

Fieldbus

Part 7. Fieldbus management

Section 7.2 Specification for Network management

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Foreword

This Part of DD 238 has been prepared by Technical Committee, AMT/7. It supersedes DD 236 : Part 2 : 1996, which is withdrawn.

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This publication contains the following parts:

Part 1	Guide to system architecture (Equivalent to FF-800 Revision 1.0 ¹)
Part 2	Specification for 31.25 kbit/s Physical layer profile (Equivalent to FF-816 Revision 1.0 ¹)
Part 3	Specification for Data link layer services subset (Equivalent to FF-821 Revision 1.0 ¹)
Part 4	Specification for Data link protocol (Equivalent to FF-822 Revision 1.0 ¹)
Part 5	Specification for Fieldbus access sublayer (Services and protocol) (Equivalent to FF-875 Revision 1.0 ¹)
Part 6	Fieldbus Message Specification (Equivalent to FF-870 Revision 1.0 ¹)
Part 7	Fieldbus management
Section 7.1	Specification for System management (Equivalent to FF-880 Revision 1.0 ¹)
Section 7.2	Specification for Network management (Equivalent to FF-801 Revision 1.0 ¹)

This Draft for Development is not to be regarded as a British Standard.

It is being issued in the Draft for Development series of publications and is of a provisional nature because the subject matter is still under development requiring wider exposure. It should be applied on this provisional basis, so that information and experience of its practical application may be obtained.

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

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

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

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

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¹Available from the Fieldbus Foundation, 9390 Research Boulevard, Suite II-250, Austin, Texas 78759, USA.

1. Scope

DD 238 Network Management provides for the management of a device's communication system by an external network manager application. This document specifies the network management objects and services necessary to manage the communication system of a DD 238 device.

The Network Management objects and services defined in this document support:

- Configuration Management initializes and maintains communication parameter values;
- Performance Management collects and characterizes the performance of device communications;
- Fault Management assists in fault detection, isolation, and recovery.

Definition of the network manager application that accesses these objects and services is beyond the scope of this specification.

2. Overview

Network Management permits DD 238 Network Manager (NMgrs) entities to conduct management operations over the network with their associated Network Management Agents (NMAs). Each NMA is responsible for managing the communication stack within a Fieldbus device. NMAs respond to instructions received from NMgrs and are capable of indicating to their NMgrs when significant events, or change in status occurs, by updating accessible objects. The NMA is represented as an FMS VFD, and objects within the NMA are accessed by NMgrs using FMS services.

This specification first describes the network management architecture. It then defines:

1. the model of the NMA as a FMS Virtual Field Device (VFD);
2. the structure of the NMA Object Dictionary (OD) and Directory of the NMA VFD;
3. the specification of the network accessible objects contained in the VFD;
4. standard data types specific to Network Management Objects.

Communication between a Network Manager and a Network Management Agent utilizes the services defined in the DD 238 Fieldbus Messaging Specification (FMS).

2.1 Network Management Capabilities

The following capabilities are provided by network management:

1. Loading a Virtual Communication Relationship (VCR) List or single entries in this list;
(A VCR represents a communication channel through the complete communication stack.)
2. Configuring the Communication Stack;
3. Loading the Link Active Schedule;
4. Performance Monitoring;
5. Fault Detection Monitoring (NMA does not generate Information Report or Event Notification, however, it is not restricted from doing so for defined variables);

3. Network Management Architecture

Figure 1 shows the architectural relationship between network management and the other communication and application components in a device. Each device contains a single Network Management Agent and Layer Management Entities (LMEs) for its protocols (FMS LME, FAS LME, DL LME and Ph LME). Each Fieldbus network, segmented or not, has at least one Network Manager (NMGr) which coordinates the Network Management of the whole system. All other NMGr get their instructions from a "Higher-Level-NMGr" and act as NMA in relation to this "Higher-Level-NMGr". A NMGr interacts with the NMAs via FMS.

