# IEC 61158-6-19

Edition 2.0 2010-08

# INTERNATIONAL STANDARD

## Industrial communication networks – Fieldbus specifications – Part 6-19: Application layer protocol specification – Type 19 elements



IEC 61158-6-19:2010(E)

## About the IEC

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

## About IEC publications

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigenda or an amendment might have been published.

- Catalogue of IEC publications: www.iec.ch/searchpub
The IEC on-line Catalogue enables you to search by a variety of criteria (reference number, text, technical committee,…). It also gives information on projects, withdrawn and replaced publications.

- IEC Just Published: www.iec.ch/online_news/justpub
Stay up to date on all new IEC publications. Just Published details twice a month all new publications released. Available on-line and also by email.

- Electropedia: www.electropedia.org
The world's leading online dictionary of electronic and electrical terms containing more than 20 000 terms and definitions in English and French, with equivalent terms in additional languages. Also known as the International Electrotechnical Vocabulary online.

- Customer Service Centre: www.iec.ch/webstore/custserv
If you wish to give us your feedback on this publication or need further assistance, please visit the Customer Service Centre FAQ or contact us:
Email: csc@iec.ch
Tel.: +41 22 919 02 11
Fax: +41 22 919 03 00

# IEC 61158-6-19

Edition 2.0 2010-08

# INTERNATIONAL STANDARD



## Industrial communication networks – Fieldbus specifications – Part 6-19: Application layer protocol specification – Type 19 elements

INTERNATIONAL ELECTROTECHNICAL COMMISSION

PRICE CODE T

ICS 25.04.40; 35.100.70; 35.110

ISBN 978-2-88912-133-5

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

___________

# INDUSTRIAL COMMUNICATION NETWORKS – FIELDBUS SPECIFICATIONS –

## Part 6-19: Application layer protocol specification – Type 19 elements

## FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
6) All users should ensure that they have the latest edition of this publication.
7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

NOTE 1 Use of some of the associated protocol types is restricted by their intellectual-property-right holders. In all cases, the commitment to limited release of intellectual-property-rights made by the holders of those rights permits a particular data-link layer protocol type to be used with physical layer and application layer protocols in Type combinations as specified explicitly in the profile parts. Use of the various protocol types in other combinations may require permission from their respective intellectual-property-right holders.

International Standard IEC 61158-6-19 has been prepared by subcommittee 65C: Industrial networks, of IEC technical committee 65: Industrial-process measurement, control and automation.

This second edition cancels and replaces the first edition published in 2007. This edition constitutes a technical revision.

The main changes with respect to the previous edition are listed below:

- increasing the number of supported devices (511 instead of 254);

- introducing a communication version identification;
- adding a mechanism for remote address allocation;
- introducing enhanced parameter addressing (32 bit instead of 16 bit);
- restructuring control and status word;
- improving the redundancy and hotplug features;
- improving the error handling;
- adding a multiplexing protocol (SMP: Type 19 Messaging Protocol).

The text of this standard is based on the following documents:

| FDIS | Report on voting |
|---|---|
| 65C/607/FDIS | 65C/621/RVD |

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with ISO/IEC Directives, Part 2.

A list of all parts of the IEC 61158 series, published under the general title *Industrial communication networks – Fieldbus specifications*, can be found on the IEC web site.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be:

- reconfirmed;
- withdrawn;
- replaced by a revised edition, or
- amended.

NOTE 2 The revision of this standard will be synchronized with the other parts of the IEC 61158 series.

# INTRODUCTION

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

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

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

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

# INDUSTRIAL COMMUNICATION NETWORKS – FIELDBUS SPECIFICATIONS –

# Part 6-19: Application layer protocol specification – Type 19 elements

## 1 Scope

### 1.1 General

The Fieldbus Application Layer (FAL) provides user programs with a means to access the fieldbus communication environment. In this respect, the FAL can be viewed as a "window between corresponding application programs."

This standard provides common elements for basic time-critical and non-time-critical messaging communications between application programs in an automation environment and material specific to Type 19 fieldbus. The term "time-critical" is used to represent the presence of a time-window, within which one or more specified actions are required to be completed with some defined level of certainty. Failure to complete specified actions within the time window risks failure of the applications requesting the actions, with attendant risk to equipment, plant and possibly human life.

