For the purpose of the description contained in this part of ISO 9314, all timers are assumed to be initialized with the unsigned two complement of the target, or remaining, time in octets. Timers are further assumed to count upward if enabled, expiring when an overflow occurs. All timer comparisons are expressed on the basis of elapsed time. These conventions are only for the convenience of documenting this part of ISO 9314 and do not prescribe implementation.

4.2 Abbreviations

Error_Ct	Count of reportable frame errors
Frame_Ct	Count of all frames received
Late_Ct	Count of TRT expirations (Token Lateness)
Lost_Ct	Count of PDUs detected as lost
A_Flag	Indicates Destination Address match in last received frame
C_Flag	Indicates successful copying of last received frame
E_Flag	Indicates error detected in last received frame
H_Flag	Indicates Higher Source Address received
L_Flag	Indicates Lower Source Address received
M_Flag	Indicates My Source Address received
N_Flag	Indicates next station addressing
R_Flag	Indicates the Token_class of the last valid Token received was restricted
A_Max	Maximum signal acquisition time
D_Max	Maximum ring latency time
F_Max	Maximum frame time
I_Max	Maximum station physical insertion time
L_Max	Maximum Transmitter Frame set-up time
M_Max	Maximum number of MAC entities allowed on the ring
S_Min	Minimum safety timing allowance
T_Bid_Rc	Bidding TTRT received by this station in Claim Frames
T_Bid_Tx	Bidding TTRT transmitted in this station's Claim Frames
T_Init	Ring initialization time
T_Max	Maximum TTRT to be supported by this station
T_Min	Minimum TTRT to be supported by this station
T_Neg	Negotiated TTRT during Claim process (in receiver)
T_Opr	Operative TTRT for this station (in transmitter)
T_Pri	Set of n priority Token rotation time thresholds
T_Pri(n)	Element n of the set T_Pri
T_React	Worst Case time to react to a station insertion or removal
T_Req	Requested TTRT for this station's synchronous traffic
T_Resp	Worst case time to recover a Token
THT	Token-Holding Timer
TRT	Token-Rotation Timer
TTRT	Target Token Rotation Time
TVX	Valid-Transmission Timer

5 General description

A Token ring consists of a set of stations serially connected by a transmission medium to form a closed loop (see figure 1). Information is transmitted sequentially, as a stream of symbols, from one active station to the next. Each station generally regenerates and repeats each symbol and serves as the means for attaching one or more devices to the ring for the purpose of communicating with other devices on the ring. A given station (the one that has access to the medium) transmits information on to the ring, where the information circulates from one station to the next. The addressed destination station(s) copies the information as it passes. Finally, the station that transmitted the information effectively removes it from the ring.



All stations are active except B (b illustrated in bypass mode)

Figure 1 - Token ring configuration example

A station gains the right to transmit its information on to the medium when it detects a Token passing on the medium. The Token is a control signal comprised of a unique symbol sequence that circulates on the medium following each information transmission. Any station, upon detection of a Token, may capture the Token by removing it from the ring. The station may then transmit one or more frames of information. At the completion of its information transmission, the station issues a new Token, which provides other stations the opportunity to gain access to the ring.

A Token-holding timer, or equivalent means, limits the length of time a station may use (occupy) the medium before passing the Token.

Multiple levels of priority are available for independent and dynamic assignment depending upon the relative class of service required. The classes of service may be synchronous (typically used for applications such as real-time voice), asynchronous (typically used for interactive applications), or immediate (used for extraordinary applications such as ring recovery). The allocation of ring bandwidth occurs by mutual agreement among users of the ring.

Error detection and recovery mechanisms are provided to restore ring operation in the event that transmission errors or medium transients (e.g., those resulting from station insertion or removal) cause the access method to deviate from normal operation. Detection and recovery for these cases utilizes a recovery function that is distributed among the stations attached to the ring.

The media access method as specified herein is not intended to place constraints on the logical link control or higher level protocols employed to effect data transfer.

6 Services

This clause specifies the services provided by MAC and the services required by MAC. The intent is to allow higher-level protocol(s) (e.g., ISO 8802-2) to operate correctly with this MAC. How many of the services described in this clause are chosen for a given implementation is up to that implementer; however, a set of MAC services shall be supplied sufficient to satisfy the higher level protocol(s) being used. The services as defined herein do not imply any particular implementation, or any interface. Services described are

- (a) MAC services provided to the local LLC entity, or other MAC users (indicated by MA__ prefix).
- (b) Services required from the local PHY entity by MAC (indicated by PH__ prefix).
- (c) MAC services provided to the local SMT entity (indicated by SM__MA__ prefix).

6.1 MAC-to-LLC services

This subclause specifies the services provided by the Medium Access Control (MAC) to allow the local LLC entity to exchange LLC service data units with peer LLC entities. These services are also used for implementer frames. The following primitives are defined:

MA__UNITDATA.request
 MA__UNITDATA.indication
 MA__UNITDATA__STATUS.indication
 MA__TOKEN.request

The description of each primitive includes a description of the information that is passed between the LLC and MAC entities.

