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Digital Imaging and Communications in Medicine (DICOM)

Part 8: Network Communication Support for Message Exchange

NEMA

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PS 3.8

Digital Imaging and Communications in Medicine (DICOM)
Part 8: Network Communication Support for Message Exchange

Approved by:
The American College of Radiology

Published by

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ACR-NEMA

Digital Imaging and Communications in Medicine
Part 8: Network Communication Support for Message Exchange

FOREWORD

ACR (the American College of Radiology) and NEMA (the National Electrical Manufacturers Association) formed a joint committee to develop a Standard for Digital Imaging and Communications in Medicine. This DICOM Standard was developed according to the NEMA Procedures.

This Standard is developed in liaison with other Standard Organizations including CEN TC251 in Europe and JIRA in Japan, with review also by other organizations including IEEE, ASTM, HL7 and ANSI in the USA.

The DICOM Standard is structured as a multi-part document using the guidelines established in the following document:

— ISO/IEC Directives, 1989 Part 3: Drafting and presentation of International Standards.

This document is one of the parts of the DICOM Standard which consists of the following parts:

PS 3.1: Introduction and Overview

PS 3.2: Conformance

PS 3.3: Information Object Definitions

PS 3.4: Service Class Specifications

PS 3.5: Data Structure and Semantics

PS 3.6: Data Dictionary

PS 3.7: Message Exchange

PS 3.8: Network Communication Support for Message Exchange

PS 3.9: Point-to-Point Communication Support for Message Exchange

These parts are related but independent documents. Their development level and approval status may differ.

NOTE—PS 3.8 may be used by implementors interested in providing ACR-NEMA Version 2.0 Application Message Exchange in a Networked Environment. Implementors need to define their own Abstract Syntaxes, Transfer Syntaxes and Application Contexts.

It is anticipated that this will be an evolving standard and that proposals for enhancements will be forthcoming from the member organizations based on input from users of this Standard. These proposals will be considered for future version of the Standard.

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In the preparation of this Standard, suggestions and comments from users, vendors, and other interested parties have been sought, evaluated, and included. Inquiries, comments, and proposed or recommended revisions should be submitted to the Diagnostic Imaging and Therapy Systems Division of NEMA by contacting:

Vice-President, Engineering Department
National Electrical Manufacturers Association
2101 L Street, N.W., Suite 300
Washington, D.C. 20037
USA

The DICOM Standard

This part (Part 8) of PS 3 specifies the services and the upper layer protocols necessary to support the communication of DICOM Application Entities in a networked environment. This part is used in conjunction with other related parts of PS 3 as presented in PS 3.1: Introduction and Overview.

The Network Communication Services and Protocols specified ensure that the communication of DICOM Application Entities is performed in an efficient and coordinated manner across the network. It allows peer Application Entities (AE) to establish associations, transfer data and terminate associations.

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Digital Imaging and Communications in Medicine
Part 8: Network Communication Support for Message Exchange

1 Scope and field of application

The Communication Protocols specified in this part of PS 3 closely fit the ISO Open Systems Interconnection Basic Reference Model (ISO 7498-1, see Figure 1-1). They relate to the following layers: Physical, Data Link, Network, Transport, Session, Presentation and the Association Control Services (ACSE) of the Application layer. These communication protocols specified by this part are general purpose communication protocols (OSI, TCP/IP) and not specific to this standard. The other aspects of the Application Layer protocols are addressed in other parts of this standard as discussed in PS 3.1: Introduction and Overview.

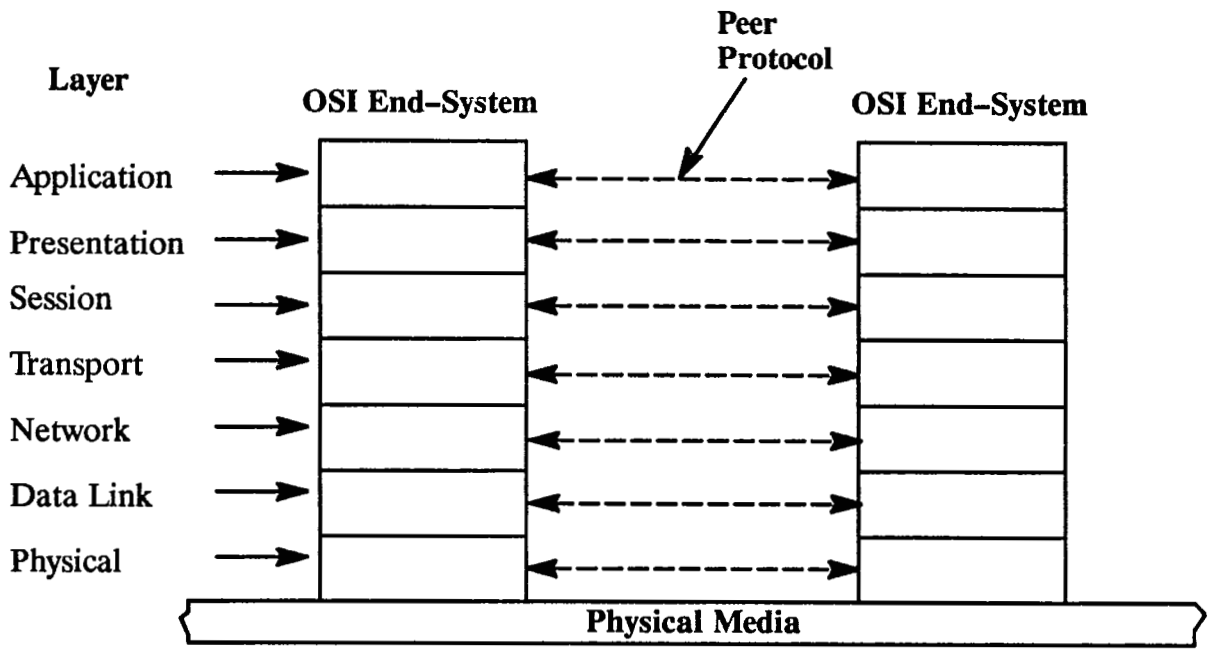

Figure 1-1—ISO OSI basic reference model

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2 Normative references

2.1 *International Standards*

ISO 7498-1, Information Processing Systems - Open Systems Interconnection - Basic Reference Model

ISO 7498-3, OSI Basic Reference Model - Part 3: Naming and Addressing

ISO 8327:1987, Information Processing Systems - Open Systems Interconnection - Connection Oriented Session Protocol Specification

ISO 8327/AM 2, Information Processing Systems - Open Systems Interconnection - Connection Oriented Session Protocol Specification - Amendment 2: Incorporation of Unlimited User Data

ISO 8649:1987, Information Processing Systems - Open Systems Interconnection - Service Definition for the Association Control Service Element

ISO 8650:1987, Information Processing Systems - Open Systems Interconnection - Protocol Specification for the Association Control Service Element

ISO TR 8509, Information Processing Systems - Open Systems Interconnection - Service Conventions

ISO 8822:1988, Information Processing Systems - Open Systems Interconnection - Connection-Oriented Presentation Service Definition

ISO 8823:1988, Information Processing Systems - Open Systems Interconnection - Connection Oriented Presentation Protocol Specification

ISO 8824:1990, Information Processing Systems - Open Systems Interconnection - Specification of Abstract Syntax Notation One (ASN.1)

ISO 8825:1990, Information Processing Systems - Open Systems Interconnection - Specification of Basic Encoding Rules for Abstract Syntax Notation One (ASN.1)

ISO/IEC 9545, Information Processing Systems - Open Systems Interconnection - Application Layer Structure

ISO/IEC 9834-3, Information Processing Systems - Open Systems Interconnection - Part 3: Procedures for the Assignment of Object Identifier Component Values for Joint OSI-CCITT Use

ISO/IEC TR 10000-1, Information Processing Systems - Open Systems Interconnection - International Standardized Profiles, Part 1: Taxonomy Framework

2.2 *Other documents*

NIST Special Publication 500-150 - Stable Implementation Agreements for Open Systems Interconnection Protocols

RFC 791, Internet Protocol - DARPA Internet Protocol Specification

RFC 792, Internet Control Message Protocol - DARPA Internet Program Protocol Specification

RFC 793, Transmission Control Program - DARPA Internet Protocol Specification

RFC 950, Internet Subnetting

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3 Definitions

3.1 *Reference model definitions*

This part of the Standard is based on the concepts developed in ISO 7498-1 and makes use of the following terms defined in it:

a) application entity

b) application layer

c) application process

d) data link layer

e) layer entity

f) network layer

g) physical layer

h) presentation layer

i) presentation service

j) protocol or layer protocol

k) protocol data unit or layer protocol data unit

l) service or layer service

m) service access point

n) session layer

o) transfer syntax

p) transport layer

q) transport protocol

r) transport connection

3.2 *Naming and addressing definitions*

This part of the Standard makes use of the following terms defined in ISO 7498-3:

a) calling presentation address

b) called presentation address

c) responding presentation address

d) called application entity title

e) calling application entity title

3.3 *Service conventions definitions*

This part of the Standard makes use of the following terms defined in ISO/TR 8509:

a) service provider

b) service user

c) confirmed service

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d) non-confirmed service

e) primitive

f) request (primitive)

g) indication (primitive)

h) response (primitive)

i) confirmation (primitive)

3.4 *Presentation service definitions*

This part of the Standard makes use of the following terms defined in ISO 8822:

a) abstract syntax

b) abstract syntax name

c) presentation context

d) presentation data values

e) transfer syntax

f) transfer syntax name

3.5 *ACSE service definitions*

This part of the Standard makes use of the following terms defined in ISO 8649:

a) association or application association

b) application context

c) association control service element

d) association initiator

3.6 *DICOM introduction and overview definition*

a) message

3.7 *DICOM communication support definitions*

The following definitions are commonly used in this part of the Standard:

3.7.1 network interface unit: A gateway system which offers a Network Interface and a DICOM Point-to-Point Interface. It relays the messages from one interface to the other.

3.7.2 unique identifier (UID): The scheme used to provide global unique identification for objects. It uses the structure defined by ISO 8824 for OSI Object Identifiers.

3.7.3 DICOM upper layer: The Upper Layer protocols are related to the Session, Presentation and part of the Application Layer of the ISO reference model. These protocols provide the Upper Layer Service. This Service is a proper subset of the ACSE Service and OSI Presentation Layer Service.

4 Symbols and abbreviations

The following symbols and abbreviations are used in this part of the Standard.

4.1 ACR American College of Radiology

4.2 ACSE Association Control Service Element

4.3 ASCII American Standard Code for Information Interchange

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4.4 AE Application Entity

4.5 ANSI American National Standards Institute

4.6 AP Application Process

4.7 ASE Application Service Element

4.8 ARTIM Association Request/Reject/Release Timer

4.9 CEN TC251 Comite Europeen de Normalisation-Technical Committee 251 - Medical Informatics

4.10 CSMA/CD Carrier Sense Multiple Access/Collision Detection

4.11 DICOM Digital Imaging and Communications in Medicine

4.12 EPHOS European Procurement Handbook for Open Systems

4.13 EWOS European Workshop for Open Systems

4.14 EWOS EG MED EWOS Expert Group Healthcare

4.15 FDDI Fiber Distributed Data Interface

4.16 HL7 Health Level 7

4.17 IEC International Electrotechnical Commission

4.18 IEEE Institute of Electrical and Electronics Engineers

4.19 ISDN Integrated Services Digital Network

4.20 ISO International Organization for Standardization

4.21 ISP International Standardized Profile

4.22 JIRA Japan Industries Association of Radiation Apparatus

4.23 LAN Local Area Network

4.24 MAP Manufacturing Automation Protocol

4.25 NEMA National Electrical Manufacturers Association

4.26 NIST National Institute of Standards and Technology

4.27 NIU Network Interface Unit

4.28 OSI Open Systems Interconnection

4.29 PDU Protocol Data Unit

4.30 PDV Presentation Data Values

4.31 SAP Service Access Point

4.32 TCP/IP Transmission Control Program/Internet Protocol

4.33 TOP Technical and Office Protocols

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4.34 UID Unique Identifier

4.35 UL Upper Layers

4.36 US GOSIP United States Government Open Systems Interconnection Profile

4.37 WAN Wide Area Network

5 Conventions

The following conventions are used for the service description tables shown in this part of the Standard.

(=)	The same parameter value used in the indication or confirmation shall be the same as used in the request or response respectively.
C	Conditional (on User Option)
M	Mandatory usage
MF	Mandatory with a fixed value
NU	Not Used
P	Provider Initiated
U	User Option
UF	User Option with a fixed value

Blank entries are not applicable.

6 Network communication support environment

The Network Communication Services specified in PS 3.8 are a set of generic services provided to support the communication of DICOM Application Entities. They are a proper subset of the services offered by the OSI Presentation Service (ISO 8822) and of the OSI Association Control Service Element (ACSE) (ISO 8649). They shall be referred to as the Upper Layer Service or UL Service. The DICOM UL Service is specified in Section 7.

This definition of the Upper Layer Service allows the use of a fully conformant stack of OSI protocols (Layers 1 through 6 plus ACSE) to achieve robust and efficient communication. It supports a large variety of international standards based network technologies using the widest choice of physical networks such as ISO 8802-3 CSMA/CD (often referred to as Ethernet), FDDI, ISDN, X.25, dedicated digital circuits and many other LAN and WAN network technologies. This DICOM stack of OSI protocols is specified in Section 8.

When this UL Service is provided by the Upper Layer Protocol for TCP/IP (see Section 9) a broad range of existing networking environments can also be used for DICOM based medical imaging communication.

The definition of an UL Service common to both OSI and TCP/IP environments allows migration from a TCP/IP to an OSI environment without impacting the DICOM Application Service Elements.

This UL Service is also a superset of the DICOM Session/Transport/Network Service defined in PS 3.9 to support a point-to-point interface ("50 pin interface"). This superset property of the UL Service permits the interconnection of a device with a point-to-point interface to a fully networked communication environment supported by OSI and TCP/IP. PS 3.1 discusses how a point-to-point interface and a networked environment coexist.