This standard defines in an abstract way the externally visible service provided by the different Types of fieldbus Application Layer in terms of

a) an abstract model for defining application resources (objects) capable of being manipulated by users via the use of the FAL service,
b) the primitive actions and events of the service;
c) the parameters associated with each primitive action and event, and the form which they take; and
d) the interrelationship between these actions and events, and their valid sequences.

The purpose of this standard is to define the services provided to

a) the FAL user at the boundary between the user and the Application Layer of the Fieldbus Reference Model, and
b) Systems Management at the boundary between the Application Layer and Systems Management of the Fieldbus Reference Model.

This standard specifies the structure and services of the IEC fieldbus Application Layer, in conformance with the OSI Basic Reference Model (ISO/IEC 7498) and the OSI Application Layer Structure (ISO/IEC 9545).

FAL services and protocols are provided by FAL application-entities (AE) contained within the application processes. The FAL AE is composed of a set of object-oriented Application Service Elements (ASEs) and a Layer Management Entity (LME) that manages the AE. The ASEs provide communication services that operate on a set of related application process object (APO) classes. One of the FAL ASEs is a management ASE that provides a common set of services for the management of the instances of FAL classes.

Although these services specify, from the perspective of applications, how request and responses are issued and delivered, they do not include a specification of what the requesting and responding applications are to do with them. That is, the behavioral aspects of the applications are not specified; only a definition of what requests and responses they can send/receive is specified. This permits greater flexibility to the FAL users in standardizing such object behavior. In addition to these services, some supporting services are also defined in this standard to provide access to the FAL to control certain aspects of its operation.

### 1.2 Specifications

The principal objective of this standard is to specify the characteristics of conceptual application layer services suitable for time-critical communications, and thus supplement the OSI Basic Reference Model in guiding the development of application layer protocols for time-critical communications.

A secondary objective is to provide migration paths from previously-existing industrial communications protocols. It is this latter objective which gives rise to the diversity of services standardized as the various Types of IEC 61158, and the corresponding protocols standardized in subparts of IEC 61158-6.

### 1.3 Conformance

This standard do not specify individual implementations or products, nor do they constrain the implementations of application layer entities within industrial automation systems.

There is no conformance of equipment to this application layer service definition standard. Instead, conformance is achieved through implementation of conforming application layer protocols that fulfill any given Type of application layer services as defined in this standard.

## 2 Normative references

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

IEC 61158-3-19, *Industrial communication networks – Fieldbus specifications – Part 3-19: Data-link layer service definition – Type 19 elements*

IEC 61158-4-19, *Industrial communication networks – Fieldbus specifications – Part 4-19: Data-link layer protocol specification – Type 19 elements*

IEC 61158-5-19, *Industrial communication networks – Fieldbus specifications – Part 5-19: Application layer service definition – Type 19 elements*

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

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

ISO/IEC 8822, *Information technology – Open Systems Interconnection – Presentation service definition*

ISO/IEC 8824, *Information technology – Open Systems Interconnection – Specification of Abstract Syntax Notation One (ASN.1)*

# 3 Terms, definitions, abbreviations, symbols and conventions

## 3.1 Referenced terms and definitions

### 3.1.1 ISO/IEC 7498-1 terms

For the purposes of this document, the following terms as defined in ISO/IEC 7498-1 apply:

a) application entity
b) application process
c) application protocol data unit
d) application service element
e) application entity invocation
f) application process invocation
g) application transaction
h) real open system
i) transfer syntax

### 3.1.2 ISO/IEC 8822 terms

For the purposes of this document, the following terms as defined in ISO/IEC 8822 apply:

a) abstract syntax
b) presentation context

### 3.1.3 ISO/IEC 9545 terms

For the purposes of this document, the following terms as defined in ISO/IEC 9545 apply:

a) application-association
b) application-context
c) application context name
d) application-entity-invocation
e) application-entity-type
f) application-process-invocation
g) application-process-type
h) application-service-element
i) application control service element

### 3.1.4 ISO/IEC 8824 terms

For the purposes of this document, the following terms as defined in ISO/IEC 8824 apply:

a) object identifier
b) type

### 3.1.5 Fieldbus Data Link Layer terms

For the purposes of this document, the following terms as defined in IEC 61158-3-19 and IEC 61158-4-19 apply.

a) DL-Time
b) DL-Scheduling-policy
c) DLCEP

d) DLC
e) DL-connection-oriented mode
f) DLPDU
g) DLSDU
h) DLSAP
i) fixed tag
j) generic tag
k) link
l) MAC ID
m) network address
n) node address
o) node
p) tag
q) scheduled
r) unscheduled