6.1.1 MA__UNITDATA.request

This primitive defines the transfer of one or more Service Data Units (SDUs) from a local LLC entity to a single peer LLC entity, or to multiple peer LLC entities in the case of group addresses.

6.1.1.1 Semantics of the primitive

```

MA__UNITDATA.request
(
    FC_value (1),
    destination_address (1),
    M__SDU (1),
    requested_service_class (1),
    stream (1),
    FC_value (2),
    destination_address (2),
    M__SDU (2),
    requested_service_class (2),
    stream (2),
    .
    .
    .
    FC_value (n),
    destination_address (n),
    M__SDU (n),
    requested_service_class (n),
    stream (n),
    Token_class
)

```

Each set of FC_value, destination_address, M__SDU, requested_service_class and stream parameters specifies one frame for transmission and is referred to as a subrequest.

The FC_value parameter supplies the Frame Control (FC) field to be transmitted as part of the frame.

The destination_address parameter may specify either an individual or a group MAC address. It shall contain sufficient information to create the DA (Destination Address) field that is included in the frame by MAC. Address length is determined by the L bit of the associated FC_value parameter (see 7.3.3).

Each M__SDU parameter specifies an LLC service data unit as received at the MAC interface to be transmitted by MAC. There is sufficient information associated with the M__SDU for MAC to determine the length of the service data unit. Associated with each M__SDU is a requested_service_class parameter.

Requested_service_class may be either Synchronous or Asynchronous. If asynchronous, the requested_Token_class and the priority level may optionally be specified.

Stream is a parameter that, if set, shall cause multiple M__SDUs to be transmitted as a result of the MA__UNITDATA.request. Stream, when reset, indicates that this M__SDU is the last one associated with this MA__UNITDATA.request. The frames shall be transmitted in the order presented by this primitive regardless of the associated requested_service_class. If TRT (Token-Rotation Timer) has expired (Late_Ct not= 0) or if a frame is encountered that cannot be transmitted because of its associated requested_service_class and the current value of THT (Token-Holding Timer), then transmission is terminated and a Token is issued as defined by the Token_class parameter. A MA__UNITDATA__STATUS.indication is subsequently returned to LLC. If the transmission_status is successful, MAC may initiate transmission of the remaining frames on the next permitted access opportunity or, alternatively, MAC may require reissuance of a new MA__UNITDATA.request.

Token__class specifies the class of Token that MAC shall issue following transmission of the associated SDUs (i.e., at the end of the request), if no other request is pending that can be honoured. With requests for synchronous service the Token__class shall be the Token__class that was captured; with requests for asynchronous service it may be either restricted or nonrestricted. If no SDUs were specified by the MA__UNITDATA.request, then MAC shall immediately issue the requested class of Token.

6.1.1.2 When generated

This primitive is generated by the local LLC entity whenever data is to be transferred to a peer LLC entity or entities or a Token is to be generated. This may be in response to a request from higher layers of protocol or from data generated internally to LLC.

6.1.1.3 Effect of receipt

The receipt of this primitive shall cause MAC to append all MAC-specific fields, including DA, SA (Source Address), and any fields that are unique to the medium access method, and pass the properly formed frames to the lower layers of protocol for transfer to peer MAC entity or entities.

NOTE - This primitive is the normal means of requesting the transfer of data. The capture of a Token is implicit in this primitive and therefore it is not necessary to issue an MA__TOKEN.request primitive in conjunction with it.

6.1.2 MA__UNITDATA.Indication

This primitive defines the transfer of data from MAC to the local LLC entity.

6.1.2.1 Semantics of the primitive

```
MA__UNITDATA.indication
(
    FC__value,
    destination__address,
    source__address,
    M__SDU,
    reception__status
)
```

The FC__value parameter specifies the value of the frame's FC (Frame Control) field. The destination__address parameter may be either an individual or a group address as specified by the DA field of the incoming frame. The source__address parameter is an individual address as specified by the SA field of the incoming frame. The M__SDU parameter shall specify the MAC service data unit as received by the local MAC entity.

The reception__status parameter indicates the success or failure of the incoming frame. It consists of the following elements:

- (a) Frame validity: FR__GOOD, FR__BAD

If a FR__BAD is reported, the reason for the error shall also be reported. The reason shall be one of the following:

- (1) Invalid FCS: Calculated FCS (Frame Check Sequence) does not match the received FCS

(2) **Length Error:** The frame did not have a valid data length

(3) **Internal Error:** An internal error has occurred that prevents MAC from transferring to LLC a frame that has been acknowledged by the setting of the A (address recognized) and C (frame copied) indicators.

(b) **Frame Status:**

The received E (error detected), A, C, and, optionally, any other Indicator values.

6.1.2.2 When generated

The MA_UNITDATA.indication primitive shall be generated by MAC to indicate to the local LLC entity the arrival of an LLC frame addressed to this station.

6.1.2.3 Effect of receipt

The effect of receipt of this primitive by the LLC entity is not specified.

6.1.3 MA_UNITDATA_STATUS.Indication

This primitive shall provide an appropriate response to MA_UNITDATA.request primitive signifying the success or failure of the request.