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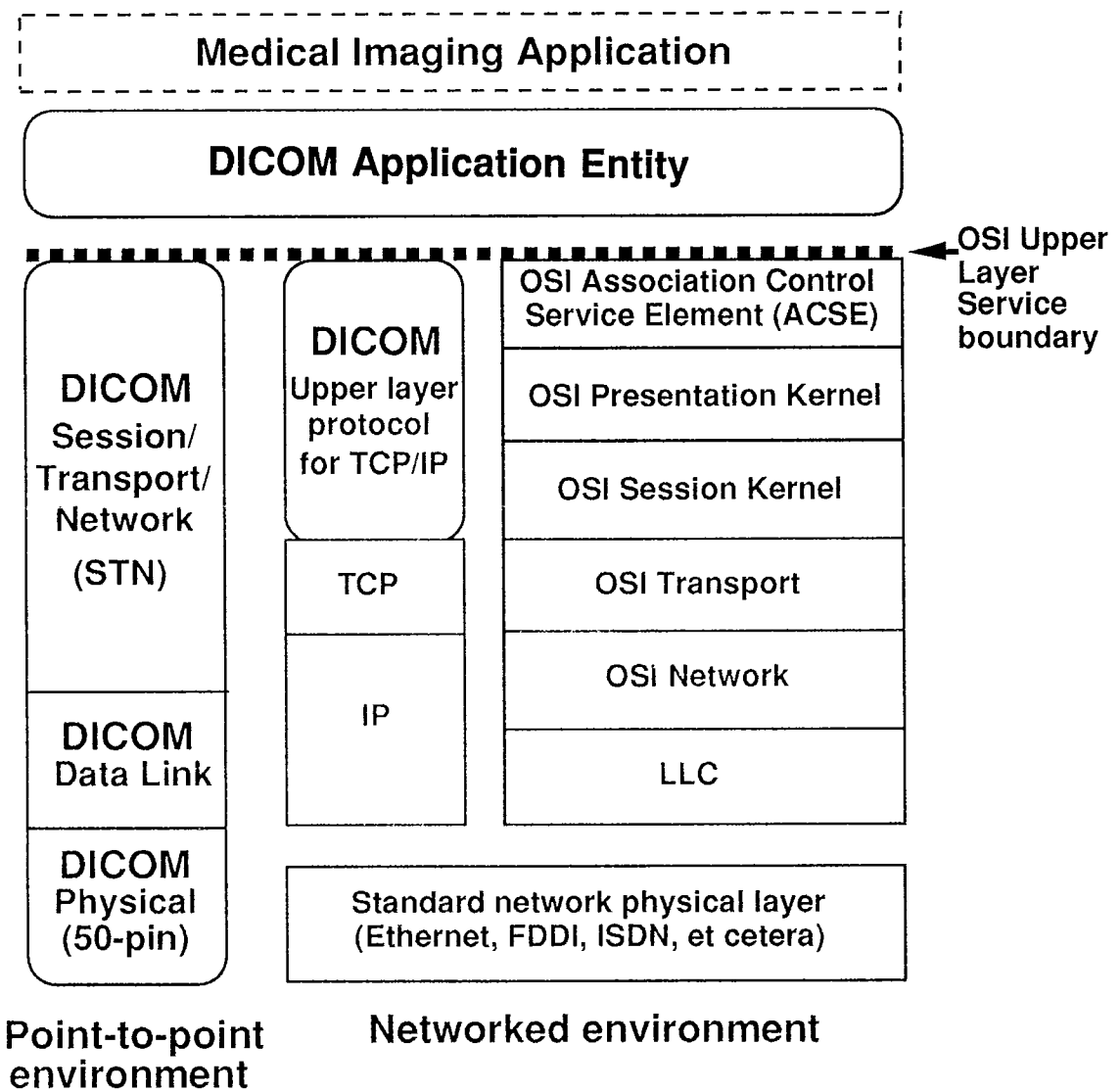
Figure 6-1 shows the three protocol stacks that are available to support the communication of DICOM Application Entities.



Note: The DICOM STN supports a subset of the OSI upper layer service.

Figure 6-1—DICOM V3.0 protocol architecture

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7 OSI upper layer service for DICOM application entities

This section provides a description of how to use the OSI Association Control Service Element (ACSE) and OSI Presentation Layer to provide the Upper Layer Service necessary to support the communication of DICOM Application Entities. This Upper Layer Service is a fully conformant subset of the services offered by the ACSE and the OSI Presentation Layer.

The UL Services are listed in Table 7-1.

Table 7-1—Upper layer services

SERVICE	TYPE
A-ASSOCIATE	Confirmed
A-RELEASE	Confirmed
A-ABORT	Non-Confirmed
A-P-ABORT	Provider-initiated
P-DATA	Non-Confirmed

In addition to the Upper Layer Service specification, this section defines at the parameter level the use of each element of this Upper Layer Service by DICOM Application Entities. The rules guiding the use of this Upper Layer Service by the DICOM Application Entities are addressed in PS 3.7.

7.1 *A-ASSOCIATE service*

The establishment of an association between two AEs shall be performed through ACSE A-ASSOCIATE request, indication, response and confirmation primitives. The initiator of the service is hereafter called a requestor and the service-user which receives the A-ASSOCIATE indication is hereafter called the acceptor. It shall be a confirmed service.

NOTE—The A-ASSOCIATE service supports the equivalent of a channel establishment in a point-to-point interface (See PS 3.9).

Figure 7-1 illustrates the association establishment between two AEs.

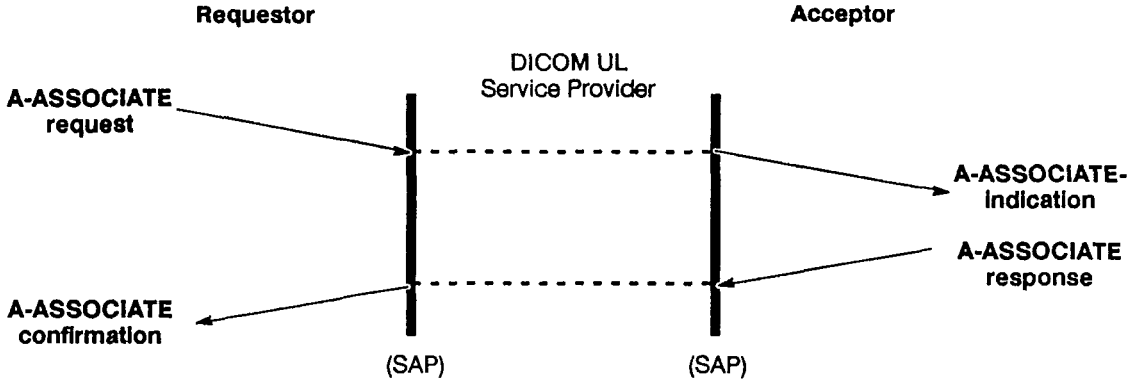

Figure 7-1—Associate request

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7.1.1 A-ASSOCIATE PARAMETERS

Table 7-2 lists the parameters that shall be required for the A-ASSOCIATE service used by DICOM Application Entities in this standard.

Table 7-2—Key A-ASSOCIATE service parameters

A-ASSOCIATE parameter name	Request	Indication	Response	Confirmation
application context name	M	M(=)	M	M(=)
calling AE title	M	M(=)	M	M(=)
called AE title	M	M(=)	M	M(=)
user information	M	M(=)	M	M(=)
result			M	M(=)
result source				M
diagnostic			U	C(=)
calling presentation address	M	M(=)		
called presentation address	M	M(=)		
presentation context definition list	M	M(=)		
presentation context definition list result			M	M(=)

NOTE—See Section 5 of this part for table conventions.

Table 7-3 lists the parameters for the A-ASSOCIATE service which shall contain fixed values or shall not be used by DICOM Application Entities in this standard.

Table 7-3—A-ASSOCIATE service parameter (fixed or not used)

A-ASSOCIATE parameter name	Request	Indication	Response	Confirmation
mode	UF	MF(=)		
responding AE title			MF	MF(=)
calling/called/responding AE qualifier	NU	NU	NU	NU
calling/called/responding AP invoc-id	NU	NU	NU	NU
calling/called/responding AE invoc-id	NU	NU	NU	NU
responding presentation address			MF	MF(=)
default context name/result	NU	NU	NU	NU
presentation & session requirements	UF	UF(=)	UF	UF(=)
other parameters (see ISO 8822 & 8649)	NU	NU	NU	NU

7.1.1.1 Mode (fixed)

This parameter allows the negotiation of the optional Mode OSI-ACSE Service parameter. Only the default value of "normal" is used by DICOM Application Entities. Therefore, this parameter shall always specify the value "normal."

7.1.1.2 Application context name

This parameter identifies the application context proposed by the requestor. The acceptor shall return either the same or a different name. The returned name shall specify the application context to be used for this association. Further discussion on Application Context Names can be found in Annex A.

An application context is an explicitly defined set of application service elements, related options, and any other information necessary for the interworking of application entities on an association.

NOTE—The offer of an alternate application context by the acceptor provides a mechanism for limited negotiation. If the requestor cannot operate in the acceptor's application context, it shall issue an A-Abort request primitive. Application Context Names for the DICOM Application Entity as well as Application Context Names usage rules are defined in PS 3.7.

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7.1.1.3 Calling AE title

This parameter identifies the Application Entity (AE) that shall contain the requestor of the A-ASSOCIATE service. It is based on the Source DICOM Application Name. The relationship between DICOM Application Names and AE titles is specified in Annex C. The Calling AE title may or may not be the same as the Initiator Address present in DICOM Messages exchanged over the association.

NOTE—It is the responsibility of the UL User that received the A-ASSOCIATE-RQ to verify whether the Calling AE Title is one of its known remote DICOM Application Names.

7.1.1.4 Called AE title

This parameter identifies the Application Entity that shall contain the intended acceptor of the A-ASSOCIATE service. It is based on the Destination DICOM Application Name. The relationship between DICOM Application Name and AE titles is specified in Annex C. The Called AE title may or may not be the same as the Receiver Address present in DICOM Messages exchanged over the association.

NOTE—It is the responsibility of the UL User that received the A-ASSOCIATE-RQ to verify whether the Called AE Title is its (or one of its) DICOM Application Name(s).

7.1.1.5 Responding AE title (fixed)

This parameter identifies the AE that shall contain the actual acceptor of the A-ASSOCIATE service. In this standard it shall always contain the same value as the Called AE Title of the A-ASSOCIATE indication.

7.1.1.6 User information

This parameter shall be used by the requestor and the acceptor of the association to include DICOM Application Entity user information. Its meaning shall depend on the application context that accompanies the primitive. The usage of this parameter is specified in Annex D.

NOTE—This parameter is used to carry initialization information for the DICOM Application Entities as defined in the application context specified by the value of the accompanying Application Context Name parameter.

7.1.1.7 Result

This parameter shall be provided either by the acceptor of the A-ASSOCIATE request, by the UL service-provider (ACSE related function), or by the UL service-provider (Presentation related function). It shall indicate the result of using the A-ASSOCIATE service. It shall take one of the following symbolic values:

a) accepted;
b) rejected (permanent);
c) rejected (transient).

NOTE—The rejected (permanent) implies that the association calling UL user (when returning such a result to an association request) does not need to "call later." A permanent situation exists that prevents the association establishment (e.g. remote DICOM Application Name unknown).

7.1.1.8 Result source

The value of the parameter is supplied by the UL service-provider. It identifies the creating source of the Result parameter and the Diagnostic parameter, if present. It shall take one of the following symbolic values:

a) UL service-user;
b) UL service-provider (ACSE related function);
c) UL service-provider (Presentation related function).

NOTE—If the Result parameter has the value "accepted," the value of this parameter is "UL service-user."

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7.1.1.9 Diagnostic

This parameter shall only be used if the Result parameter has the value of "rejected (permanent)" or "rejected (transient)." It shall be used to provide diagnostic information about the result of the A-ASSOCIATE service.

If the Result Source parameter has the value "UL service-user," it shall take one of the following symbolic values:

a) no-reason-given

b) application-context-name not supported

c) calling-AE-title not recognized

d) called-AE-title not recognized

e) calling-AE-qualifier not recognized (see note)

f) calling-AP-invocation-identifier not recognized (see note)

g) calling-AE-invocation-identifier not recognized (see note)

h) called-AE-qualifier not recognized (see note)

i) called-AP-invocation-identifier not recognized (see note)

j) called-AE-invocation-identifier not recognized (see note)

If the Result Source parameter has the value "UL service-provider" (ACSE related function), it shall take one of the following symbolic values:

a) no-reason-given

b) no-common-UL version

If the result source has the value "UL service-provider" (Presentation related function), it shall take the following symbolic values:

a) no-reason-given

b) temporary-congestion

c) local-limit-exceeded

d) called-(Presentation)-address-unknown

e) Presentation-protocol version not supported

f) no-(Presentation) Service Access Point (SAP) available

NOTE—Even though some of the above symbolic values correspond to parameter errors not used in this standard, they are included to allow the notification of errors resulting from the unauthorized use of these parameters.

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7.1.1.10 Calling presentation address

This parameter shall contain a structured destination address unambiguous within the global network address structure. This shall be either an OSI Presentation Address or a TCP/IP Address. See Annex C.

7.1.1.11 Called presentation address

This parameter shall contain a structured destination address unambiguous within the global network address structure. This shall be either an OSI Presentation Address or a TCP/IP Address. See Annex C.

7.1.1.12 Responding presentation address

In this standard, a responding presentation address shall always contain the same value as the called Presentation Address of the A-ASSOCIATE indication. This parameter shall contain a structured destination address unambiguous within the global network address structure.

7.1.1.13 Presentation context definition list

This parameter used in an A-ASSOCIATE request or indication shall consist of a list containing one or more presentation contexts. Each item shall contain three components, a presentation context identification, an Abstract Syntax Name, and a list of one or more Transfer Syntax Names.

The presentation context identification components of this parameter exist to distinguish presentation contexts in communication. Such an identification of presentation context(s) applies only within the context of a given association (i.e. different presentation contexts may be identified by the same presentation context identification on different associations). It is the association-requestor's responsibility to assign an arbitrary, but unused identifier for each proposed presentation context on a given association.

NOTE—A separate presentation context will be associated with each Abstract Syntax Name in each of the elements of the Presentation Context Definition List parameter. If the same Abstract Syntax Name occurs more than once, a separate and distinctly identified presentation context will be generated for each occurrence (as only one Transfer Syntax per presentation context can be accepted).

Abstract Syntaxes defined by this standard and used by DICOM Application Entites are defined in PS 3.4. Transfer Syntaxes defined by this standard and used by DICOM Application Entities are defined in PS 3.5. Further discussion on Abstract Syntaxes and Transfer Syntaxes can be found in Annex B.

7.1.1.14 Presentation context definition result list

This parameter used in the A-ASSOCIATE Response and Confirmation indicates the acceptance or rejection of each of the presentation context definitions proposed in the presentation context definition list parameter (Section 7.1.1.13). The Presentation Context Definition Result List parameter shall take the form of a list of result values. There is a one to one correspondence between each one of these result values and each of the presentation contexts proposed in the Presentation Context Definition List parameter. Each result value represents either "acceptance," "user-rejection," or "provider-rejection." The values of the results are assigned by the UL user on the response service primitive.