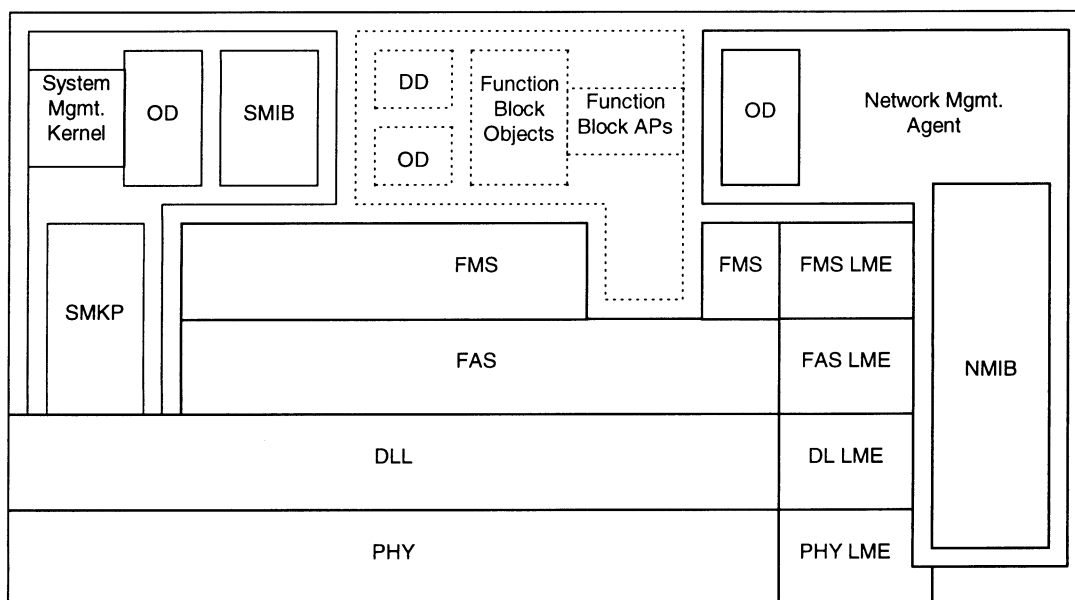


Figure 1 – General DD 238 Architecture

The NMA has access to management information of the different sublayers through local Layer Management Entities (LMEs). It also maintains information about the communication stack as a whole. This information is collectively referred to as the Network Management Information Base (NMIB) and represents communication stack parameters and operations such as:

- data within the protocol that controls, or reflects protocol operation;
- actions, represented by FMS variables, which may be written to manage protocol operation;

The NMA is modeled as an FMS VFD and its NMIB is modeled as a set of FMS objects. These objects are accessed by NMGr using FMS services through Virtual Communication Relationships (VCRs) established with the NMA. For interoperability purposes, a standard VCR is defined in Section 6 of this specification. Figure 2 illustrates these concepts.

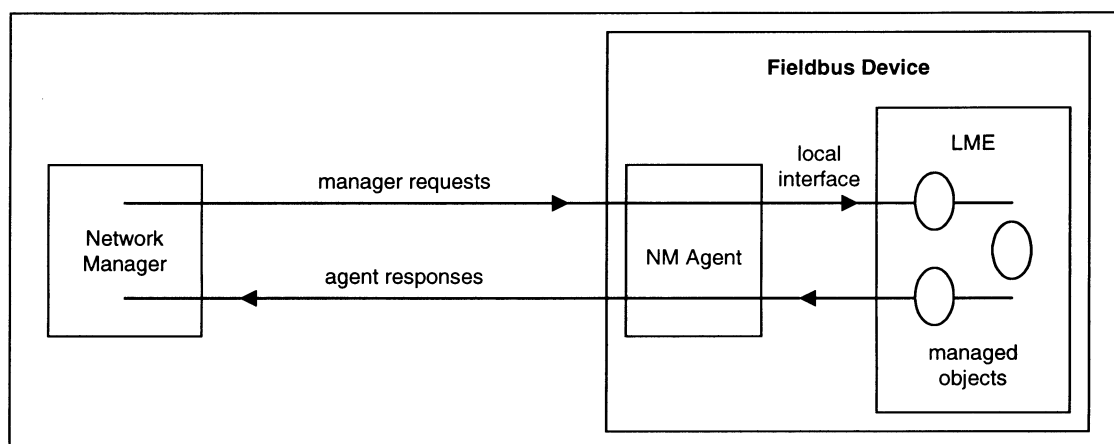


Figure 2 – Interaction between Manager, Agent, Managed Objects

Network Manager (NMGr)

The NMGr is responsible for maintaining the operation of the network according to the policies defined for it by the System Manager (SMGr). The NMGr enforces SM policies by monitoring the status of the communication stack in each device, and by taking action when necessary (or when directed to do so by the SM). The NMGr performs these tasks by processing information reports produced by the NMAs, and by directing the NMAs to perform services requested via FMS.