6.1.3.1 Semantics of the primitive

```
MA_UNITDATA_STATUS.indication    (  
    number_of_SDUs,  
    transmission_status,  
    provided_service_class  
)
```

The number_of_SDUs parameter reports the number of M_SDUs transmitted on a given access opportunity as a result of this request.

The transmission_status parameter shall be used to pass information back to the local requesting LLC entity. It shall be used to indicate the success or failure of the previous associated MA_UNITDATA.request. If the MA_UNITDATA.request primitive specified more than one M_SDU, then the transmission_status parameter may apply to all of the SDUs transmitted, indicating if all were acknowledged, via the A and C indicators, by a peer MAC entity. In this case, the resolution of the transmission_status is implementer defined.

The provided_service_class parameter specifies the service class that was provided for the transfer.

6.1.3.2 When generated

This primitive shall be generated by MAC in response to an MA_UNITDATA.request primitive from the local LLC entity.

6.1.3.3 Effect of receipt

The effect of receipt of this primitive by LLC is unspecified.

NOTE - In the event of multiple outstanding requests, additional information may be needed in order for LLC to associate the response with the appropriate request. The association may be implied by the requests being serviced in a first-in-first-out (FIFO) manner. Alternatively, MAC may maintain multiple queues of requests, at least one for each class_of_service implemented, servicing each of these queues in a FIFO manner. It is assumed that if the addressed peer MAC entity, or entities, acknowledge receipt of the frame(s) (by setting the A and C indicators), then either the frame(s) will be delivered, or an internal error will be reported, to the corresponding LLC entity, or entities, via an MA_UNITDATA.indication.

6.1.4 MA_TOKEN.request

This primitive is used by LLC to request the capture of the next Token.

6.1.4.1 Semantics of the primitive

```
MA_TOKEN.request          (
                           requested_Token_class
                           )
```

Requested_Token_class may be either restricted or nonrestricted. The priority level may also be specified if multiple levels of priorities are implemented.

6.1.4.2 When generated

This primitive may be generated by the local LLC entity when data of a time critical nature is to be transferred.

6.1.4.3 Effect of receipt

The receipt of this primitive shall cause MAC to capture the next usable Token based on the requested_Token_class parameter. MAC then enters State T2 (Transmit Data) and transmits Idle symbols until an MA_UNITDATA.request primitive is received from LLC unless TRT expires first, in which case MAC shall issue another Token of the same Token_class as was captured.

NOTE - This primitive may be used for time critical operations to minimize the effects of ring latency. This mode of operation may cause longer than usual preambles preceding a frame, thus wasting ring bandwidth; therefore it should not be used for transfers of data on the FDDI ring that are not time critical.

6.2 PHY-to-MAC services

This subclause specifies the services provided at the interface between the MAC and PHY entities to allow MAC to exchange MAC protocol data units with peer MAC entities. Additional detail is provided in the FDDI Physical Layer Protocol standard (ISO 9314-1) concerning conditions that generate these primitives and PHY actions upon receipt of MAC generated primitives.

The following primitives are defined:

```
PH_UNITDATA.request
PH_UNITDATA.indication
PH_UNITDATA_STATUS.indication1)
PH_INVALID.indication
```

¹⁾ This PHY-to-MAC primitive is not used in this part of ISO 9314 on FDDI MAC.

The description of each primitive includes a description of the information that is passed between the MAC and PHY entities. All PHY service data units have the duration of one symbol period.

These services shall be "synchronous", e.g., each PH_UNITDATA.indication causes exactly one PH_UNITDATA.request. Depending upon the current internal configuration of the station, the PH_UNITDATA.request may be returned to the same PHY, or to a different PHY.

6.2.1 PH_UNITDATA.request

This primitive defines the transfer of data from MAC to the local PHY entity.

6.2.1.1 Semantics of the primitive

```
PH_UNITDATA.request      {
                           PH_Request(symbol)
                           }
```

The symbol specified by PH_Request(symbol) shall be one of the following: J, K, T, R, S, I, or n, where n is any of the 16 data symbols specified in the FDDI Physical Layer Protocol standard (ISO 9314-1).

6.2.1.2 When generated

MAC shall send PHY one PH_UNITDATA.request for each PH_UNITDATA.indication received from PHY.

6.2.1.3 Effect of receipt

The effect of receipt of this primitive by PHY is not specified.

6.2.2 PH_UNITDATA.indication

This primitive defines the transfer of data from the PHY entity to MAC.

6.2.2.1 Semantics of the primitive

```
PH_UNITDATA.indication   {
                           PH_Indication(symbol)
                           }
```

The symbol specified by PH_Indication(symbol) shall be one of the following: J, K, T, R, S, I, n, Q, H, or V.

6.2.2.2 When generated

The PHY entity sends MAC a PH_UNITDATA.indication every time PHY decodes a symbol. This indication is sent once every symbol period.

6.2.2.3 Effect of receipt

Upon receipt of this primitive, MAC shall accept a symbol from PHY, process it, and generate a corresponding PH_UNITDATA.request to PHY.