In this standard only one Transfer Syntax per presentation context shall be agreed to, even though more than one choice of Transfer Syntaxes may have been offered in a specific presentation context of the Presentation Context Definition list.

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7.1.1.15 Presentation requirements (fixed value)

This parameter allows the negotiation of optional presentation functional units beyond the Presentation Kernel. Only the Kernel Functional Unit is used by DICOM Application Entities. Therefore, this parameter shall always specify "Presentation Kernel."

7.1.1.16 Session requirements (fixed value)

This parameter allows the negotiation of optional session Functional Units beyond the Session Kernel. Only the Kernel functional unit with the Full Duplex Functional Unit shall be used by DICOM Application Entities.

7.1.1.17 Other parameters

A few optional parameters defined in the OSI ACSE (ISO 8649) and OSI Presentation Service (ISO 8822) Standards are not identified here. They are not necessary for the communication of DICOM Application Entities and shall not be used in this standard.

7.1.2 A-ASSOCIATE SERVICE PROCEDURE

7.1.2.1 A DICOM Application Entity (which includes the Upper Layer service-user) that desires to establish an association shall issue an A-ASSOCIATE request primitive. The called AE is identified by parameters of the request primitive. The requestor shall not issue any primitives except an A-ABORT request primitive until it receives an A-ASSOCIATE confirmation primitive.

7.1.2.2 The Upper Layer (UL) service-provider shall issue an A-ASSOCIATE indication primitive to the called AE.

7.1.2.3 The called AE shall accept or reject the association by sending an A-ASSOCIATE response primitive with an appropriate Result parameter. The Upper layer service-provider shall issue an A-ASSOCIATE confirmation primitive having the same Result parameter. The Result Source parameter shall be assigned the symbolic value of "UL service-user."

7.1.2.4 If the acceptor accepts the association, the association is available for use. Both AEs may now use any service provided by the DICOM application context that is in effect (with the exception of A-ASSOCIATE).

NOTE—This implies that once the association has been established, DICOM Messages can be exchanged as defined in PS 3.7.

7.1.2.5 If the called AE rejects the association, the association shall not be established.

7.1.2.6 The UL service-provider may not be capable of supporting the requested association. In this situation, it shall return an A-ASSOCIATE confirmation primitive to the requestor with an appropriate Result parameter (rejected). The Result Source parameter shall be appropriately assigned either the symbolic value of "UL service-provider (ACSE related function)" or "UL service-provider (Presentation related function)." The indication primitive shall not be issued. The association shall not be established.

7.1.2.7 Either an association-requestor or acceptor may disrupt the A-ASSOCIATE service procedure by issuing an A-ABORT request primitive (see Section 7.3). The remote AE receives an A-ABORT indication primitive. The association shall not be established.

7.2 *A-RELEASE service*

The graceful release of an association between two AEs shall be performed through ACSE A-RELEASE request, indication, response, and confirmation primitives. The initiator of the service is hereafter called a requestor and the service-user which receives the A-RELEASE indication is hereafter called the acceptor. It shall be a confirmed service.

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Figure 7-2 illustrates the graceful release of an association between two AEs.

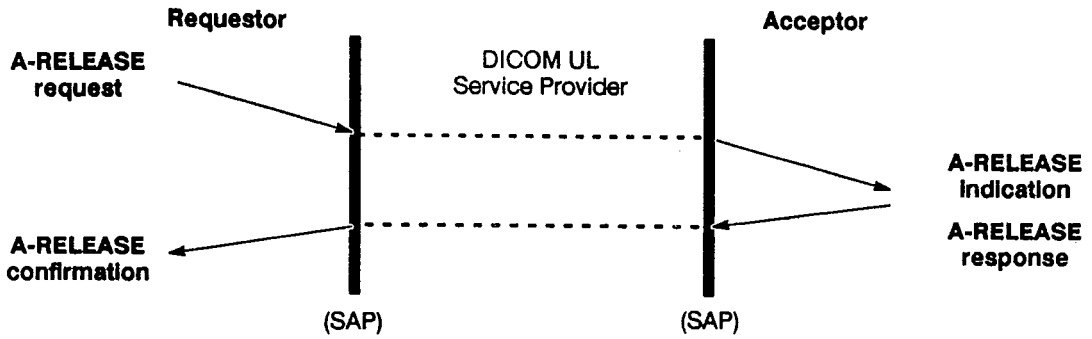

Figure 7-2—Association release

7.2.1 A-RELEASE PARAMETERS

Table 7-4 lists the parameters for the A-RELEASE service which shall contain fixed values or shall not be used by DICOM Application Entities in this standard.

Table 7-4—A-RELEASE service parameters

A-RELEASE parameter name	Request	Indication	Response	Confirmation
reason	UF	UF(=)	UF	UF(=)
user information	NU	NU(=)	NU	NU(=)
result			MF	MF(=)

7.2.1.1 Reason (fixed)

When used on the request primitive, this parameter identifies the general level of urgency of the request. This parameter shall always use the value "normal" in this standard.

7.2.1.2 Result (fixed)

This parameter shall always take the value "affirmative" in this standard.

7.2.2 A-RELEASE SERVICE PROCEDURE

7.2.2.1 An UL service-user that desires to release the association shall issue an A-RELEASE request primitive. This requestor shall not issue any further primitives other than an A-ABORT request primitive until it receives an A-RELEASE confirmation primitive.

NOTE—Even though the requestor of the A-RELEASE service shall not issue any further primitive other than A-ABORT, it may receive P-DATA Indication primitives.

7.2.2.2 The UL service-provider shall issue an A-RELEASE indication primitive to the acceptor. The acceptor then shall not issue any UL primitives other than an A-RELEASE response primitive, an A-ABORT request primitive, or P-DATA Request primitive.

7.2.2.3 To complete the A-RELEASE service, the acceptor shall reply to the A-RELEASE indication primitive by issuing an A-RELEASE response primitive. An accepting DICOM Application Entity shall always issue an A-RELEASE response primitive with an "affirmative" result parameter (i.e. accept the release).

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7.2.2.4 After an A-RELEASE response has been issued, the acceptor shall not issue any further primitives for the association thereafter, including P-DATA Requests.

7.2.2.5 The UL service-provider shall issue an A-RELEASE confirmation primitive always with an "affirmative" value for the Result parameter.

7.2.2.6 A requestor in either AE may disrupt the A-RELEASE service procedure by issuing an A-ABORT request. When the acceptor receives an A-ABORT indication, the association is released with the possible loss of information in transit.

7.2.2.7 An A-RELEASE service procedure collision results when requestors in both AEs simultaneously issue an A-RELEASE service primitive. In this situation, both UL service-users receive an unexpected A-RELEASE indication primitive. The following sequence shall occur to complete the normal release of the association:

a) The association-requestor shall issue an A-RELEASE response primitive.

b) The association-acceptor waits for an A-RELEASE confirmation primitive from its peer. When it receives one, it shall then issue an A-RELEASE response primitive.

c) The association-requestor receives an A-RELEASE confirmation primitive.

The association shall be released when both ACSE service-users have received an A-RELEASE confirmation primitive.

7.3 *A-ABORT service*

The ACSE A-ABORT service shall be used by a requestor in either of the AEs to cause the abnormal release of the association. It shall be a non-confirmed service. However, because of the possibility of an A-ABORT service procedure collision, the delivery of the indication primitive is not guaranteed. Should such a collision occur, both AEs are aware that the association has been terminated. The abort shall be performed through A-ABORT request and A-ABORT indication primitives.

NOTE—An A-ABORT request primitive used on an established association may result in the destruction of data in transit.

Figure 7-3 illustrates aborting an established association between two AEs.

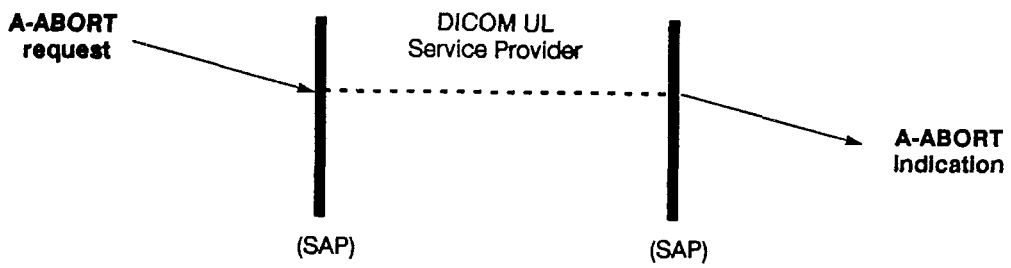

Figure 7-3—Association user initiated abort

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7.3.1 A-ABORT PARAMETERS

Table 7-5 lists the parameters for the A-ABORT service. Only the first parameter shall be used by DICOM Application Entities in this standard.

Table 7-5—A-ABORT service parameters

A-ABORT Parameter Name	Request	Indication
abort source		M
user information	NU	NU(=)

7.3.1.1 Abort source

This parameter indicates the initiating source of this abort. It shall take one of the following symbolic values:

a) UL service-user
b) UL service-provider (ACSE related)

7.3.2 A-ABORT SERVICE PROCEDURE

7.3.2.1 When the A-ABORT service is used, the association shall be released abnormally and simultaneous with the abnormal release of the underlying connection.

7.3.2.2 A UL service-user that desires to release the association abnormally shall issue the A-ABORT request primitive. This requestor shall not issue any further primitives for the association.

7.3.2.3 The UL service-provider shall issue an A-ABORT indication primitive to the acceptor. The UL service-provider shall assign the value of "UL service-user" for the Abort Source parameter. The association and the underlying connection have been released.

7.3.2.4 The UL service-provider (ACSE related functions) may itself cause the abnormal release of the association because of internal errors. In this case, the UL service-provider shall issue A-ABORT indication primitives to acceptors in both AEs. The UL service-provider shall assign the value of "UL service-provider" to the Abort Source parameter. The user information parameter shall not be used.

7.4 *A-P-ABORT service*

The ACSE A-P-ABORT service shall be used by the UL service-provider to signal the abnormal release of the association due to problems in services at the Presentation Layer and below. This occurrence indicates the possible loss of information in transit. A-P-ABORT is a provider-initiated service.

Figure 7-4 illustrates aborting an established association by an UL service-provider.

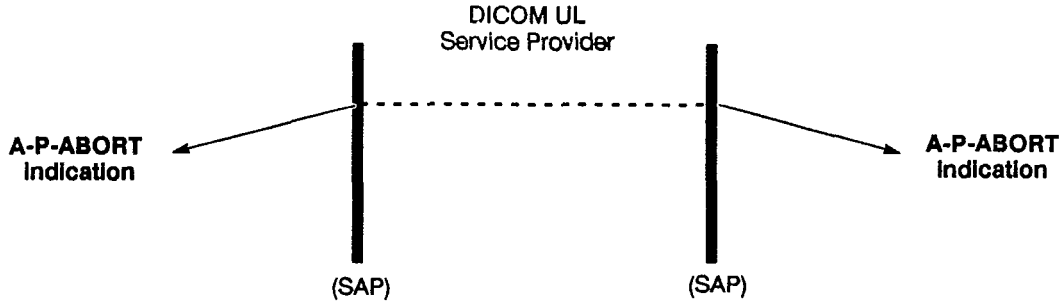

Figure 7-4—Provider initiated abort

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7.4.1 A-P-ABORT PARAMETER

Table 7-6 lists the parameter which shall be required for the A-P-ABORT service.

Table 7-6—A-P-ABORT service parameters

A-P-ABORT Parameter Name	Indication
provider reason	P

The provider reason parameter shall be used to convey one of the following reasons:

a) reason-not-specified

b) unrecognized-pdu

c) unexpected-pdu

d) unexpected-session-service primitive

e) unrecognized-pdu parameter

f) unexpected-pdu parameter

g) invalid-pdu-parameter value

NOTE—In addition to these reasons, a locally defined list of reasons may be used to reflect errors that caused the abort and originated in the Session, Transport, Network, Data Link, and Physical layers. The generation and handling of such errors is internal to an implementation and, therefore, is outside the scope of this communications standard.

7.4.2 A-P-ABORT SERVICE PROCEDURE

When the UL service-provider detects an internal error, A-P-ABORT indication primitives shall be issued to acceptors in both AEs. The association shall be abnormally released. Requestors in both AEs shall not issue any further primitives for the association.

7.5 *Sequencing information*

Interactions among the specific service procedures, discussed in Sections 7.1 through 7.4 for the ACSE subset of the Upper Layer Service, are defined in clause 10 of ISO 8649 - The ACSE Service Definition.

7.6 *P-DATA service*

This Presentation P-DATA Service shall be used by either AE to cause the exchange of application information (i.e. DICOM Messages). DICOM Messages shall be exchanged as defined in PS 3.7. An association provides a simultaneous bi-directional exchange of P-DATA request/indication primitives.

Figure 7-5 illustrates the transfer of data on an established association between two AEs.

7.6.1 P-DATA PARAMETERS

Table 7-7 lists the parameter which shall be required for the P-DATA service.

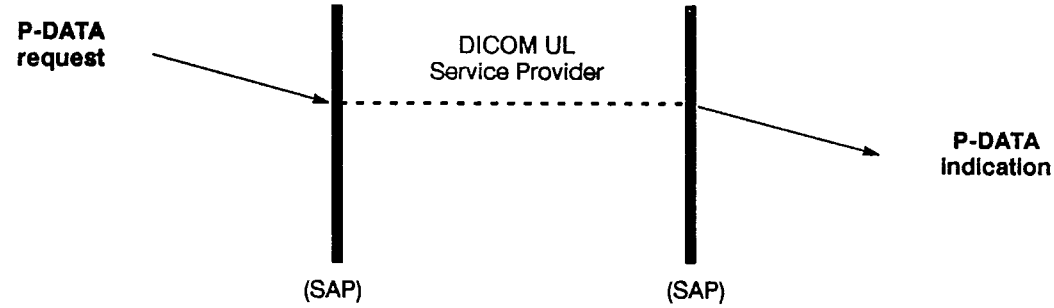

Figure 7-5—Data transfer

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Table 7-7—P-DATA service parameter

P-DATA Paramater Name	Request	Indication
presentation data value list	M	M(=)

The Presentation Data Value List parameter shall contain one or more Presentation Data Values (PDV). Each PDV shall consist of two parameters: a Presentation Context ID and User Data values. The User Data values are taken from the Abstract Syntax and encoded in the Transfer Syntax identified by the Presentation Context ID. This referenced Presentation Context ID identifies one of the presentation contexts agreed to at association time. The User Data values format used in each PDV by the DICOM Application Entities is specified in Annex E.

