INTERNATIONAL STANDARD

ISO/IEEE 11073-10201

First edition
2004-12-15

Health informatics — Point-of-care medical device communication —

Part 10201:

Domain information model

Informatique de santé — Communication entre dispositifs médicaux sur le site des soins —
Partie 10201: Modèle d'information du domaine

Reference number
ISO/IEEE 11073-10201:2004(E)

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Health informatics — Point-of-care medical device communication —
Part 10201:
Domain information model

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Abstract: Within the context of the ISO/IEEE 11073 family of standards for point-of-care (POC) medical device communication (MDC), this standard provides an abstract object-oriented domain information model that specifies the structure of exchanged information, as well as the events and services that are supported by each object. All elements are specified using abstract syntax (ASN.1) and may be applied to many different implementation technologies, transfer syntaxes, and application service models. Core subjects include medical, alert, system, patient, control, archival, communication, and extended services. Model extensibility is supported, and a conformance model and statement template is provided.

Keywords: abstract syntax, alarm, alert, ASN.1, information model, medical device communications, medical information bus, MIB, point-of-care, POC, object-oriented, patient, remote control

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Print: ISBN 0-7381-4089-9 SH95256
PDF: ISBN 0-7381-4090-2 SS95256

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IEEE Introduction

This introduction is not part of ISO/IEEE 11073-10201:2004(E), Health informatics — Point-of-care medical device communication — Part 10201: Domain information model.

ISO/IEEE 11073 standards enable communication between medical devices and external computer systems. They provide automatic and detailed electronic data capture of patient vital signs information and device operational data. The primary goals are to:

— Provide real-time plug-and-play interoperability for patient-connected medical devices

— Facilitate the efficient exchange of vital signs and medical device data, acquired at the point-of-care, in all health care environments

"Real-time" means that data from multiple devices can be retrieved, time correlated, and displayed or processed in fractions of a second. "Plug-and-play" means that all the clinician has to do is make the connection — the systems automatically detect, configure, and communicate without any other human interaction.

"Efficient exchange of medical device data" means that information that is captured at the point-of-care (e.g., patient vital signs data) can be archived, retrieved, and processed by many different types of applications without extensive software and equipment support, and without needless loss of information. The standards are especially targeted at acute and continuing care devices, such as patient monitors, ventilators, infusion pumps, ECG devices, etc. They comprise a family of standards that can be layered together to provide connectivity optimized for the specific devices being interfaced.

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Contents

1. Scope ... 1

2. Normative references ... 1

3. Definitions ... 4

4. Abbreviations and acronyms ... 8

5. General requirements ... 9

6. DIM ... 9

6.1 General ... 9
6.1.1 Modeling concept ... 9
6.1.2 Scope of the DIM ... 11
6.1.3 Approach ... 11
6.1.4 Extension of the model ... 12
6.2 Package diagram–overview ... 12
6.3 Model for the Medical Package ... 12
6.3.1 VMO (i.e., virtual medical object) ... 14
6.3.2 VMD (i.e., virtual medical device) object ... 14
6.3.3 Channel object ... 15
6.3.4 Metric object ... 15
6.3.5 Numeric object ... 15
6.3.6 Sample Array object ... 15
6.3.7 Real Time Sample Array object ... 15
6.3.8 Time Sample Array object ... 15
6.3.9 Distribution Sample Array object ... 16
6.3.10 Enumeration object ... 16
6.3.11 Complex Metric object ... 16
6.3.12 PM-Store (i.e., persistent metric) object ... 16
6.3.13 PM-Segment object ... 16
6.4 Model for the Alert Package ... 17
6.4.1 Alert object ... 17
6.4.2 Alert Status object ... 18
6.4.3 Alert Monitor object ... 18
6.5 Model for the System Package ... 19
6.5.1 VMS (i.e., virtual medical system) object ... 19
6.5.2 MDS object ... 19
6.5.3 Simple MDS object ... 20
6.5.4 Hydra MDS object ... 20
6.5.5 Composite Single Bed MDS object ... 20
6.5.6 Composite Multiple Bed MDS object ... 20
6.5.7 Log object ... 20
6.5.8 Event Log object ... 20
6.5.9 Battery object ... 20
6.5.10 Clock object ... 20
6.6 Model for the Control Package ... 21
6.6.1 SCO ... 22
6.6.2 Operation object ... 22
6.6.3 Select Item Operation object ... 22