Interactions between NM and SM are local behavior.

Network Management Agent (NMA)

The NMA is responsible for providing the NMgr with an FMS interface to the managed objects of the communication stack. Internal to the device, the NMA maps FMS service requests to objects that it maintains for the communication stack as a whole, and to objects maintained by the Layer Management Entities (LMEs).

Layer Management Entities (LMEs)

Layer Management Entities provide the management capability of a layer protocol, such as FMS, FAS, DLL or the PhL. They provide NMA a local interface to the managed objects of the protocol. All network access to the LMEs and their objects is provided by the NMA.

Managed Objects

A managed object represents a capability or set of information about a protocol, or set of protocols, that is accessible through the LME. Each is defined by its attributes and behavior. Managed objects are represented remotely by the NMA as FMS objects in the NMIB.

Network Management Information Base (NMIB)

The collection of managed variables is called the Network Management Information Base (NMIB). The NMIB contains configuration, performance, and fault related information for the communication system of the device.

Network Management Communication Relationship

A standard Virtual Communication Relationship (VCR) is defined in Section 6 of this specification for communication between a NMA and its NMgr. This VCR is always the first VCR in the VCR List. It provides Time-Available, queued, user-triggered, bi-directional network access. This Network Management VCR exists at a well-known DLCEP address in all devices that contain an NMA. Additionally, all NMAs are required to support this VCR. An NMA may be accessed simultaneously through other VCRs, but for consistency, only monitoring is permitted via these VCRs.

Network Management VFD

This Virtual Field Device (VFD) is an FMS view of the Network Management Agent. It makes the NMA accessible across the network using FMS services.

3.1 References

IEC 1158 Fieldbus standard for use in industrial control systems

Part 2 (1993) Physical layer specification and service definition

IEC 1158-2 (1993): Amendment 1 (1995)¹⁾

IEC 1158-2 (1993): Draft Amendment 2 (65C/158/FDIS)²⁾

IEC 1158-2 (1993): Draft Amendment 3 (65C/155/CDV)³⁾

NOTE. This document references this specification as IEC 1158-2 or where appropriate by reference as [IEC 1158-2 Clause].

IEC/CDV 1158-4 (65C/161/CDV), *Digital data communications for measurement and control--Fieldbus for use in industrial control systems--Part 4 : Data link protocol specification*

NOTE. This document references this specifications as IEC/CDV 1158-4 or where appropriate by reference as [IEC/CDV 1158-4 Clause].

1) Amendment 1 amended annex A, and added new clauses 15, 16, 17 and 18 and new annexes D, E and F.

2) Draft amendment 2 amends clauses 12 and 14, and adds new clause 21.

3) Draft amendment 3 amends annex B (referred to as annex C in the draft amendment), and adds new clauses 18, 19, 20 and 22 (referred to as clause 24 in the draft amendment).

4. NMA VFD

4.1 VFD Definition

The Network Management Agent is an application process modeled by the Management VFD. The Management VFD is shared between the NMA and the System Management Kernel, and contains the NMIB and the SMIB.

VFD:	Management VFD
VendorName:	Not Defined Here (vendor dependent)
ModelName:	Not Defined Here (vendor dependent)
Revision:	Not Defined Here (vendor dependent)
ProfileNumber:	0x4D47 ("MG")
LogicalStatus:	Dynamic data
PhysicalStatus:	Dynamic data
ListofVfdSpecificObjects:	NMA Directory Object

VendorName

This attribute, of type VisibleString, identifies the manufacturer of the Management VFD. This is not represented in the OD, but is accessible from the VFD by using the FMS Identify service.

ModelName

This attribute, of type VisibleString, identifies the manufacturer specific model of the Management VFD. This is not represented in the OD, but is accessible from the VFD by using the FMS Identify service.