8 DICOM OSI upper layer profile

The DICOM OSI Upper Layer Profile (see note 1) defines the Upper Layer Service which supports the communication of DICOM Application Entities. These UL Services are a proper subset of the OSI Presentation Service (ISO 8822) augmented by the OSI Association Control Service Element (ACSE) Services (ISO 8649).

This DICOM OSI Upper Layer Profile can be supported by the various OSI Connection-mode Transport Service Profiles corresponding to a wide range of physical networks, such as ISO 8802-3 CSMA/CD, FDDI, X.25, ISDN, dedicated digital circuits, and many other LAN and WAN network technologies (see note 2).

This DICOM OSI Upper Layer Profile specifies the subset of the OSI Protocols pertaining to Layer 5 (Session), Layer 6 (Presentation), and Layer 7 (ACSE) necessary to provide the Upper Layer Service as defined in Section 7. The specification of such a profile, in addition to one or more Transport Profiles, is necessary to ensure interoperability of implementations.

NOTES

1 This concept of a "Profile" is defined by the ISO/IEC TR 10000. When developed, harmonized, and ratified by ISO/IEC it is called an International Standardized Profile or ISP. This same concept is defined as a "Functional Standard" by CEN and the European Workshop for Open Systems (EWOS). In the USA, the National Institute of Standards and Technology (NIST) is hosting an OSI Implementors Workshop which defines such profiles as "Implementor Agreements." These profiles are used as the basis of Government Procurement Profiles (e.g. US GOSIP or EPHOS) or Industry Procurement Profiles (e.g. MAP or TOP).

2 A number of International Standardized Profiles (ISPs) may be used, examples of such ISPs are:

a) TA51 (Transport over CSMA/CD)

1 ISO/IEC 10608-1, International Standardized Profile TA - Connection-mode Transport Service over Connection less Network Service, Part 1: General Overview and Subnetwork-independent Requirements.

2 ISO/IEC 10608-2, Part 2: TA51 Profile Including Subnetwork-dependent Requirements for CSMA/CD LANs

b) TB 1111/1121 (Transport over X.25)

1 ISO/IEC 10609-1, International Standardized Profiles TB, TC, TD, and TE - Connection-mode Transport Service over Connection-mode Network Service, Part 1: Subnetwork-type Independent Requirements for Group TB

2 ISO/IEC 10609-5, Part 5: Definition of Profile TB 1111/TB 1121

3 The DICOM OSI Upper Layer Profile specified in this section is a candidate to become an "International Standardized Profile." In this initial version, technical content has been the primary focus using a simplified format. It is mainly intended to be a set of technical agreements.

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8.1 *Naming and addressing*

The ISO 7498-3 addressing principles shall be followed. See Annex C for more information.

8.2 *ACSE protocol requirements*

The conformance requirements of ISO 8650:1987 shall be met with the following:

a) Application Contexts shall be supported as defined by the UL Service. Application Context Names are defined in PS 3.7 and Annex A.

b) Only the parameters defined in Section 7 as Mandatory, Mandatory Fixed, User Option, User Option with a fixed value, and Conditional need to be supported in the corresponding PDUs.

8.3 *Presentation protocol requirements*

The Conformance Requirements of ISO 8823:1988 shall be met with the following:

a) The Kernel Presentation Functional Unit shall be supported.

b) At least 16 presentation contexts per presentation connection must be supported (either accepted or rejected).

c) Abstract Syntaxes shall be supported as defined by the UL Service. Abstract Syntax Names are defined in PS 3.4 and Annex B.

d) Transfer Syntaxes shall be supported as defined by the UL Service definition. Transfer Syntax Names are defined in PS 3.5 and Annex B.

e) The general Presentation Protocol agreements documented in the Stable Implementors Agreements of the OSI Implementors Workshop (NIST Special Publication 500-150) apply.

8.4 *Session protocol requirements*

The Conformance Requirements of ISO 8327:1987 and AM 2 shall be met with the following:

a) The Session Kernel and Full Duplex Functional Units shall be supported.

b) Session Version 2 shall be used.

c) Maximum size of the User Data parameter of the S-Connect PDU is 10,240 octets.

d) The general Session Protocol agreements documented in the Stable Implementors Agreements of the OSI Implementors Workshop (NIST Special Publication 500-150) apply.

9 DICOM upper layer protocol for TCP/IP

The DICOM Upper Layer Protocol specified in this section shall be used in conjunction with the TCP/IP transport layers. It is intended to be used only in network environments where OSI support is not available.

NOTE—The DICOM Upper Layer Protocol should not be used in conjunction with the OSI transport layers. OSI upper layers in conjunction with OSI Transport Layers should be used as defined in Section 8.

9.1 *Use of the transport service provided by TCP*

9.1.1 GENERAL

There is a one-to-one relationship between a TCP Transport Connection and an Upper Layer Association. Therefore, the following rules apply:

a) Each Upper Layer Association shall be supported by one and only one TCP Transport Connection.

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b) Each TCP Transport Connection shall support one and only one Upper Layer Association.

The Services provided by the TCP Transport Services are not formally documented. This section, therefore, makes use of "commonly" used terms in a number of TCP Programming Interface Implementations (e.g. Sockets). However, the following RFCs shall be required for TCP/IP support:

a) RFC 793, Transmission Control Program - DARPA Internet Protocol Specification

b) RFC 791, Internet Protocol - DARPA Internet Protocol Specification

c) RFC 792, Internet Control Message Protocol - DARPA Internet Program Protocol Specification

d) RFC 950, Internet Subnetting

For the establishment of a TCP connection, a TCP port shall be used to serve as the transport selector. A DICOM UL entity is identified on a given system on the network by a port number unique within the scope of this system. Port numbers of remote DICOM UL entities (well known port number or other numbers) shall be configurable on DICOM UL entities.

NOTE—It is strongly recommended that systems supporting a single DICOM UL entity use as their port the "well known port" registered for the DICOM Upper Layer Protocol: port number 104 (decimal).

9.1.2 OPENING A TCP TRANSPORT CONNECTION

When an Association is to be established by a DICOM Upper Layer Entity, a TRANSPORT CONNECT request primitive shall be issued to the TCP Transport Service (Active Open). Once the TCP Transport Connection Confirmation is received (Open Completed), an A-ASSOCIATE-RQ PDU shall be sent/written on the now established transport connection.

When a DICOM Upper Layer Entity becomes activated (Association Idle State), it shall wait for TCP Transport Connections in a passive mode by initiating a "listen." When an incoming TCP Transport Connection Indication is received from the network, it is accepted and a timer ARTIM (Association Request/Reject/Release Timer) shall be set. Any further exchange of PDUs (read/write) shall be performed as specified by the Upper Layer State Machine (including ARTIM Timer expiration before an A-ASSOCIATE-RQ PDU is received, see Section 9.2).

9.1.3 TRANSFERRING DATA ON A TCP CONNECTION

Data exchange of PDUs (read/write) on an established TCP Connection shall follow the specifications of the DICOM Upper Layer Protocol State Machine (see Section 9.2) and the DICOM Upper Layer PDU structure (see Section 9.3).

9.1.4 CLOSING A TCP TRANSPORT CONNECTION

TCP Transport Connections shall be closed using the "don't linger" option.

A TCP Transport Connection is closed under a number of situations. These are described in the DICOM Upper Layer Protocol State Machine. Some typical cases are discussed below:

a) After an A-RELEASE-RQ has been sent and the A-RELEASE-RP PDU is received

b) When a Transport Connection has been established by the DICOM remote UL Entity and no A-ASSOCIATE-RQ is received before the ARTIM Timer expires

c) When an A-ABORT PDU has been received

d) When an A-ABORT PDU has been sent and the ARTIM Timer expires before the Transport Connection is closed

e) When a TCP connection is being disconnected by the Transport Service Provider (e.g. network failure)

f) When a TCP connection is being disconnected by the remote DICOM UL Entity

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NOTES

1 Except following the normal completion of an association reject, release or abort and in specific situations such as temporary lack of resources, an Upper Layer State Machine should not disconnect a TCP connection or reject its establishment. The appropriate behavior is to use the Association Reject or Abort services.

2 The ARTIM Timer should not be used to oversee the Association Establishment or Release. Such a mechanism falls under the protocol definition of the layer above the DICOM Upper Layer (i.e. DICOM Application Entity, see PS 3.7).

9.1.5 ARTIM TIMER

The value of the ARTIM Timer used to manage the Request, Reject, and Release of associations on a DICOM UL entity shall be configurable to address a wide range of network configurations.

9.2 *DICOM upper layer protocol for TCP/IP state machine*

9.2.1 MACHINE STATES DEFINITION:

Table 9-1—No association

State	Definition
Sta1	Idle

Table 9-2—Association establishment

State	Definition
Sta2	Transport connection open (Awaiting A-ASSOCIATE-RQ PDU)
Sta3	Awaiting local A-ASSOCIATE response primitive (from local user)
Sta4	Awaiting transport connection opening to complete (from local transport service)
Sta5	Awaiting A-ASSOCIATE-AC or A-ASSOCIATE-RJ PDU

Table 9-3—Data transfer

State	Definition
Sta6	Association established and ready for data transfer

Table 9-4—Association release

State	Definition
Sta7	Awaiting A-RELEASE-RP PDU
Sta8	Awaiting A-RELEASE response primitive (from local user)
Sta9	Release collision requestor side; awaiting A-RELEASE response (from local user)
Sta10	Release collision acceptor side; awaiting A-RELEASE-RP PDU
Sta11	Release collision requestor side; awaiting A-RELEASE-RP PDU
Sta12	Release collision acceptor side; awaiting A-RELEASE response primitive (from local user)

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Table 9-5—Waiting for transport connection close

State	Definition
Sta13	Awaiting Transport Connection Close Indication (Association no longer exists)

9.2.2 STATE MACHINE ACTIONS DEFINITION:

Table 9-6—Association establishment related actions

Action	Definition
AE-1	Issue TRANSPORT CONNECT request primitive to local transport service Next state is Sta4
AE-2	Send A-ASSOCIATE-RQ-PDU Next state is Sta5
AE-3	Issue A-ASSOCIATE confirmation (accept) primitive Next state is Sta6
AE-4	Issue A-ASSOCIATE confirmation (reject) primitive and close transport connection Next state is Sta1
AE-5	Issue Transport connection response primitive; start ARTIM timer Next state is Sta2
AE-6	Stop ARTIM timer and if A-ASSOCIATE-RQ acceptable by service-provider: - issue A-ASSOCIATE indication primitive Next state is Sta3 otherwise: -issue A-ASSOCIATE-RJ-PDU and start ARTIM timer Next state is Sta13
AE-7	Send A-ASSOCIATE-AC PDU Next state is Sta6
AE-8	Send A-ASSOCIATE-RJ PDU and start ARTIM timer Next state is STA13

Table 9-7—Data transfer related actions

Action	Definition
DT-1	Send P-DATA-TF PDU Next state is Sta6
DT-2	Send P-DATA indication primitive Next state is Sta6

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Table 9-8—Association release related actions

Action	Definition
AR-1	Send A-RELEASE-RQ PDU Next state is Sta7
AR-2	Issue A-RELEASE indication primitive Next state is Sta8
AR-3	Issue A-RELEASE confirmation primitive, and close transport connection Next state is Sta1
AR-4	Issue A-RELEASE-RP PDU and start ARTIM timer Next state is Sta13
AR-5	Stop ARTIM timer Next state is Sta1
AR-6	Issue P-DATA indication Next state is Sta7
AR-7	Issue P-DATA-TF PDU Next state is Sta8
AR-8	Issue A-RELEASE indication (release collision): - if association-requestor, next state is Sta9 - if not, next state is Sta10
AR-9	Send A-RELEASE-RP PDU Next state is Sta11
AR-10	Issue A-RELEASE confirmation primitive Next state is Sta12

Table 9-9—Association abort related actions

Action	Definition
AA-1	Send A-ABORT PDU (service-user source) and start (or restart if already started) ARTIM timer; Next state is Sta13
AA-2	Stop ARTIM timer if running. Close transport connection Next state is Sta1
AA-3	If (service-user inititated abort) - issue A-ABORT indication and close transport connection otherwise (service-provider inititated abort): - issue A-P-ABORT indication and close transport connection Next state is Sta1
AA-4	Issue A-P-ABORT indication primitive Next state is Sta1
AA-5	Stop ARTIM timer Next state is Sta1
AA-6	Ignore PDU Next state is Sta13
AA-7	Send A-ABORT PDU Next state is Sta13
AA-8	Send A-ABORT PDU (service-provider source-), issue an A-P-ABORT indication, and start ARTIM timer; Next state is Sta13

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9.2.3 DICOM UPPER LAYER PROTOCOL FOR TCP/IP STATE TRANSITION TABLE

The DICOM Upper Layer Protocol State transitions are specified in Table 9-10. This table addresses both the normal and error cases for the protocol operation. Both the called and the calling aspects of an association are described in this table.