### 3.2 Additional terms and definitions

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

**3.2.1**
**communication cycle**
fixed time period between two master synchronization telegrams in which real-time telegrams are transmitted in the RT channel and non real-time telegrams are transmitted in the IP channel

**3.2.2**
**control unit**
control device (e.g., a PLC as specified in the IEC 61131 standard family)

**3.2.3**
**control word**
two adjacent octets inside the master data telegram containing commands for the addressed device

**3.2.4**
**cycle time**
duration of a communication cycle

**3.2.5**
**device**
a slave in the communication network, (e.g., a power drive system as defined in the IEC 61800 standard family, I/O stations as defined in the IEC 61131 standard family).

**3.2.6**
**device status**
four adjacent octets inside the acknowledge telegram containing status information for each device

**3.2.7**
**identification number**
**(IDN)**
designation of operating data under which a data block is preserved with its attribute, name, unit, minimum and maximum input values, and the data

**3.2.8**
**little endian**
describes a model of memory organisation which stores the least significant octet at the lowest address, or for transfer, which transfers the lowest order octet first

**3.2.9**
**master data telegram**
**(MDT)**
telegram, in which the master inserts its data

**3.2.10**
**protocol**
convention about the data formats, time sequences, and error correction in the data exchange of communication systems

**3.2.11**
**slave**
node, which is assigned the right to transmit by the master

**3.2.12**
**status word**
two adjacent octets inside the acknowledge telegram containing status information of a device

**3.2.13**
**S-0-nnnn**
designation of IDNs

## 3.3 Additional abbreviations and symbols

| | |
|---|---|
| AT | acknowledge telegram |
| CC | cross communication between participants |
| IDLE | inter packet gap (see IPG) |
| IDN | identification number |
| IPOSYNC | synchronization for PDS interpolator |
| MDT | master data telegram |
| RTC | real-time channel |
| SERCOS | serial real-time communication system interface |

## 3.4 Conventions

The FAL is defined as a set of object-oriented ASEs. Each ASE is specified in a separate subclause. Each ASE specification is composed of three parts: its class definitions, its services, and its protocol specification. The first two are contained in IEC 61158-5-19. The protocol specification for each of the ASEs is defined in this standard.

The class definitions define the attributes of the classes supported by each ASE. The attributes are accessible from instances of the class using the Management ASE services specified in IEC 61158-5-19 standard. The service specification defines the services that are provided by the ASE.

This standard uses the descriptive conventions given in ISO/IEC 10731.

# 4 Abstract syntax

The abstract syntax and the transfer syntax are merged into a fixed format that is defined in the the next clause.

# 5 Transfer syntax

## 5.1 Introduction

Type 19 transfer syntax shall be bit-coded, and therefore does not comply with usual data type specifications such as integer32 and alike.

The octet encoding shall use little endian.

## 5.2 RTC PDU merged abstract and transfer syntax

The merged abstract and transfer syntax for attributes belonging to this class is described in Table 1.

**Table 1 – RTC PDU attribute format**

| Attribute | Format | Size (bits) |
|---|---|---|
| Consumer control word | 2 Octets, bit mapped | 16 |
| Reserved for DLL | 16 Bit | 16 |
| Configurable part of data record with producer data | List of 2, 4 or 8 Octets | |
| Configured cyclic producer data 1 | 2, 4 or 8 Octets | |
| Configured cyclic producer data 2 | 2, 4 or 8 Octets | |
| … | … | |
| Configured cyclic producer data n | 2, 4 or 8 Octets | |
| NOTE n = number of configured cyclic producer data. The structure and content of the configurable part of the data record is determined by the configuration list labeled IDN S-0-1212, S-0-1222, S-0-1232 or S-0-1242. | | |

# 6 Structure of FAL protocol state machines

Interface to FAL services and protocol machines are specified in this subclause.

The behavior of the FAL is described by three integrated protocol machines. Specific sets of these protocol machines are defined for different AREP types. The three protocol machines are: FAL Service Protocol Machine (FSPM), the Application Relationship Protocol Machine (ARPM), and the Data Link Layer Mapping Protocol Machine (DMPM). The relationships among these protocol machines as well as primitives exchanged among them are depicted in Figure 1.