Revision

This attribute, of type VisibleString, is the software revision level of the Management VFD. This is not represented in the OD, but is accessible from the VFD by using the FMS Identify service.

Profile

This attribute, of type OctetString, specifies the DD 238 Profile information concerning the Management VFD conformance. This is not represented in the OD, but is used by FMS during the establishment of the a VCR. Its value is the hexadecimal value of "MG", which is 0x4D47.

ListofVfdSpecificObjects

This attribute is represented by the NMA Directory Object. It is the second directory object in the Management VFD. Figure 3 illustrates the structure of the NMA Directory and its relationship to the Object Dictionary for the NMA VFD.

4.2 NMA VFD OD Object Description

This section defines the contents of the OD Object Description (entry 0) in the Object Dictionary for the NMA VFD.

OD Object Description:	NMIB OD Description
Numeric Identifier:	0
ROM/RAM-Flag:	Not Defined Here
NameLength:	0 to indicate that object names are not supported in the OD.
AccessProtectionSupported:	Not Defined Here (defined per configuration or vendor)
VersionOD:	Not Defined Here (defined per configuration)
LocalAddress-OD-DES:	Not Defined Here (defined per configuration)
ST-OD-Length:	>= 256
LocalAddress-ST-OD:	Not Defined Here (defined per configuration)
FirstIndex-S-OD:	Object index of the First Directory Object.
S-OD-Length:	Not Defined Here (defined per configuration)
LocalAddress-S-OD:	Not Defined Here (defined per configuration)
First-Index-DV-OD:	Not Defined Here (defined per configuration)
DV-OD-Length:	Not Defined Here (defined per configuration)
LocalAddress-DV-OD:	Not Defined Here (defined per configuration)
FirstIndex-DP-OD:	Not Defined Here (defined per configuration)
DP-OD-Length:	Not Defined Here (defined per configuration)
LocalAddress-DP-OD:	Not Defined Here (defined per configuration)

4.3 NMA Directory Object

The NMA directory object is a map to a set of logically grouped objects contained in the NMIB. Each directory object contains the information necessary to access objects managed by the NMA.

NOTE: Examples of directories are: the directory describing the objects defined in this specification; the directory describing the objects defined by a communication profile; and the directory describing the objects defined by the manufacturer.

Communication profilers, device profilers, and/or manufacturers may extend the definitions of the network accessible objects contained in the NMA VFD. These additional objects are included in the OD by adding a separate directory to the NMA OD, and by referencing the objects via this directory. This ensures that added object definitions do not interfere with a minimum level of management interoperability. That is, objects, attributes and data types defined by this specification may not be changed, altered, or deleted.

The NMA directory object is defined as an FMS Array object. The NMA Standard Directory is always described by the second S-OD entry in the object dictionary. When there are N Directory objects, they will be individually referenced by the first N consecutive S-OD entries in the object dictionary. The number N is contained as the value in directory object array. The specific position within the array is defined below.

The following table summarizes network access to the directory entries.

OD index	Attribute name	Object Type	Data Type	Number of Elements	Size in octets	Valid Values	Initial Value	Access
S-OD+1 (second entry)	NMA Standard Directory	Array	Unsigned16	max 50	max 100	-----	-----	RaWa
1 entry for each additional directory object	Additional Directory	Array	Unsigned16	max 50	max 100	-----	-----	RaWa

Table 1 – Network Access to the Directory Entries

The FMS directory array object is defined as follows:

Array:

NMA Standard Directory Object

Name:	Not Applicable
Numeric Identifier:	First Index-S-OD +(Number of This Directory Object = 1)
Data Type Index:	6 (Unsigned16)
Element Length:	2
Number of Elements:	6 (hdr) + 16 (defined references) + (Number of MME Composites x 2)
Password:	Configuration Defined
Access Groups:	Configuration Defined
Access Rights:	Configuration Defined
Local Address:	Configuration Defined
Extension:	Not Defined Here

NOTE: The "Number of This Directory Object" in the description of the Numeric Identifier indicates which directory object is being identified. For this calculation, directory objects are numbered consecutively starting at 0 (zero). Therefore, the first directory object is located at the First Index S-OD, and the successive directory objects (if present) are located at consecutive OD Indexes following the first directory object.