Table 9-10—DICOM upper layer protocol state transition table

STATES / EVENTS	No association	Association establishment				Data transfer	Association release (normal & collision)						Wait for Tp Close
	Sta1	Sta2	Sta3	Sta4	Sta5	Sta6	Sta7	Sta8	Sta9	Sta10	Sta11	Sta12	Sta13
A-ASOCIATE Request (local user)	AE-1 Sta4												
Transport Conn. Confirmation (local transport service)				AE-2 Sta5									
A-ASSOCIATE-AC PDU (received on transport connection)		AA-1 Sta13	AA-8 Sta13		AE-3 Sta6	AA-8 Sta13	AA-8 Sta13	AA-8 Sta13	AA-8 Sta13	AA-8 Sta13	AA-8 Sta13	AA-8 Sta13	AA-6 Sta13
A-ASSOCIATE-RJ PDU (received on transport connection)		AA-1 Sta13	AA-8 Sta13		AE-4 Sta1	AA-8 Sta13	AA-8 Sta13	AA-8 Sta13	AA-8 Sta13	AA-8 Sta13	AA-8 Sta13	AA-8 Sta13	AA-6 Sta13
Transport Connection Indication (local transport service)	AE-5 Sta2												
A-ASSOCIATE-RQ PDU (received on transport connection)		AE-6 Sta3 or 13	AA-8 Sta13		AA-8 Sta13	AA-8 Sta13	AA-8 Sta13	AA-8 Sta13	AA-8 Sta13	AA-8 Sta13	AA-8 Sta13	AA-8 Sta13	AA-7 Sta13
A-ASSOCIATE response primitive (accept)			AE-7 Sta6										
A-ASSOCIATE response primitive (reject)			AE-8 Sta13										
P-DATA request primitive						DT-1 Sta6		AR-7 Sta8					
P-DATA-TF PDU		AA-1 Sta13	AA-8 Sta13		AA-8 Sta13	DT-2 Sta6	AR-6 Sta7	AA-8 Sta13	AA-8 Sta13	AA-8 Sta13	AA-8 Sta13	AA-8 Sta13	AA-6 Sta13
A-RELEASE Request primitive						AR-1 Sta7							
A-RELEASE-RQ PDU (received on open transport connection)		AA-1 Sta13	AA-8 Sta13		AA-8 Sta13	AR-2 Sta8	AR-8 Sta9 or 10	AA-8 Sta13	AA-8 Sta13	AA-8 Sta13	AA-8 Sta13	AA-8 Sta13	AA-6 Sta13
A-RELEASE-RP PDU (received on transport connection)		AA-1 Sta13	AA-8 Sta13		AA-8 Sta13	AA-8 Sta13	AR-3 Sta1	AA-8 Sta13	AA-8 Sta13	AR-10 Sta12	AR-3 Sta1	AA-8 Sta13	AA-6 Sta13
A-RELEASE Response primitive								AR-4 STA13	AR-9 STA11			AR-4 STA13	
A-ABORT Request primitive			AA-1 Sta13	AA-2 Sta1	AA-1 Sta13	AA-1 Sta13	AA-1 Sta13	AA-1 Sta13	AA-1 Sta13	AA-1 Sta13	AA-1 Sta13	AA-1 Sta13	
A-ABORT PDU (received on open transport connection)		AA-2 Sta1	AA-3 Sta1		AA-3 Sta1	AA-3 Sta1	AA-3 Sta1	AA-3 Sta1	AA-3 Sta1	AA-3 Sta1	AA-3 Sta1	AA-3 Sta1	AA-2 Sta1
Transport connection closed Indication (local transport service)		AA-5 Sta1	AA-4 Sta1	AA-4 Sta1	AA-4 Sta1	AA-4 Sta1	AA-4 Sta1	AA-4 Sta1	AA-4 Sta1	AA-4 Sta1	AA-4 Sta1	AA-4 Sta1	AR-5 Sta1
ARTIM timer expired (Association reject/release timer)		AA-2 Sta1											AA-2 Sta1
Unrecognized or invalid PDU received		AA-1 Sta13	AA-8 Sta13		AA-8 Sta13	AA-8 Sta13	AA-8 Sta13	AA-8 Sta13	AA-8 Sta13	AA-8 Sta13	AA-8 Sta13	AA-8 Sta13	AA-7 Sta13

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9.3 *DICOM upper layer protocol for TCP/IP data units structure*

9.3.1 GENERAL

The Protocol Data Units (PDUs) are the message formats exchanged between peer entities within a layer. A PDU shall consist of protocol control information and user data. PDUs are constructed by mandatory fixed fields followed by optional variable fields which contain one or more items and/or sub-items.

Items of unrecognized types shall be ignored and skipped. Items shall appear in an increasing order of their item types. Several instances of the same item shall be acceptable or shall not as specified by each item.

The DICOM UL protocol consists of seven Protocol Data Units:

a) A-ASSOCIATE-RQ PDU

b) A-ASSOCIATE-AC PDU

c) A-ASSOCIATE-RJ PDU

d) P-DATA-TF PDU

e) A-RELEASE-RQ PDU

f) A-RELEASE-RP PDU

g) A-ABORT PDU

The encoding of the DICOM UL PDUs is defined as follows (Big Endian byte ordering):

NOTE—The Big Endian byte ordering has been chosen for consistency with the OSI and TCP/IP environment. This pertains to the DICOM UL PDU headers only. The encoding of the PDV message fragments is defined by the Transfer Syntax negotiated at association establishment.

a) Each PDU type shall consist of one or more bytes that when represented, are numbered sequentially, with byte 1 being the lowest byte number.

b) Each byte within the PDU shall consist of eight bits that, when represented, are numbered 7 to 0, where bit 0 is the low order bit.

c) When consecutive bytes are used to represent a string of characters, the lowest byte numbers represent the first character.

d) When consecutive bytes are used to represent a binary number, the lower byte number has the most significant value.

e) The lowest byte number is placed first in the transport service data flow.

An overview of the PDUs is shown in Figures 9-1 and 9-2. The detailed structure of each PDU is specified in the following sections.

NOTE—A number of parameters defined in the UL Service are not reflected in these PDUs (e.g. service parameters, fixed values, values not used by DICOM Application Entities.)

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A-ASSOCIATE-RQ PDU/A-ASSOCIATE-AC PDU

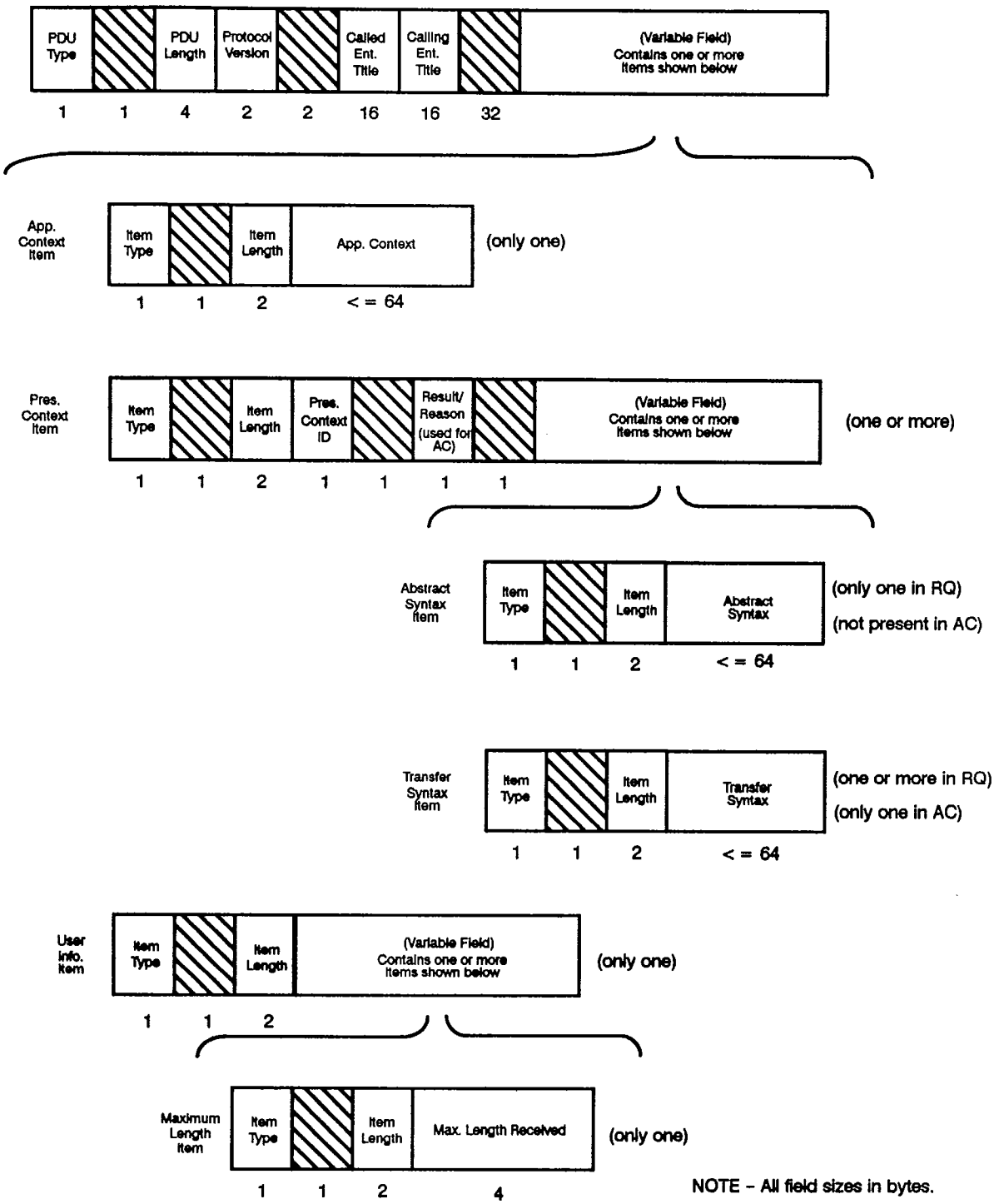

Figure 9-1—Protocol stat units structure and encoding

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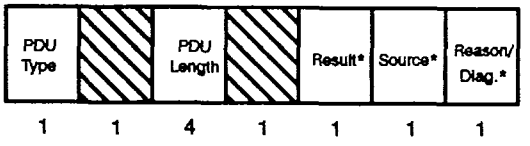
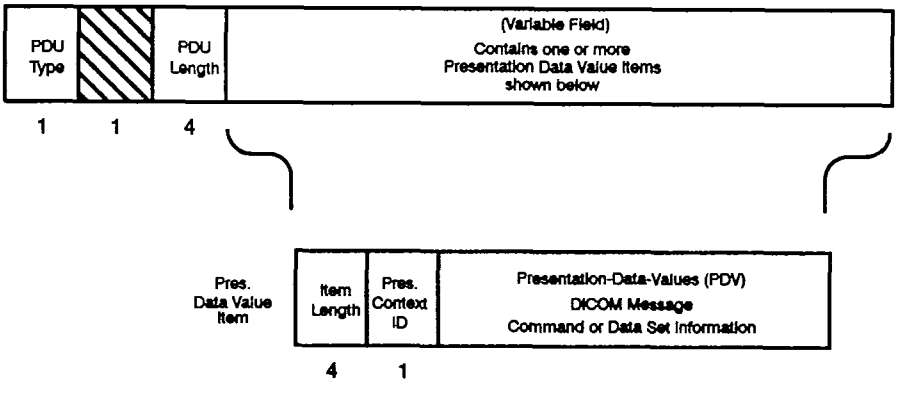
A-ASSOCIATE-RJ PDU/A-RELEASE-RQ PDU/A-RELEASE-RP PDU/A-ABORT PDU



*NOTE: Depending on the specific PDU this field may be used or reserved.

P-DATA-TF PDU



NOTE - All field sizes in bytes.

Figure 9-2—Protocol data units structure and encoding

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9.3.2 A-ASSOCIATE-RQ PDU STRUCTURE

An A-ASSOCIATE-RQ PDU shall be made of a sequence of mandatory fields followed by a variable length field. Table 9-11 shows the sequence of the mandatory fields.

The variable field shall consist of one Application Context Item, one or more Presentation Context Items, and one User Information Item. Sub-Items shall exist for the Presentation Context and User Information Items.

Table 9-11—ASSOCIATE-RQ PDU fields

PDU bytes	Field name	Description of field
1	PDU-type	01H
2	Reserved	This reserved field shall be sent with a value 00H but not tested to this value when received.
3–6	PDU-length	This PDU-length shall be the number of bytes from the first byte of the following field to the last byte of the variable field. It shall be encoded as an unsigned binary number.
7–8	Protocol-version	This two byte field shall use one bit to identify each version of the DICOM UL protocol supported by the calling end-system. This is Version 1 and shall be identified with bit 0 set. A receiver of this PDU implementing only this version of the DICOM UL protocol shall only test that bit 0 is set.
9–10	Reserved	This reserved field shall be sent with a value 0000H but not tested to this value when received.
11–26	Called-AE-title	Destination DICOM Application Name. It shall be encoded as 16 characters as defined by the ISO 646:1990-Basic G0 Set with leading and trailing spaces (20H) being non-significant. The value made of 16 spaces (20H) meaning "no Application Name specified" shall not be used. For a complete description of the use of this field, see Section 7.1.1.4.
27–42	Calling-AE-title	Source DICOM Application Name. It shall be encoded as 16 characters as defined by the ISO 646:1990-Basic G0 Set with leading and trailing spaces (20H) being non-significant. The value made of 16 spaces (20H) meaning "no Application Name specified" shall not be used. For a complete description of the use of this field, see Section 7.1.1.3.
43–74	Reserved	This reserved field shall be sent with a value 00H for all bytes but not tested to this value when received.
75–xxx	Variable items	This variable field shall contain the following items: one Application Context Item, one or more Presentation Context Items and one User Information Item. For a complete description of the use of these items see Sections 7.1.1.2, 7.1.1.13, and 7.1.1.6.

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9.3.2.1 Application context item structure

An Application Context Item shall be made of a sequence of mandatory fields followed by a variable length field. Table 9-12 shows the sequence of the mandatory fields.

Table 9-12—Application context item fields

Item bytes	Field name	Description of field
1	Item-type	10H
2	Reserved	This reserved field shall be sent with a value 00H but not tested to this value when received.
3–4	Item-length	This Item-length shall be the number of bytes from the first byte of the following field to the last byte of the Application-context-name field. It shall be encoded as an unsigned binary number.
5–xxx	Application-context-name	A valid Application-context-name shall be encoded as defined in Annex F. For a description of the use of this field see Section 7.1.1.2. Application-context-names are structured as UIDs as defined in PS 3.5 (see Annex A for an overview of this concept). DICOM Application-context-names are registered in PS 3.7.

9.3.2.2 Presentation context item structure

The Presentation Context Item shall be made of a sequence of mandatory fixed length fields followed by a variable field. Table 9-13 shows the sequence of the mandatory fields.

The variable field shall consist of one Abstract Syntax Sub-Item followed by one or more Transfer Syntax Sub-Items.

Table 9-13—Presentation context item fields

Item bytes	Field name	Description of field
1	Item-type	20H
2	Reserved	This reserved field shall be sent with a value 00H but not tested to this value when received.
3–4	Item-length	This Item-length shall be the number of bytes from the first byte of the following field to the last byte of the last Transfer Syntax Item. It shall be encoded as an unsigned binary number.
5	Presentation-context-ID	Presentation-context-ID values shall be odd integers between 1 and 255, encoded as an unsigned binary number. For a complete description of the use of this field see Section 7.1.1.13.
6	Reserved	This reserved field shall be sent with a value 00H but not tested to this value when received.
7	Reserved	This reserved field shall be sent with a value 00H but not tested to this value when received.
8	Reserved	This reserved field shall be sent with a value 00H but not tested to this value when received.
9–xxx	Abstract/Transfer Syntax Sub-Items	This variable field shall contain the following sub-items: one Abstract Syntax and one or more Transfer Syntax(es). For a complete description of the use and encoding of these sub-items see Sections 9.3.2.2.1 and 9.3.2.2.2.