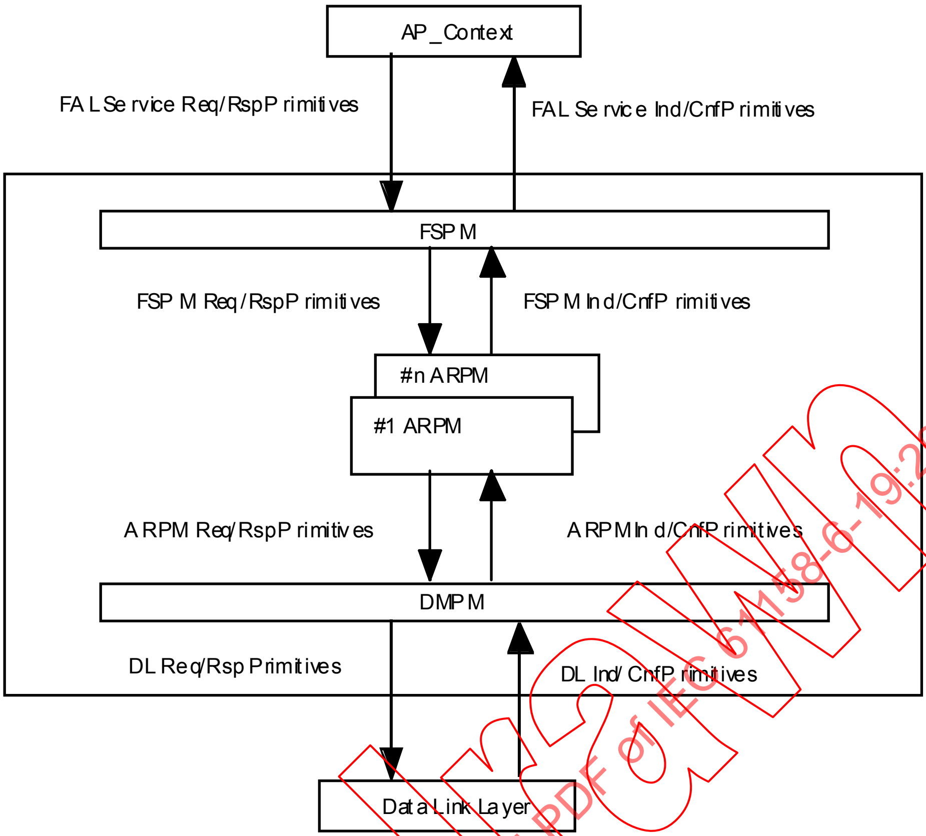


**Figure 1 – Relationships among protocol machines and adjacent layers**

The FSPM describes the service interface between the AP-Context and a particular AREP. The FSPM is common to all the AREP classes and does not have any state changes. The FSPM is responsible for the following activities:

a) to accept service primitives from the FAL service user and convert them into FAL internal primitives;

b) to select an appropriate ARPM state machine based on the AREP Identifier parameter supplied by the AP-Context and send FAL internal primitives to the selected ARPM;

c) to accept FAL internal primitives from the ARPM and convert them into service primitives for the AP-Context;

d) to deliver the FAL service primitives to the AP-Context based on the AREP Identifier parameter associated with the primitives.

The ARPM describes the establishment and release of an AR and exchange of FAL-PDUs with a remote ARPM(s). The ARPM is responsible for the following activities:

a) to accept FAL internal primitives from the FSPM and create and send other FAL internal primitives to either the FSPM or the DMPM, based on the AREP and primitive types;

b) to accept FAL internal primitives from the DMPM and send them to the FSPM as a form of FAL internal primitives;

c) if the primitives are for the Establish or Abort service, it shall try to establish or release the specified AR.

The DMPM describes the mapping between the FAL and the DLL. It is common to all the AREP types and does not have any state changes. The DMPM is responsible for the following activities:

a) to accept FAL internal primitives from the ARPM, prepare DLL service primitives, and send them to the DLL;

b) to receive DLL indication or confirmation primitives from the DLL and send them to the ARPM in a form of FAL internal primitives.

# 7 AP-context state machine

## 7.1 Overview

The AP-Context State Machine (APCSM) manages the behavioral states, transitions and interactions of all the objects contained in an implementation of the Type 19 FAL. As shown in Figure 2, there are three states. Event notifications are delivered to the APCSM from the FAL Services Protocol Machine (FSPM) or the AR Protocol Machine (ARPM) as specified. These event notifications, identified in Figure 2, result in state transitions.