The directory object array is logically divided into a header and a set of object references. Three types of objects may be referenced in the directory:

FMS Objects.....	The object referenced by the directory is an individual FMS Object.
Composite Objects	The object referenced by the directory is composed of a set of two or more individual FMS Objects with consecutive object indices. The objects in the set do not have to be of the same FMS object type. The reference provided by the directory is the object index of the first object (lowest object index) in the set.
Composite List Objects	The object referenced by the directory is a set of related, consecutive directory entries, each of which is a reference to the same type of composite object.

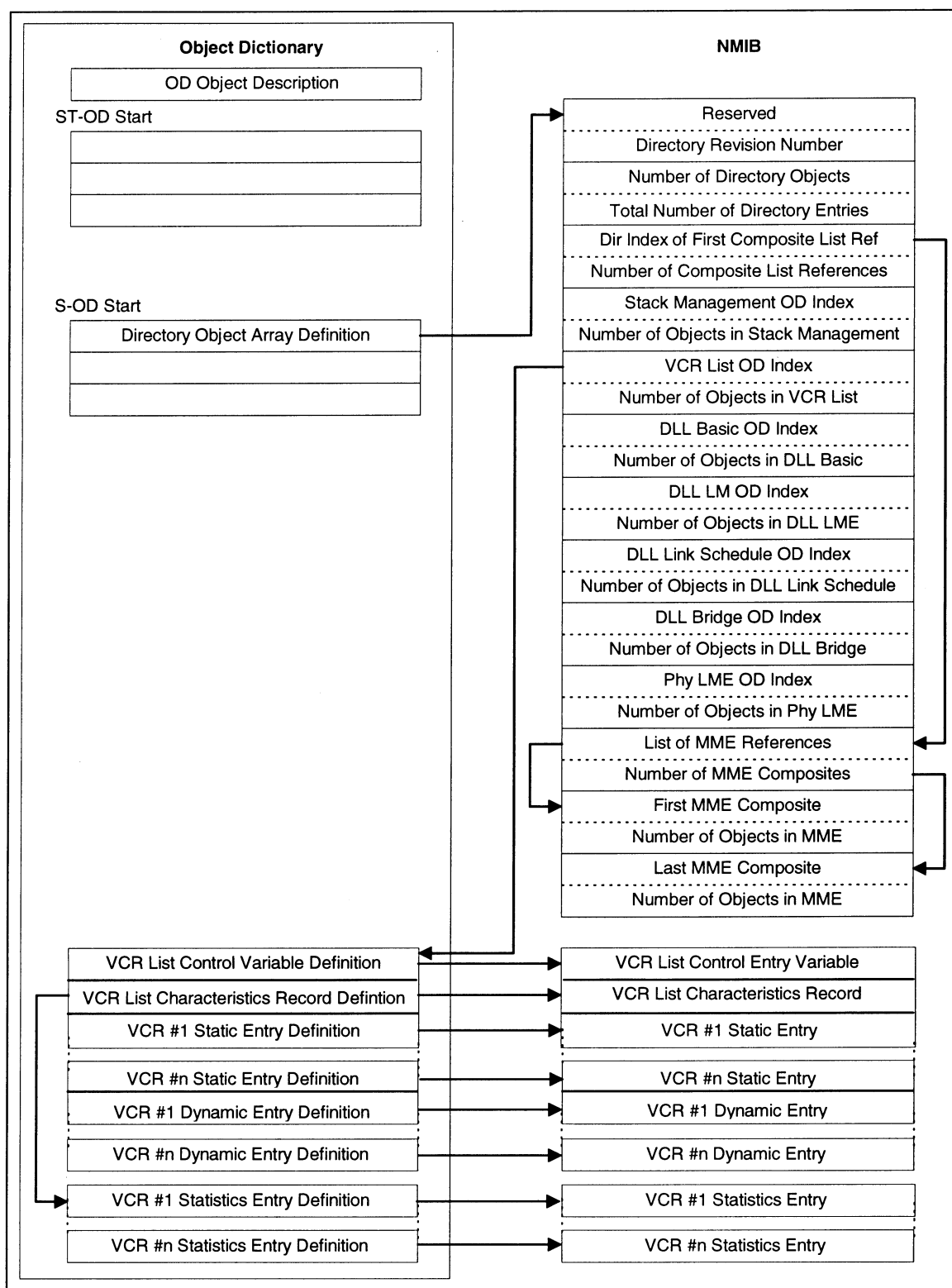


Figure 3 – Network Management Object Dictionary and Object Directory Structure

4.3.1 Directory Header

The directory header consists of six unsigned 16-bit integers and is structured as shown below. It is present only for the first directory object in a directory. The table below specifies the content of the directory header. Each entry in the array is an unsigned 16-bit integer.