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9.3.2.2.1 Abstract syntax sub-item structure

The Abstract Syntax Sub-Item shall be made of a sequence of mandatory fixed length fields followed by a variable field. Table 9-14 shows the sequence of the mandatory fields.

Table 9-14—Abstract syntax sub-item fields

Item bytes	Field name	Description of field
1	Item-type	30H
2	Reserved	This reserved field shall be sent with a value 00H but not tested to this value when received.
3–4	Item-length	This Item-length shall be the number of bytes from the first byte of the following field to the last byte of the Abstract-syntax-name field. It shall be encoded as an unsigned binary number.
5–xxx	Abstract-syntax-name	This variable field shall contain the Abstract-syntax-name related to the proposed presentation context. A valid Abstract-syntax-name shall be encoded as defined in Annex F. For a description of the use of this field see Section 7.1.1.13. Abstract-syntax-names are structured as UIDs as defined in PS 3.5 (see Annex B for an overview of this concept). DICOM Abstract-syntax-names are registered in PS 3.4.

9.3.2.2.2 Transfer syntax sub-item structure

The Transfer Syntax Sub-Item shall be made of a sequence of mandatory fixed length fields followed by a variable field. Table 9-15 shows the sequence of the mandatory fields.

Table 9-15—Transfer syntax sub-item fields

Item bytes	Field name	Description of field
1	Item-type	40H
2	Reserved	This reserved field shall be sent with a value 00H but not tested to this value when received.
3–4	Item-length	This Item-length shall be the number of bytes from the first byte of the following field to the last byte of the Transfer-syntax-name field(s). It shall be encoded as an unsigned binary number.
5–xxx	Transfer-syntax-name(s)	This variable field shall contain the Transfer-syntax-name proposed for this presentation context. A valid Transfer-syntax-name shall be encoded as defined in Annex F. For a description of the use of this field see Section 7.1.1.13. Transfer-syntax-names are structured as UIDs as defined in PS 3.5 (see Annex B for an overview of this concept). DICOM Transfer-syntax-names are registered in PS 3.5.

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9.3.2.3 User information item structure

The User Information Item shall be made of a sequence of mandatory fixed length fields followed by a variable field. Table 9-16 shows the sequence of the mandatory fields.

The variable field shall consist of one or more User-Data Sub-Items.

Table 9-16—User information item fields

Item bytes	Field name	Description of field
1	Item-type	50H
2	Reserved	This reserved field shall be sent with a value 00H but not tested to this value when received.
3–4	Item-length	This Item-length shall be the number of bytes from the first byte of the following field to the last byte of the User-data information field(s). It shall be encoded as an unsigned binary number.
5–xxx	User-data	This variable field shall contain User-data sub-items as defined by the DICOM Application Entity. The structure and content of these sub-items is defined in Annex D.

9.3.3 A-ASSOCIATE-AC PDU STRUCTURE

An A-ASSOCIATE-AC PDU shall be made of a sequence of mandatory fields followed by a variable length field. Table 9-17 shows the sequence of the mandatory fields.

The variable field consist of one Application Context Item, one or more Presentation Context Items, and one User Information Item. Sub-Items shall exist for the Presentation Context and User Information Items.

Table 9-17—Presentation context item fields

Item bytes	Field name	Description of field
1	PDU-type	02H
2	Reserved	This reserved field shall be sent with a value 00H but not tested to this value when received.
3–6	PDU-length	This PDU-length shall be the number of bytes from the first byte of the following field to the last byte of the variable field. It shall be encoded as an unsigned binary number.
7–8	Protocol-version	This two byte field shall use one bit to identify each version of the DICOM UL protocol supported by the calling end-system. This is Version 1 and shall be identified with bit 0 set. A receiver of this PDU implementing only this version of the DICOM UL protocol shall only test that bit 0 is set.
9–10	Reserved	This reserved field shall be sent with a value 0000H but not tested to this value when received.
11–26	Reserved	This reserved field shall be sent with a value identical to the value received in the same field of the A-ASSOCIATE-RQ PDU, but its value shall not be tested when received.
27–42	Reserved	This reserved field shall be sent with a value identical to the value received in the same field of the A-ASSOCIATE-RQ PDU, but its value shall not be tested when received.
43–74	Reserved	This reserved field shall be sent with a value identical to the value received in the same field of the A-ASSOCIATE-RQ PDU, but its value shall not be tested when received.
75–xxx	Variable items	This variable field shall contain the following items: one Application Context Item, one or more Presentation Context Item(s) and one User Information Item. For a complete description of these items see Sections 7.1.1.2, 7.1.1.14, and 7.1.1.6.

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9.3.3.1 Application context item structure

An Application Context Item shall be made of a sequence of mandatory fields followed by a variable length field. Table 19 shows the sequence of the mandatory fields.

9.3.3.2 Presentation context item structure

The Presentation Context Item shall be made of a sequence of mandatory fixed length fields followed by a variable field. Table 9-18 shows the sequence of the mandatory fields.

The variable field shall consist of one Transfer Syntax Sub-Item.

Table 9-18—Presentation context item fields

Item bytes	Field name	Description of field
1	Item-type	21H
2	Reserved	This reserved field shall be sent with a value 00H but not tested to this value when received.
3–4	Item-length	This Item-length shall be the number of bytes from the first byte of the following field to the last byte of the Transfer Syntax Sub-Item. It shall be encoded as an unsigned binary number.
5	Presentation-context-ID	Presentation-context-ID values shall be odd integers between 1 and 255, encoded as an unsigned binary number. For a complete description of the use of this field see Section 7.1.1.13.
6	Reserved	This reserved field shall be sent with a value 00H but not tested to this value when received.
7	Result/Reason	This Result/Reason field shall contain an integer value encoded as an unsigned binary number. One of the following values shall be used: 0 - acceptance 1 - user-rejection 2 - no-reason (provider rejection) 3 - abstract-syntax-not-supported (provider rejection) 4 - transfer-syntaxes-not-supported (provider rejection)
8	Reserved	This reserved field shall be sent with a value 00H but not tested to this value when received.
9–xxx	Transfer syntax sub-item	This variable field shall contain one Transfer Syntax Sub-Item. When the Result/Reason field has a value other than acceptance(0), this field shall not be significant and its value shall not be tested when received. For a complete description of the use and encoding of this item see Section 9.3.3.2.1.

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9.3.3.2.1 Transfer syntax sub-item structure

The Transfer Syntax Sub-Item shall be made of a sequence of mandatory fixed length fields followed by a variable field. Table 9-19 shows the sequence of the mandatory fields.

Table 9-19—Transfer syntax sub-item fields

Item bytes	Field name	Description of field
1	Item-type	40H
2	Reserved	This reserved field shall be sent with a value 00H but not tested to this value when received.
3–4	Item-length	This Item-length shall be the number of bytes from the first byte of the following field to the last byte of the Transfer-syntax-name field. It shall be encoded as an unsigned binary number.
5–xxx	Transfer-syntax-name	This variable field shall contain the Transfer-syntax-name proposed for this presentation context. A valid Transfer-syntax-name shall be encoded as defined in Annex F. For a description of the use of this field see Section 7.1.1.14. Transfer-syntax-names are structured as UIDs as defined in PS 3.5 (see Annex B for an overview of this concept). DICOM Transfer-syntax-names are registered in PS 3.5.

9.3.3.3 User information item structure

The User Information Item shall be made of a sequence of mandatory length fields followed by a variable field. Table 9-20 shows the sequence of the mandatory fields.

The variable field shall consist of one or more User-Data Sub-Items.

Table 9-20—User information item fields

Item bytes	Field name	Description of field
1	Item-type	50H
2	Reserved	This reserved field shall be sent with a value 00H but not tested to this value when received.
3–4	Item-length	This Item-length shall be the number of bytes from the first byte of the following field to the last byte of the User-data information field(s). It shall be encoded as an unsigned binary number.
5–xxx	User-data	This variable field shall contain User-data sub-items as defined by the DICOM Application Entity. The structure and content of these sub-items is defined in Annex D.

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9.3.4 A-ASSOCIATE-RJ PDU STRUCTURE

An A-ASSOCIATE-RJ PDU shall be made of a sequence of mandatory fields. Table 9-21 shows the sequence of the mandatory fields.

Table 9-21—Associate-RJ PDU fields

PDU bytes	Field name	Description of field
1	PDU-type	03H
2	Reserved	This reserved field shall be sent with a value 00H but not tested to this value when received.
3–6	PDU-length	This PDU-length shall be the number of bytes from the first byte of the following field to the last byte of the Reason/Diag. field. In the case of this PDU, it shall have the fixed value of 00000004H encoded as an unsigned binary number.
7	Reserved	This reserved field shall be sent with a value 00H but not tested to this value when received.
8	Result	This Result field shall contain an integer value encoded as an unsigned binary number. One of the following values shall be used: 1 - rejected-permanent 2 - rejected-transient
9	Source	This Source field shall contain an integer value encoded as an unsigned binary number. One of the following values shall be used: 1 - DICOM UL service-user 2 - DICOM UL service-provider (ACSE related function) 3 - DICOM UL service-provider (Presentation related function)
10	Reason/Diag.	This field shall contain an integer value encoded as an unsigned binary number. If the Source field has the value (1) "DICOM UL service-user", it shall take one of the following: 1 - no-reason-given 2 - application-context-name-not-supported 3 - calling-AE-title-not-recognized 4–6 - reserved 7 - called-AE-title-not-recognized 8–10 - reserved If the Source field has the value (2) "DICOM UL service provided (ACSE related function)," it shall take one of the following: 1 - no-reason-given 2 - protocol-version-not-supported If the Source field has the value (3) "DICOM UL service provided (Presentation related function)," it shall take one of the following: 0 - reserved 1 - temporary-congestion 2 - local-limit-exceeded 3–7 - reserved NOTE—The reserved fields are used to preserve symmetry with OSI ACSE/Presentation Services and Protocols.

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9.3.5 P-DATA-TF PDU STRUCTURE

A P-DATA-TF PDU shall be made of a sequence of mandatory fixed length fields followed by a variable length field. Table 9-22 shows the sequence of the mandatory fields.

The variable data field shall contain one or more Presentation-Data-Value Items.

Table 9-22—P-DATA-TF PDU fields

PDU bytes	Field name	Description of field
1	PDU-type	04H
2	Reserved	This reserved field shall be sent with a value 00H but not tested to this value when received.
3–6	PDU-length	This PDU-length shall be the number of bytes from the first byte of the following field to the last byte of the variable field. It shall be encoded as an unsigned binary number.
7–xxx	Presentation-data-value Item(s)	This variable data field shall contain one or more Presentation-data-value Items(s). For a complete description of the use of this field see Section 9.3.5.1.

9.3.5.1 Presentation data value item structure

The Presentation Data Value Item shall be made of a sequence of mandatory fixed length fields followed by one variable length field. Table 9-23 shows the sequence of the fields.

The variable field shall consist of one Presentation-Data-Value.

Table 9-23—Presentation-data-value item fields

Item bytes	Field name	Description of field
1–4	Item-length	This Item-length shall be the number of bytes from the first byte of the following field to the last byte of the Presentation-data-value field. It shall be encoded as an unsigned binary number.
5	Presentation-context-ID	Presentation-context-ID values shall be odd integers between 1 and 255, encoded as an unsigned binary number. For a complete description of the use of this field see Section 7.1.1.13.
6–xxx	Presentation-data-value	This Presentation-data-value field shall contain DICOM message information (command and/or data set) with a message control header. For a complete description of the use of this field see Annex E.

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9.3.6 A-RELEASE-RQ PDU STRUCTURE

An A-RELEASE-RQ PDU shall be made of a sequence of mandatory fields. Table 9-24shows the sequence of the fields.

Table 9-24—A-RELEASE-RQ PDU fields

PDU bytes	Field name	Description of field
1	PDU-type	05H
2	Reserved	This reserved field shall be sent with a value 00H but not tested to this value when received.
3–6	PDU-length	This PDU-length shall be the number of bytes from the first byte of the following field to the last byte of the Reserved field. In the case of this PDU, it shall have the fixed value of 00000004H encoded as an unsigned binary number.
7–10	Reserved	This reserved field shall be sent with a value 00000000H but not tested to this value when received.

9.3.7 A-RELEASE-RP PDU STRUCTURE

An A-RELEASE-RP PDU shall be made of a sequence of mandatory fields. Table 9-25 shows the sequence of the fields.

Table 9-25—A-RELEASE-RP PDU fields

PDU bytes	Field name	Description of field
1	PDU-type	06H
2	Reserved	This reserved field shall be sent with a value 00H but not tested to this value when received.
3–6	PDU-length	This PDU-length shall be the number of bytes from the first byte of the following field to the last byte of the Reserved field. In the case of this PDU, it shall have the fixed value of 00000004H encoded as an unsigned binary number.
7–10	Reserved	This reserved field shall be sent with a value 00000000H but not tested to this value when received.

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9.3.8 A-ABORT PDU STRUCTURE

An A-ABORT PDU shall be made of a sequence of mandatory fields. Table 9-26 shows the sequence of the fields.

The A-ABORT PDU shall support both the A-ABORT Service (user initiated) and the A-P-ABORT Service (provider initiated).

Table 9-26—A-ABORT PDU fields

PDU bytes	Field name	Description of field
1	PDU-type	07H
2	Reserved	This reserved field shall be sent with a value 00H but not tested to this value when received.
3–6	PDU-length	This PDU-length shall be the number of bytes from the first byte of the following field to the last byte of the Reason/Diag. field. In the case of this PDU, it shall have the fixed value of 00000004H encoded as an unsigned binary number.
7	Reserved	This reserved field shall be sent with a value 00H but not tested to this value when received.
8	Reserved	This reserved field shall be sent with a value 00H but not tested to this value when received.
9	Source	This Source field shall contain an integer value encoded as an unsigned binary number. One of the following values shall be used: 0 - DICOM UL service-user (initiated abort) 1 - reserved 2 - DICOM UL service-provider (initiated abort)
10	Reason/Diag.	This field shall contain an integer value encoded as an unsigned binary number. If the Source field has the value (2) "DICOM UL service-provider," it shall take one of the following: 0 - reason-not-specified 1 - unrecognized-pdu 2 - unexpected-pdu 3 - reserved 4 - unrecognized-pdu parameter 5 - unexpected-pdu parameter 6 - invalid-pdu-parameter value If the Source field has the value (0) "DICOM UL service-user," this reason field shall not be significant. It shall be sent with a value 00H but not tested to this value when received. NOTE—The reserved fields are used to preserve symmetry with OSI ACSE/Presentation Services and Protocol.