The APCSM is initiated in the Idle state.


**Figure 2 – APCSM state diagram**

## 7.2 States

### 7.2.1 Idle

#### 7.2.1.1 Behavior

The FAL is not connected to the network. The only behavior associated with the Idle state is a determination of errors or other fault conditions that are specified as preventing the transition to the Running state. If there are no such preventative conditions, an automatic invocation of the Establish primitive is self generated by the APCSM.

#### 7.2.1.2 Events

Establish – Connects the FAL to the network. Upon successful completion, the APCSM transitions to the Running state.

### 7.2.2 Running

#### 7.2.2.1 Behavior

The FAL is connected to the network. The Master type device is able to perform the behavior associated with communicating to the Slaves to which it is connected. Slave type devices are able to perform the behavior associated responding to the Master to which it is connected.

#### 7.2.2.2 Events

Release – Disconnects the FAL from the network. Upon successful completion, the APCSM transitions to the Idle state.

## 7.3 States, events and transitions

The combination of all states events and possible transitions are shown in Table 2.

**Table 2 – APCSM state-event table**

| Current State | Event | Action | Next State |
|---|---|---|---|
| Idle | Establish | Initiate the methods specified for the Running state | Running |
| Idle | Release | Return an error | Running |
| Running | Establish | Return an error | Running |
| Running | Release | Initiate the methods specified for the Idle state | Idle |

# 8 FAL service protocol machine (FSPM)

## 8.1 Overview

The FSPM provides the interface to the FAL user in the form of service handlers which convert service parameters into APDUs and process service requests from the FAL user or convert APDUs into service parameters and deliver service indications to the FAL user.

The FSPM operates in a single state with events defined by the receipt of service primitives.

## 8.2 MGT services

### 8.2.1 Get network status

Upon receipt of a Get Network Status service request from the FAL user, the FSPM prepares and delivers an appropriately encoded FSP-get network status primitive to the ARPM.

### 8.2.2 Get device status

Upon receipt of a Get Device Status service request from the FAL user, the FSPM prepares and delivers an appropriately encoded FSP-get device status primitive to the ARPM.

### 8.2.3 Network status change report

Upon receipt of an FSP-network status change indication from the ARPM, the FSPM prepares and delivers an appropriately encoded network status change indication to the FAL user.

### 8.2.4 Device status change report

Upon receipt of an FSP-device status change indication from the ARPM, the FSPM prepares and delivers an appropriately encoded device status change indication to the FAL user.

### 8.2.5 Set device status

Upon receipt of a Set Device Status service request from the FAL user, the FSPM prepares and delivers an appropriately encoded FSP-set device status primitive to the ARPM.

### 8.2.6 Enable RTC

Upon receipt of an Enable RTC service request from the FAL user, the FSPM prepares and delivers an appropriately encoded FSP-enable RTC primitive to the ARPM.

### 8.2.7 Enable hot-plug

Upon receipt of an Enable Hot-plug service request from the FAL user, the FSPM prepares and delivers an appropriately encoded FSP-enable hot-plug primitive to the ARPM.

#### 8.2.8 Notify RTC

Upon receipt of an FSP-notify RTC indication from the ARPM, the FSPM prepares and delivers an appropriately encoded notify RTC change indication to the FAL user.

#### 8.2.9 Disable RTC

Upon receipt of a Disable RTC service request from the FAL user, the FSPM prepares and delivers an appropriately encoded FSP-disable RTC primitive to the ARPM.

#### 8.2.10 Notify error

Upon receipt of an FSP-notify error indication from the ARPM, the FSPM prepares and delivers an appropriately encoded notify error indication to the FAL user.

### 8.3 IDN services

#### 8.3.1 Read

Upon receipt of a Read service request from the FAL user, if the ARPM is not in the Running state, an error is returned to the FAL user, otherwise the FSPM prepares and delivers an appropriately encoded FSP-read primitive to the ARPM.

#### 8.3.2 Write

Upon receipt of a Write service request from the FAL user, if the ARPM is not in the Running state, an error is returned to the FAL user, otherwise the FSPM prepares and delivers an appropriately encoded FSP-write primitive to the ARPM.

### 8.4 CYCIDN services

#### 8.4.1 Read_cyclic

Upon receipt of a Read_cyclic service request from the FAL user, the FSPM prepares and delivers an appropriately encoded FSP-read cyclic primitive to the ARPM.