Array Element	Contents
1	Reserved
2	Directory Revision Number
3	Number of Directory Objects
4	Total Number of Directory Entries
5	Directory Index of First Composite List Reference
6	Number of Composite List References

Table 2 – Object Directory Header

Directory Revision Number

This entry identifies the revision level of the NMA Directory Object. It is assigned by the implementor.

Number of Directory Objects

This entry identifies the total number of directory objects in the NMA. The directory objects are consecutively numbered in the Object Dictionary beginning with the first S-OD index + 1.

NOTE: The standard SMK and NMA directories are always present.

Total Number of Directory Entries

This entry identifies the total number of references in a single directory. Each reference is composed of 2 Unsigned16 array entries. Each directory object may have a maximum length of 100 octets. The value of this entry will be larger than 22 (12 octets for the header plus 22 entries x 4 octets/entry) when the directory spans multiple directory objects.

Directory Index of First Composite List Reference

This entry is the directory entry number of the first composite list referenced by the directory. Each composite list reference is a reference to the first in a series of consecutive composite references in the directory. Composite list references are the only type of reference that contain a directory offset and not an OD Index.

Number of Composite List References

This entry is the number of composite lists referenced by the directory. Composite list references are consecutively entered in the directory.

4.3.2 FMS and Composite Object References

This portion of the directory immediately follows the directory header. Each directory entry consists of a pair of unsigned 16-bit integers. The first in the pair is the Object Dictionary Index for the object being referenced. The second is the number of consecutive Object Dictionary Indices used by the object. If this value is 1, then the object being referenced is a single FMS object.

The table below specifies the content of this portion of the directory.

Directory Entry	Contents	
1	StackMgtOdIndex	Number of Objects in Stack Management Composite
2	VcrListOdIndex	Number of VCR Objects
3	DlmeBasicOdIndex	Number of Objects in DlmeBasic Composite
4	DlmeLinkMasterOdIndex	Number of Objects in DlmeLinkMaster Composite
5	LinkScheduleListOdIndex	Number of Objects in DlmeLinkScheduleList
6	DlmeBridgeOdIndex	Number of Objects in DlmeBridge Composite
7	PlmeBasicOdIndex	Number of Objects in PlmeBasic Composite

Table 3 – Composite Object References

StackMgtOdIndex

This NMA directory entry contains the OD Index for the composite for Stack Management Entity for the NMA.

VcrListOdIndex

This element is the OD Index for the composite for the list of Virtual Communication Relationships (VCRs) accessible through the NMA.

DlmeBasicOdIndex

This NMA directory entry contains the OD Index for the composite representing the objects for the BASIC class devices that are accessible through the NMA.

DlmeLinkMasterOdIndex

This NMA directory entry contains the OD Index for the composite representing the additional objects (all BASIC class attributes are implicit) for a LINK MASTER class device accessible through the NMA. If the DLL is a BASIC class device, both entries of this reference are set to zero.

LinkScheduleListOdIndex

This NMA directory entry contains the OD Index for the composite representing the objects for a DlmeLinkScheduleList class accessible through the NMA. If the DLL is a BASIC class device, both entries of this reference are set to zero.

DlmeBridgeOdIndex

This NMA directory entry contains the OD Index for the composite representing the additional objects (all BASIC and LINK MASTER class attributes are implicit) for the BRIDGE device class accessible through the NMA. If the DLL is not a BRIDGE device, both components of this entry are set to zero.

PlmeBasicOdIndex

This NMA directory entry contains the OD Index for the composite representing the PlmeBasic object(s) accessible through the NMA.

4.3.3 Composite List References

This NMA directory entry contains a series of references to composite lists. Each element in the series references a list of composite references of the same type. The only list of composite references for the NMA VFD is the ListOfMmeReferences.