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10 Conformance

10.1 *Conformance requirements*

10.1.1 OSI NETWORK COMMUNICATION SUPPORT

An implementation claiming conformance to *DICOM V3.0 OSI Network Communication Support* shall:

a) Meet the OSI ACSE, Presentation and Session Protocols requirements as defined in Section 8.

b) Use registered Application Context Names, Abstract Syntax Names and Transfer Syntax Names as defined for OSI Object Identifiers (ISO 8824 and ISO 9834-3).

c) Use one of the International Standardized Profiles for OSI Transport over specific physical networks.

10.1.2 TCP/IP NETWORK COMMUNICATION SUPPORT

An implementation claiming conformance to *DICOM V3.0 TCP/IP Network Communication Support* shall:

a) Meet the DICOM Upper Layers Protocol requirements as defined in Section 9.

b) Use registered Application Context Names, Abstract Syntax Names and Transfer Syntax Names as defined for OSI Object Identifiers (ISO 8824 and ISO 9834-3).

NOTE –Annex F defines the DICOM Upper Layer Protocol encoding for the Application Context Names, Abstract Syntax Names, and Transfer Syntax Names. ISO 8825 defined encoding is not used.

c) Use one of the published and approved RFCs defining the operation of TCP/IP over specific physical networks.

10.2 *Conformance statement*

An implementation claiming conformance to DICOM V3.0 for communication support in a networked environment shall state one of the following:

a) *DICOM V3.0 OSI Network Communication Support with the following list of Transport ISPs: (ISPxxx, ISPyyy, etc.) and relevant implementation information.* This implies that the conformance requirements defined in Section 10.1.1 are met.

b) *DICOM V3.0 TCP/IP Network Communication Support with the following list of physical networks and corresponding RFC/relevant implementation information.* This implies that the conformance requirements defined in Section 10.1.2 are met.

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Annex A
(Informative)
Application context names

A.1 Application context definition

An application context explicitly defines the set of application service elements, related options and any other information necessary for the interworking of Application Entities on an association. The usage of the application context is defined in PS 3.7.

Two Application Entities when establishing an association agree on an application context. The requestor of an association proposes an Application Context Name and the acceptor returns either the same or a different Application Context Name. The returned name specifies the application context to be used for this association. The offer of an alternate application context by the acceptor provides a mechanism for limited negotiation. If the requestor cannot operate in the acceptor's application context, it will issue an A-Abort request primitive. Such a negotiation will facilitate the introduction of future versions of the DICOM Application Entity.

A.2 DICOM application context name encoding and registration

The Application Context Name structure is based on the OSI Object Identification (numeric form) as defined by ISO 8824. Application Context Names are registered values as defined by ISO 9834-3 to ensure global uniqueness. Application Context Names are encoded as defined in ISO 8825 (Object Identifiers of numeric form) when the OSI network communication support is used as defined in Section 8. They are encoded as defined in Annex F when the TCP/IP network communication support is used as defined in Section 9.

A.2.1 DICOM registered application context names

The organization responsible for the definition and registration of DICOM Application Context Names is NEMA. NEMA guarantees uniqueness for all DICOM Application Context Names. A choice of DICOM registered Application Context Names related to the DICOM Application Entities, as well as the associated negotiation rules, are defined in PS 3.7.

A.2.2 Privately defined application context names

Privately defined Application Context Names may also be used, however, they will not be registered by NEMA. Organizations which define private Application Context Names are responsible to obtain their proper registration as defined for OSI Object Identifiers. National Standards Organizations representing a number of countries (e.g. UK, France, Germany, Japan, USA, etc.) to the International Standards Organization act as a registration authority as defined by ISO 9834-3.

NOTE—For example, in the USA, ANSI assigns (for a fee) Organization Identifiers to any requesting organization. This identifier is made of a series of four numeric components; 1 (identifies ISO), 2 (identifies the ISO member bodies branch), 840 (identifies ANSI as the ISO member body representing the USA), and xxxxxx (identifies a specific organization and is issued by ANSI). Such an identifier may be used by the identified organization as a root to which it may add a suffix made of one or more numeric components. The identified organization accepts the responsibility to properly register these suffixes to ensure uniqueness. The ANSI contact is as follows:

ANSI
Registration Coordinator
11 West 42nd Street, New York, New York 10036
Tel. (212) 642-4900

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Annex B
(Informative)
Abstract and transfer syntaxes

B.1 Abstract syntax definition

An Abstract Syntax is the specification of Application Layer data elements with associated semantics or Application Layer protocol control information by using notation rules which are independent of the encoding technique used to represent them.

NOTE—In particular, it allows the communicating Application Entities to negotiate an agreed set of DICOM Data Elements (e.g. from a specific version of the Data Dictionary) and/or Information Object Class definitions.

B.2 Transfer syntax definition

A Transfer Syntax is a set of encoding rules able to unambiguously represent the data elements defined by one or more Abstract Syntaxes. In particular, negotiation of Transfer Syntaxes allows the communicating Application Entities to agree on the encoding techniques they are able to support (e.g. byte ordering, compression, etc.).

B.3 DICOM abstract and transfer syntax names encoding and registration

The Abstract and Transfer Syntax Name structure is based on the OSI Object Identification (numeric form) as defined by ISO 8824. Abstract and Transfer Syntax Names are registered values as defined by ISO 9834-3 to ensure global uniqueness. Abstract and Transfer Syntax Names are encoded as defined in ISO 8825 (Object Identifiers of numeric form) when the OSI network communication support is used as defined in Section 8. They are encoded as defined in Annex F when the TCP/IP network communication support is used as defined in Section 9.

B.3.1 DICOM registered abstract and transfer syntax names

The organization responsible for the definition and registration of DICOM Abstract and Transfer Syntax Names is NEMA. NEMA guarantees uniqueness for all DICOM Abstract and Transfer Syntax Names. A choice of DICOM registered Abstract and Transfer Syntax Names related to a specific version of the DICOM Application Entities, as well as the associated negotiation rules, are defined in PS 3.4 for Abstract Syntaxes and PS 3.5 for Transfer Syntaxes.

B.3.2 Privately defined abstract and transfer syntax names

Privately defined Abstract and Transfer Syntax Names may also be used, however, they will not be registered by NEMA. Organizations which define private Abstract and Transfer Syntax Names are responsible to obtain their proper registration defined for OSI Object Identifiers. National Standards Organizations representing a number of countries (e.g. UK, France, Germany, Japan, USA, etc.) to the International Standards Organization act as a registration authority as defined by ISO 9834-3.

NOTE—For example, in the USA, ANSI assigns (for a fee) Organization Identifiers to any requesting organization. This identifier is made of a series of four numeric components; 1 (identifies ISO), 2 (identifies the ISO member bodies branch), 840 (identifies ANSI as the ISO member body representing the USA), and xxxxxx (identifies a specific organization and is issued by ANSI). Such an identifier may be used by the identified organization as a root to which it may add a suffix made of one or more numeric components. The identified organization accepts the responsibility to properly register these suffixes to ensure uniqueness. The ANSI contact is as follows:

ANSI
Registration Coordinator
11 West 42nd Street, New York, New York 10036
Tel. (212) 642-4900

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Annex C
(Normative)
DICOM addressing

C.1 DICOM application names

DICOM Application Names identify a unique service or application on a specific system in the network. Application names are independent of network topology so a device may be physically moved while its corresponding application name(s) may remain the same. A DICOM Application Name is often a set of acronyms or abbreviations which may convey some meaning to a user. See PS 3.5 for the encoding of DICOM Application Names.

NOTE—DICOM Application Name was called Logical Address in the previous version of this Standard.

DICOM Application Names are used in two instances of communication as shown in Figure C.1-1:

a) to identify the Called/Calling Application Entity Titles. They are used to establish an association and to ensure that the association is established with the expected application. The method of mapping to OSI or TCP/IP addresses is implementation specific (e.g. static definition, name server, etc.). OSI or TCP/IP addresses are conveyed to the UL Service as the Called and Calling Presentation Address parameters of the A-ASSOCIATE request/indication.
b) to identify the Initiator/Receiver of DICOM Messages. They are conveyed in DICOM Commands with each message exchanged over an established association.

C.2 Naming and addressing usage rules

C.2.1 DICOM Application Names are used in both the Called/Calling Application Entity Title fields of the Generic OSI UL Service and the DICOM Message Initiator/Receiver data elements in the DICOM Message. DICOM Called/Calling Application Entity Title fields used when establishing an association may or may not contain the same name as the corresponding DICOM Message Initiator/Receiver fields of messages exchanged over this association.

C.2.2 A DICOM system on a network may support several application processes identified by different DICOM Application Names.

C.2.3 Upon receiving an association request, the Called Application Entity Title shall be validated so an association can be rejected when the corresponding local application does not exist.

C.2.4 A DICOM Application Entity, upon receiving a message, shall validate the DICOM Receiver data element in the command group to be sure the message has reached the correct local DICOM application.

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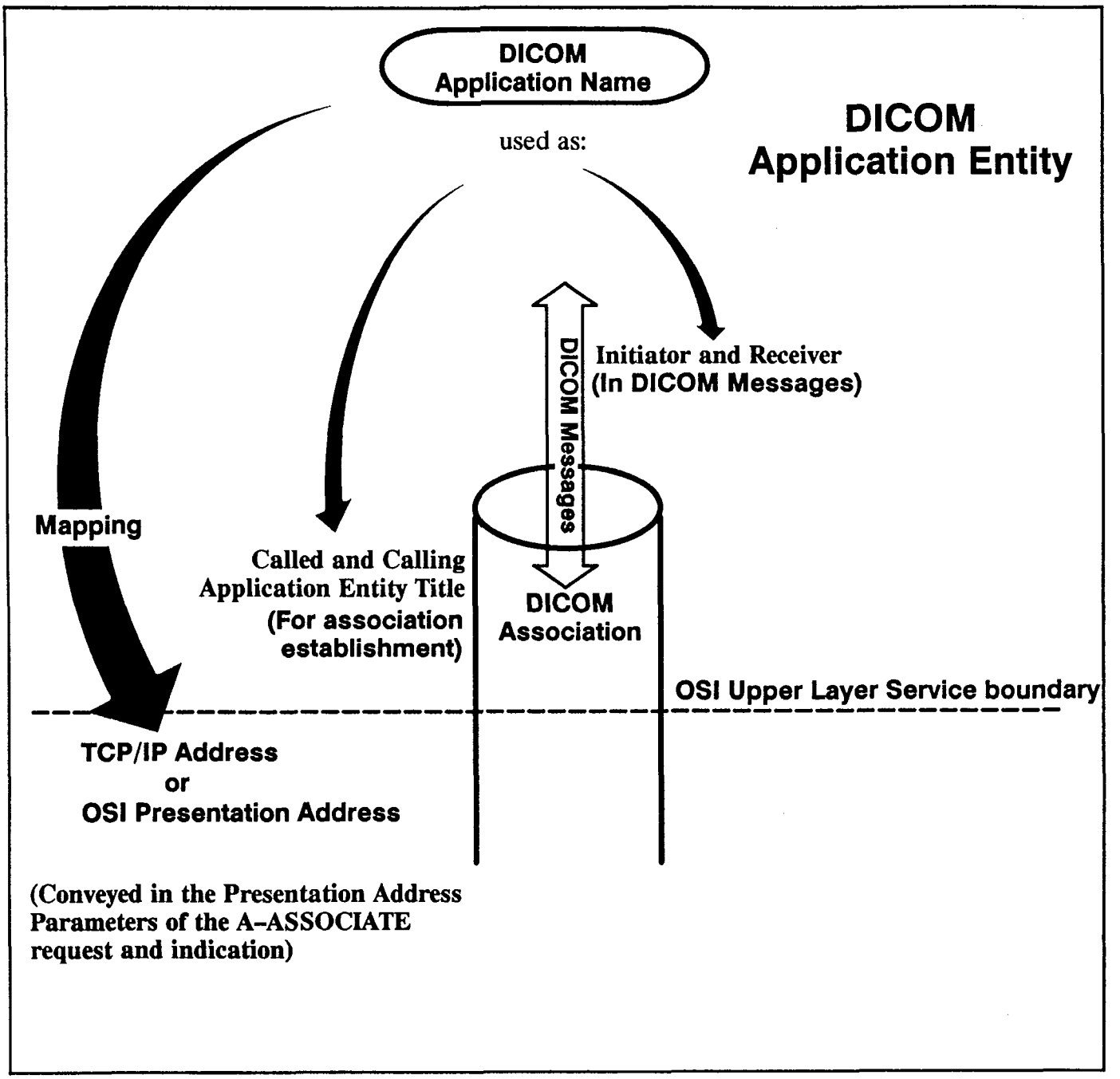

Figure C.1-1—Naming and addressing

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Annex D
(Normative)
Use and format of the A-ASSOCIATE user information parameter

This parameter allows for the negotiation of a number of features related to the communication of DICOM Application Entities at association establishment.

D.1 Maximum length negotiation

This negotiation allows the receivers to limit the size of the Presentation Data Values List parameters of each P-DATA Indication. The association-requestor shall specify in the user information parameter of the A-ASSOCIATE request primitive the maximum length in bytes for the PDV list parameter it is ready to receive in each P-DATA indication. The association-acceptor shall ensure in its fragmentation of the DICOM Messages that the list of PDVs included in each P-DATA request does not exceed this maximum length. Likewise, the association-acceptor can specify in the user information parameter of A-ASSOCIATE response primitive the maximum length in bytes for the PDV list parameter it is ready to receive in each P-DATA indication. The association-requestor shall ensure in its fragmentation of the DICOM Messages that the list of PDVs included in each P-DATA request does not exceed this maximum length. Different maximum lengths can be specified for each direction of data flow on the association.

The Maximum Length Item support is required for all DICOM V3.0 conforming implementations.

D.1.1 *Maximum length sub-item structure (A-ASSOCIATE-RQ)*

The Maximum Length Sub-Item shall be made of a sequence of mandatory fixed length fields. Only one Maximum Length Sub-Item shall be present in the User Data information in the A-ASSOCIATE-RQ. Table D.1-1 shows the sequence of the mandatory fields.