#### 8.4.2 Write_cyclic

Upon receipt of a Write_cyclic service request from the FAL user, if the ARPM is not in the Running state, an error is returned to the FAL user, otherwise the FSPM prepares and delivers an appropriately encoded FSP-write cyclic primitive to the ARPM.

#### 8.4.3 Notify_cyclic

Upon receipt of an FSP-notify cyclic indication from the ARPM, the FSPM prepares and delivers an appropriately encoded notify_cyclic indication to the FAL user.

## 9 Application relationship protocol machine (ARPM)

### 9.1 Overview

The ARPM manages the functions and behaviors of the ARs by

a) receiving, decoding and processing service requests from the FSPM,

b) preparing, encoding and delivering service requests to the DMPM,

c) receiving, decoding and processing service indications from the DMPM,

d) preparing, encoding and delivering service indications to the FSPM,

e) monitoring critical functions of the ARs including timeout times and other fault conditions,

f) delivering event notifications to the APCSM.

The behavior of the ARPM is managed by the APCSM.

There are two types of AR: Master and Slave.

## 9.2 Master ARPM

### 9.2.1 Overview

The Master ARPM manages the behavioral states, transitions and interactions of a Master AR. As shown in Figure 3, there are two states.

Sub-states are not represented as definitive states, but exist as abstractions used to identify a set of behaviors with a state.

The ARPM is initiated in the Idle state.

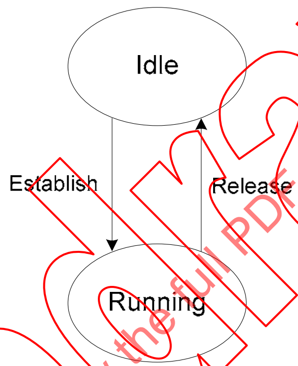


**Figure 3 – ARPM master AR state diagram**

### 9.2.2 State descriptions

#### 9.2.2.1 Idle

##### 9.2.2.1.1 Behavior

The FAL is not connected to the network. The only behavior associated with the Idle state is a determination of errors or other fault conditions that are specified as preventing the transition to the Running state.

##### 9.2.2.1.2 Events

**Establish** – Connects the FAL to the network. Upon successful completion, the Master ARPM transitions to the Running state.

#### 9.2.2.2 Running state

##### 9.2.2.2.1 Behavior

In this state the FAL is connected to the network.

##### 9.2.2.2.2 Events

**Release** – Disconnects the FAL from the network. Upon successful completion, the Master ARPM transitions to the Idle state.

### 9.2.3 States, events and transitions

The combination of all states events and possible transitions are shown in Table 3.

**Table 3 – Master ARPM state-event table**

| Current State | Event | Action | Next State |
|---|---|---|---|
| Idle | Establish | Initiate the methods specified for the Running state | Running |
| Idle | Release | Return an error | Running |
| Running | Establish | Return an error | Running |
| Running | Release | Initiate the methods specified for the Idle state | Idle |

## 9.3 Slave ARPM

### 9.3.1 Overview

The Slave ARPM manages the behavioral states, transitions and interactions of a Slave AR. As shown in Figure 4, there are two states.

Sub-states are not represented as definitive states, but exist as abstractions used to identify a set of behaviors with a state.

The ARPM is initiated in the Idle state.

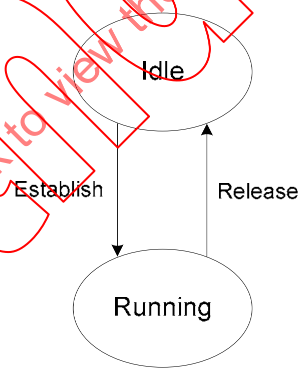


**Figure 4 – ARPM slave AR state diagram**

### 9.3.2 State descriptions

#### 9.3.2.1 Idle

##### 9.3.2.1.1 Behavior

The FAL is not connected to the network. The only behavior associated with the Idle state is a determination of errors or other fault conditions that are specified as preventing the transition to the Running state.

##### 9.3.2.1.2 Events

**Establish** – Connects the FAL to the network. Upon successful completion, the Slave ARPM transitions to the Running state.

#### 9.3.2.2 Running state

##### 9.3.2.2.1 Behavior

In this state the FAL is connected to the network.