Directory Entry	Composite Lists	
8	ListOfMmeReferences = 9	Number of MME References
	Composite References	
*	MmeWireOdIndex	Number of MmeWire Objects
* represents 9 through (9 + Number_Of_MME_References - 1) entries		

Table 4 – Composite List References

ListOfMmeReferences

This entry is a reference to the list of Media Management Entity (MME) composite objects (MmeWireOdIndex, Number of Mme Objects) accessible via the NMA. More than one MmeWire composite may be defined (e.g. for redundancy). The number of MME composites in the list is implementation and configuration dependent. That is, the implementation may support a certain number of media, and the configuration may restrict that number.

Number of Mme References

This entry indicates the number of consecutive MME Composite References in the List of MME References.

MmeWireOdIndex

This element is composite reference for the MmeWire class object(s) accessible through the NMA. Like the other composite references, it is composed of the OD Index for the first object in the composite, and the number of objects in the composite.

This element is repeated in the directory for each MME object defined for VFD and, as specified by the previous element, for Number of Mme References.

5. NMA Composite Object Definitions

The NMA composite objects, those defined as more than one FMS object, are defined using class templates. The individual attributes represented in these templates are represented as OD Indices or as FMS objects.

5.1 Stack Management Definition

This model specifies the characteristics common to the Communication Stack Management Agent Entity for Management Agents.

Class : StackManagement

Subclass of : Root

Attributes :

1. (m) KeyAttribute: StackMgtOdIndex
2. (m) (r) Attribute: StackCapabilitiesRecord
- 2.1. (m) (r) Attribute: FasArTypesAndRolesSupported
- 2.2. (m) (r) Attribute: MaxDlsapAddressesSupported
- 2.3. (m) (r) Attribute: MaxDlcepAddressesSupported
- 2.4. (m) (r) Attribute: DlcepDeliveryFeaturesSupported
- 2.5. (m) (r) Attribute: VersionOfNmSpecSupported
- 2.6. (m) (r) Attribute: AgentFunctionsSupported
- 2.7. (m) (r) Attribute: FmsFeaturesSupported

Attribute Descriptions

StackMgtOdIndex

This attribute specifies the index of the StackCapabilitiesRecord in the OD. Its value is contained in the directory entry, Stack Management OD Index.

StackCapabilitiesRecord

This attribute specifies capabilities of the communication stack. It is represented in FMS as:

FMS Object Name	Object Type	Data Type	FMS Access Rights
StackCapabilitiesRecord	Record	StackCapabilities	Ra

Table 5 – StackCapabilitiesRecord Definition

The elements contained in this record variable are:

FasArTypesAndRolesSupported

This element, of type OctetString, specifies the FAS Roles supported for each FAS AR Type. The first octet of the string represents the roles supported for AR type QUB. The second octet of the string defines the roles supported for AR type QUU. The third octet of the string defines the roles supported for AR type BNU. The fourth octet is reserved for future use. If an FAS AR type is not supported, all roles for this type shall be set to zero (not supported). Unused bits are reserved for future use and are set to zero.

The DD 238 FAS specification defines the valid combinations of AR type and role. The following figure reflects the FAS restrictions, and illustrates the contents of the octets.

Octet	B8	B7	B6	B5	B4	B3	B2	B1 (lsb)
1 (QUB)	reserved	== 0	== 0	== 0	== 0	server	client	peer
2 (QUU)	reserved	== 0	== 0	sink	source	== 0	== 0	== 0
3 (BNU)	reserved	subscriber	publisher	== 0	== 0	== 0	== 0	== 0
4 (reserved)	reserved	reserved	reserved	reserved	reserved	reserved	reserved	reserved

Table 6 – FasArTypeAndRoleSupported Coding

NOTE: B8 is the first bit transmitted. This is defined to be compatible with the definition of FMS encoding rules.

MaxDlsapAddressesSupported

This element specifies the maximum number of Data Link Service Access Point (DLSAP) Addresses supported, including the standard addresses used by the standard relationships defined in clause 6, and by the communication profiles.

MaxDlcepAddressesSupported

This element specifies the maximum number of Data Link Connection Endpoint (DLCEP) Addresses supported, including the standard DLCEPs defined by the communication profile.