Table D.1-1—Maximum length sub-item fields (A-ASSOCIATE-RQ)

Item bytes	Field name	Description of field
1	Item-type	51H
2	Reserved	This reserved field shall be sent with a value 00H but not tested to this value when received.
3–4	Item-length	This Item-length shall be the number of bytes from the first byte of the following field to the last byte of the Maximum-length-received field. In the case of this Item, it shall have the fixed value of 00000004H encoded as an unsigned binary number.
5–8	Maximum-length-received	This parameter allows the association-requestor to restrict the maximum length of the variable field of the P-DATA-TF PDUs sent by the acceptor on the association once established. This length value is indicated as a number of bytes encoded as an unsigned binary number. The value of (0) indicates that no maximum length is specified. This maximum length value shall never be exceeded by the PDU length values used in the PDU-length field of the P-DATA-TF PDUs received by the association-requestor. Otherwise, it shall be a protocol error.

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D.1.2 *Maximum length sub-item structure (A-ASSOCIATE-AC)*

The Maximum Length Sub-Item shall be made of a sequence of mandatory fixed length fields. Only one Maximum Length Sub-Item shall be present in the User Data information in the A-ASSOCIATE-AC. Table D.1-2 shows the sequence of the mandatory fields.

Table D.1-2—Maximum length sub-item fields (A-ASSOCIATE-AC)

Item bytes	Field name	Description of field
1	Item-type	51H
2	Reserved	This reserved field shall be sent with a value 00H but not tested to this value when received.
3–4	Item-length	This Item-length shall be the number of bytes from the first byte of the following field to the last byte of the Maximum-length-received field. In the case of this Item, it shall have the fixed value of 00000004H encoded as an unsigned binary number.
5–8	Maximum-length-received	This parameter allows the association-acceptor to restrict the maximum length of the variable field of the P-DATA-TF PDUs sent by the requestor on the association once established. This length value is indicated as a number of bytes encoded as an unsigned binary number. The value of (0) indicates that no maximum length is specified. This maximum length value shall never be exceeded by the PDU length values used in the PDU-length field of the P-DATA-TF PDUs received by the association-acceptor. Otherwise, it shall be a protocol error.

D.2 Extended user information negotiation

The user information parameter, of the A-ASSOCIATE primitive, can be extended to support the negotiation needs of DICOM Application Entities using the UL Service. This will result in the definition of specific user information sub-items. These sub-items shall be assigned unique item-type values registered in PS 3.7.

NOTE—The values of the Sub-Items types in the User Information Field are assigned by this standard in the range of 51H through FFH. Sub-Item values are defined by PS 3.7 and PS 3.8.

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Annex E
(Normative)
Usage of the P-DATA service by the DICOM application entity

This Annex specifies how DICOM messages are encapsulated into the P-DATA Service by the DICOM Application Entity.

E.1 Encapsulation rules

DICOM Messages are encapsulated in P-DATA request primitives as the user data of Presentation Data Values (PDV). A DICOM Message is fragmented in Command Fragments and Data Fragments, each placed in a PDV. The same presentation context shall be used for every fragment of the same message (i.e. same Presentation Context ID for the user data of the PDVs containing the fragments of a same message). A PDV User Data parameter shall contain one and only one fragment (either Command or Data) preceded by a Message Control Header. This header will indicate:

a) whether the fragment is of the Command or Data type

b) whether the fragment is or is not the last fragment of a Command/Data Stream of a DICOM Message

A P-DATA request PDV List parameter shall contain one or more such PDV(s) (Message Control Header and a complete message fragment). Each PDV is wholly contained in a given P-DATA request primitive and does not span across several P-DATA request primitives. The PDVs contained in a P-DATA request primitive shall be related to the same DICOM message. Each fragment of a message shall consist of an even number of bytes.

NOTES
1 No padding is necessary as PS 3.5 defines messages on an even byte boundary.
2 The above rules state that each fragment contained in a PDV shall consist of an even number of bytes (only). Therefore, encoding such as Group Number, Element Number, Value Length, etc. (as defined by the DICOM Application Entity, see PS 3.5) is not guaranteed to be within the same PDV.

The fragmentation of any message results in a series of PDVs which shall be sent, on a given association, by a corresponding series of P-DATA requests preserving the ordering of the fragments of any message. Furthermore, no fragments of any other message shall be sent until all fragments of the current message have been sent (i.e. interleaving of fragments from different messages is not permitted).

It is strongly recommended that two consecutive PDVs in the same P-DATA Request primitive (therefore containing fragments of the same message using the same Presentation Context ID) do not contain two message Control Headers with the same type (Command or Data). These should have been combined in a single PDV by the sender. However, receivers must be able to receive and process such PDVs.

NOTE—The above rules allow the sending in the same P-DATA request/indication of a Command fragment in the first PDV (with the last fragment flag set) followed by a Data Fragment in the second PDV (with the last fragment flag set or not). In particular, if the negotiated maximum length for the PDV List parameter of the P-DATA request is sufficient to hold a complete message, a single P-DATA request can be used to exchange an entire message.

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E.2 Message control header encoding

The Message Control Header is located in front of each DICOM message fragment (see Figure E.2-1). Its presence is mandatory for all DICOM Abstract Syntaxes (see Annex B for further discussion on Abstract Syntaxes).

The Message Control Header shall be made of one byte with the least significant bit (bit 0) taking one of the following values:

a) If bit 0 is set to 1, the following fragment shall contain Message Command information.

b) If bit 0 is set to 0, the following fragment shall contain Message Data Set information.

The next least significant bit (bit 1) shall be defined by the following rules:

a) If bit 1 is set to 1, the following fragment shall contain the last fragment of a Message Data Set or of a Message Command.

b) If bit 1 is set to 0, the following fragment does not contain the last fragment of a Message Data Set or of a Message Command.

Bits 2 through 7 are always set to 0 by the sender and never checked by the receiver.

NOTE—The Message Control Header, in the Transport data flow, is the 1st byte in each PDV. The Transfer Syntax, negotiated at association establishment, defines the encoding for the Command/Data fragment.

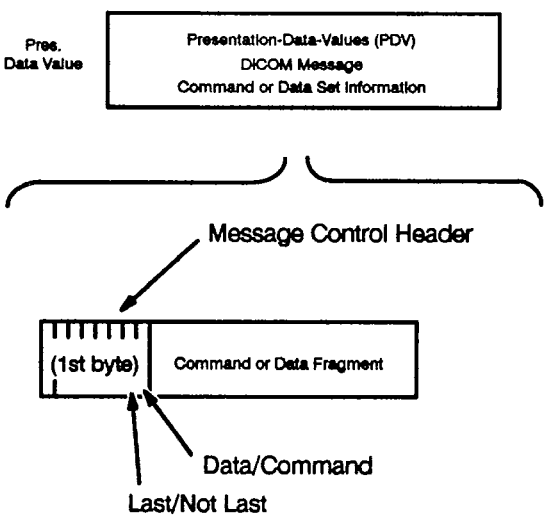

Figure E.2-1—Presentation data value and the message control header

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Annex F
(Normative)
DICOM UL encoding rules for application contexts, abstract syntaxes, transfer syntaxes

F.1 Encoding rules

Application Context Names, Abstract Syntax Names, Transfer Syntax Names, and Service Class UIDs are OSI Object Identifiers in a numeric form as defined by ISO 8824. The encoding of these names in the DICOM UL protocol is specified in this Annex. This is not applicable to OSI Upper Layer protocols.

Each component of a Name or UID is encoded as an ISO 646:1990-Basic G0 Set Numeric String of bytes (characters 0–9). Leading 0's of each component are not significant and shall not be sent. Components shall not be padded. Components shall be separated by the character "." (2EH). "Null" components (no numeric value between two separators) shall not exist. Components with the value zero (0) shall be encoded as (nnn.0.ppp). No separator nor padding shall be present before the first digit of the first component or after the last digit of the last component.

NOTES
1 The string "1.2.840.123456.0.21.4" encoded as an ISO 646:1990-Basic G0 Set character string conveys the following UID or Name with the following sequence of Object Identifier components: { (1), (2), (840), (123456), (0), (21), (4) }.
2 The above rules have been made to simplify performing the comparison of UIDs.

DICOM Application Context Names (root plus suffix) shall not exceed 64 total characters (digits and separators between components).

DICOM Abstract and Transfer Syntax Names (root plus suffix) shall not exceed 64 total characters (digits and separators between components).

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Annex G
(Informative)
Overview of the OSI layer and services concepts

In a layered communication model, such as the OSI 7 layer reference model, each layer uses the service provided by the layer immediately below. The operation of a protocol layer on top of the lower layer service provides a new service to the layer above. The service is the "glue" between the layers of protocols.

Services describe the resulting effects of the operation of a protocol without requiring knowledge of the detailed specifications of the protocol itself. A protocol specifies a horizontal dialogue between two computing systems across a network, while a service describes a vertical relationship within a system. See Figure G-1.

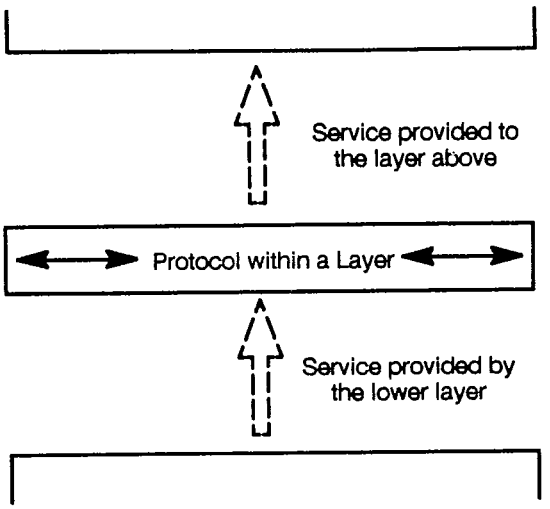

Figure G-1—Relationship of services to protocols

The OSI Upper Layer Service is described by a number of service primitives. They each model one of the functional interactions between the service-user in the layer above and the service-provider. In the context of this Standard, the service-user is called the DICOM Application Service Element. The service-provider is called the Upper Layer and performs the Upper Layer Protocol.

NOTE—The OSI UL Services defined in this standard can be provided either by the DICOM OSI Upper Layer Profile (Section 8) or the DICOM Upper Layer Protocol for TCP/IP (Section 9).

These service primitives cross the layer boundary at what is called a Service Access Point (SAP). In most cases a direct relationship exists between service primitives in two Application Entities (AEs). This is reflected in the names of these primitives:

a) A request primitive in System A induces an indication primitive in System B.

b) If an indication primitive in System B requires a reply, a response primitive may be issued at the Service Access Point (SAP) in System B. This response primitive will induce a confirmation primitive in System A.

The different types of service primitives and their relationship are shown in Figure G-2. The dotted lines represent the exchange of Protocol Data Units that are triggered by request/response primitives or generated indication/confirmation primitives.

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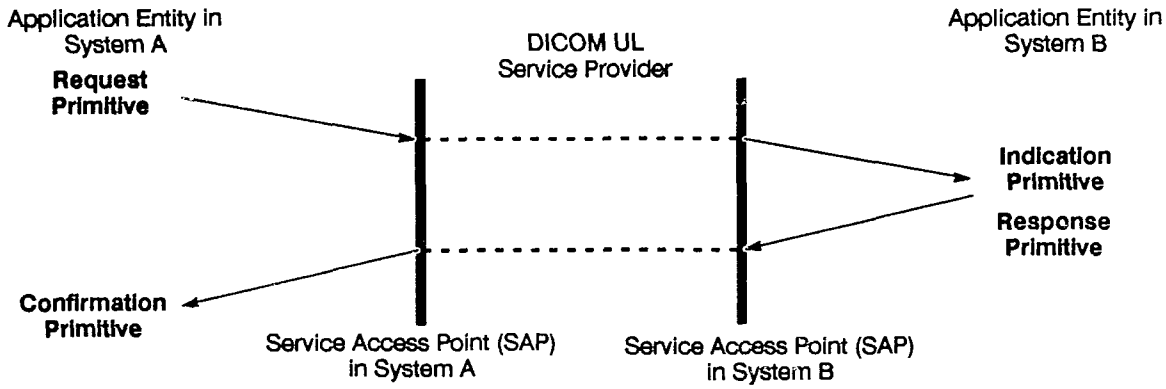

Figure G-2—Service description conventions

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NEMA STANDARDIZIATION BACKGROUND

The purpose of NEMA standards, their classification, and status are set forth in certain clauses of the NEMA *Standardization Policies and Procedures* manual and are referenced below:

Purpose of Standards

National Electrical Manufacturers Association Standards are adopted in the public interest and are designed to eliminate misunderstandings between the manufacturer and the purchaser and to assist the purchaser in selecting and obtaining the proper product for their particular needs. Existence of a National Electrical Manufacturers Association Standard does not in any respect preclude any member or nonmember from manufacturing or selling products not conforming to the standard.

Definition of a Standard

A standard of the National Electrical Manufacturers Association defines a product, process, or procedure with reference to one or more of the following: nomenclature, composition, dimensions, tolerances, safety, operating characteristics, performance, rating, testing, and the service for which they are designed.

(Standardization Policies and Procedures, p. 1)

Dimensions

Where dimensions are given for interchangeability purposes, alternate dimensions satisfying the other provisions of the Standards Publication may be capable of otherwise equivalent performance.

(Standardization Policies and Procedures, p. 6)

Categories of Standards

National Electrical Manufacturers Association Standards are of three classes, which have received the affirmative vote of at least two-thirds of the Subdivision votes cast in the affirmative or negative:

1. NEMA Standard, which relates to a product, process, or procedure commercially standardized and subject to repetitive manufacture.
2. Suggested Standard for Future Design, which may not have been regularly applied to a commercial product, but which suggests a sound engineering approach to future development.
3. Adoptive Standard, which is adopted in whole or in part from the standards of another organization, either domestic, regional, or international.

(Standardization Policies and Procedures, pp. 5)

Authorized Engineering Information

Authorized Engineering Information consists of explanatory data and other engineering information of an informative character not falling within the classification of NEMA Standard or Suggested Standard for Future Design, which standard has received the affirmative vote of at least two-thirds of the Subdivision votes cast in the affirmative or negative.

(Standardization Policies and Procedures, pp. 5)

Identification of Status

Standards in NEMA Standards Publications are identified as "NEMA Standard," "Suggested Standard for Future Design," or "Adoptive Standard." These indicate the status of the standard. A statement incorporating the auxiliary verb "shall" indicates that compliance with a requirement is mandatory for compliance with the standard. These classes of standards are identified in the foreword or throughout the text.

The material identified as "Authorized Engineering Information" is designated similarly. Statements incorporating other auxiliary verbs such as "should," "may," etc. refer to the authorized engineering information and not to procedures required for compliance with the standard.

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