##### 9.3.2.2.2 Events

**Release** – Disconnects the FAL from the network. Upon successful completion, the Slave ARPM transitions to the Idle state.

### 9.3.3 States, events and transitions

The combination of all states events and possible transitions are shown in Table 4.

**Table 4 – Slave ARPM state-event table**

| Current State | Event | Action | Next State |
|---|---|---|---|
| Idle | Establish | Initiate the methods specified for the Running state | Running |
| Idle | Release | Return an error | Running |
| Running | Establish | Return an error | Running |
| Running | Release | Initiate the methods specified for the Idle state | Idle |

## 9.4 Primitives received from the FSPM

### 9.4.1 FSP-get network status

Upon receipt of an FSP-get network status service request from the FAL user, the ARPM prepares and delivers an appropriately encoded ARP-get network status primitive to the DMPM if the ARPM is in the running state. Otherwise, it discards the request. This primitive uses no attributes.

### 9.4.2 FSP-get device status

Upon receipt of an FSP-get device status service request from the FAL user, the ARPM prepares and delivers an appropriately encoded ARP-get device status primitive to the DMPM if the ARPM is in the running state. Otherwise, it discards the request. This primitive uses the network address of the selected device as attribute.

### 9.4.3 FSP-set device status

The FSP-set device status primitive is only valid for M type FAL users.

Upon receipt of an FSP-set device status from the FAL user, the APCSM prepares and delivers an appropriately encoded ARP-set device status primitive to the DMPM if the ARPM is in the running state. Otherwise, it discards the request. This primitive uses the network address of the selected device and the status to be set as attributes.

### 9.4.4 FSP-enable RTC

The FSP-enable RTC primitive is only valid for M type FAL users.

Upon receipt of an enable RTC service request from the FAL user, if the ARPM is in the Running state, an error is returned to the FAL user, otherwise the APCSM prepares and delivers an appropriately encoded ARP-enable RTC primitive to the DMPM. This primitive uses the network addresses of the selected devices as attributes.

#### 9.4.5 FSP-enable Hot-plug

The FSP-enable Hot-plug primitive is only valid for M type FAL users.

Upon receipt of an enable Hot-plug service request from the FAL user, if the ARPM is in the Idle state, an error is returned to the FAL user, otherwise the APCSM prepares and delivers an appropriately encoded ARP-enable Hot-plug primitive to the DMPM. This primitive uses the network addresses of the selected devices as attributes.

#### 9.4.6 FSP-disable RTC

The FSP-disable RTC primitive is only valid for M type FAL users.

Upon receipt of a disable RTC service request from the FAL user, if the ARPM is in the Idle state, an error is returned to the FAL user, otherwise the APCSM prepares and delivers an appropriately encoded ARP-disable RTC primitive to the DMPM. This primitive uses the network addresses of the selected devices as attributes.

#### 9.4.7 FSP-read

The FSP-read primitive is only valid for M type FAL users.

Upon receipt of a read service request from the FAL user, the APCSM prepares and delivers an appropriately encoded ARP-read acyclic primitive to the DMPM if the ARPM is in the running state. Otherwise, it discards the request. This primitive uses the network addresses of the selected device and the IDN as attributes.

#### 9.4.8 FSP-write

The FSP-write primitive is only valid for M type FAL users.

Upon receipt of a write service request from the FAL user, the APCSM prepares and delivers an appropriately encoded ARP-write acyclic primitive to the DMPM if the ARPM is in the running state. Otherwise, it discards the request. This primitive uses the network addresses of the selected device, the IDN and the value to be written as attributes.

#### 9.4.9 FSP-read_cyclic

Upon receipt of a read_cyclic service request from the FSPM, if the APCSM is not in the Running state, an error is returned, otherwise the ARPM prepares and delivers an appropriately encoded ARP-read_cyclic primitive to the DMPM. This primitive uses the network addresses of the selected device and the IDN as attributes.

#### 9.4.10 FSP-write_cyclic

Upon receipt of a write_cyclic service request from the FSPM, if the APCSM is not in the Running state, an error is returned; otherwise the ARPM prepares and delivers an appropriately encoded ARP-write_cyclic primitive to the DMPM. This primitive uses the network addresses of the selected device, the IDN and the value to be written as attributes.

### 9.5 Indications received from the DMPM

#### 9.5.1 ARP-network status change report

The ARP-network status change report indication is only valid for M type FAL users.