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6.6.4 Set Value Operation object 23
6.6.5 Set String Operation object 23
6.6.6 Toggle Flag Operation object 23
6.6.7 Activate Operation object 23
6.6.8 Limit Alert Operation object 23
6.6.9 Set Range Operation object 23
6.7 Model for the Extended Services Package 24
6.7.1 Scanner object 24
6.7.2 CfgScanner (i.e., configurable scanner) object 25
6.7.3 EpiCfgScanner (i.e., episodic configurable scanner) object 25
6.7.4 PeriCfgScanner (i.e., periodic configurable scanner) object 25
6.7.5 FastPeriCfgScanner (i.e., fast periodic configurable scanner) object 26
6.7.6 UcfgScanner (i.e., unconfigurable scanner) object 26
6.7.7 Context Scanner object 26
6.7.8 Alert Scanner object 26
6.7.9 Operating Scanner object 26
6.8 Model for the Communication Package 26
6.8.1 Communication Controller object 27
6.8.2 DCC (i.e., device communication controller) object 27
6.8.3 BCC (i.e., bedside communication controller) object 28
6.8.4 Device Interface object 28
6.8.5 MibElement object 28
6.8.6 Specialized MibElement object 28
6.9 Model for the Archival Package 28
6.9.1 Multipatient Archive object 29
6.9.2 Patient Archive object 29
6.9.3 Session Archive object 30
6.9.4 Physician object 30
6.9.5 Session Test object 30
6.9.6 Session Notes object 30
6.9.7 Ancillary object 30
6.10 Model for the Patient Package 30
6.10.1 Patient Demographics object 31
6.11 DIM—dynamic model 31
6.11.1 General 31
6.11.2 MDS communication finite state machine (FSM) 31
6.11.3 Communicating systems—startup object interaction diagram 33
6.11.4 Communication Package—MibElement data access 34
6.11.5 Dynamic object relations 34

7. DIM object definitions 36

7.1 General 36
7.1.1 Notation 36
7.1.2 Common data types 37
7.2 Top object 45
7.2.1 Attributes 45
7.2.2 Behavior 45
7.2.3 Notifications 45
7.3 Objects in the Medical Package 46
7.3.1 VMO 46
7.3.2 VMD object 47
7.3.3 Channel object 49
7.3.4 Metric object 50

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7.3.5 Numeric object ... 56
7.3.6 Sample Array object ... 58
7.3.7 Real Time Sample Array object ... 63
7.3.8 Time Sample Array object ... 65
7.3.9 Distribution Sample Array object ... 67
7.3.10 Enumeration object ... 69
7.3.11 Complex Metric object ... 72
7.3.12 PM-Store object ... 75
7.3.13 PM-Segment object ... 78
7.4 Objects in the Alert Package ... 80
7.4.1 Alert object ... 80
7.4.2 Alert Status object ... 82
7.4.3 Alert Monitor object ... 84
7.5 Objects in the System Package ... 86
7.5.1 VMS object ... 86
7.5.2 MDS object ... 89
7.5.3 Simple MDS object ... 93
7.5.4 Hydra MDS object ... 93
7.5.5 Composite Single Bed MDS object ... 93
7.5.6 Composite Multiple Bed MDS object ... 93
7.5.7 Log object ... 93
7.5.8 Event Log object ... 95
7.5.9 Battery object ... 97
7.5.10 Clock object ... 99
7.6 Objects in the Control Package ... 105
7.6.1 SCO ... 105
7.6.2 Operation object ... 108
7.6.3 Select Item Operation object ... 110
7.6.4 Set Value Operation object ... 112
7.6.5 Set String Operation object ... 113
7.6.6 Toggle Flag Operation object ... 114
7.6.7 Activate Operation object ... 116
7.6.8 Limit Alert Operation object ... 116
7.6.9 Set Range Operation object ... 118
7.7 Objects in the Extended Services Package ... 120
7.7.1 Scanner object ... 120
7.7.2 CfgScanner object ... 121
7.7.3 EpiCfgScanner object ... 123
7.7.4 PeriCfgScanner object ... 124
7.7.5 FastPeriCfgScanner object ... 125
7.7.6 UcfgScanner object ... 126
7.7.7 Context Scanner object ... 127
7.7.8 Alert Scanner object ... 129
7.7.9 Operating Scanner object ... 130
7.8 Objects in the Communication Package ... 132
7.8.1 Communication Controller object ... 132
7.8.2 DCC object ... 135
7.8.3 BCC object ... 135
7.8.4 Device Interface object ... 135
7.8.5 MibElement object ... 136
7.8.6 Device Interface MibElement object ... 137
7.8.7 General Communication Statistics MibElement object ... 138
7.9 Objects in the Archival Package ... 140
7.9.1 Multipatient Archive object ... 140

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7.9.2 Patient Archive object 141
7.9.3 Session Archive object 142
7.9.4 Physician object 143
7.9.5 Session Test object 145
7.9.6 Session Notes object 146
7.10 Objects in the Patient Package 147
7.10.1 Patient Demographics object 147

8. Service model for communicating systems 151

8.1 General 151
8.2 Communicating systems 151
8.3 General service model overview 152
8.3.1 Conceptual architecture of communicating systems 153
8.4 General object management services definition 154
8.4.1 EVENT REPORT service 155
8.4.2 GET service 156
8.4.3 SET service 156
8.4.4 ACTION service 157
8.4.5 CREATE service 158
8.4.6 DELETE service 159

9. MDIB nomenclature 160

10. Conformance model 161

10.1 Applicability 161
10.2 Conformance specification 161
10.3 ICSs 162
10.3.1 General format 162
10.3.2 General ICS 162
10.3.3 Service Support ICS 164
10.3.4 DIM managed object class (MOC) ICS 165
10.3.5 MOC Attribute ICS 165
10.3.6 MOC Behavior ICS 166
10.3.7 MOC Notification ICS 166

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Health informatics — Point-of-care medical device communication —
Part 10201:
Domain information model

1. Scope

Within the context of the ISO/IEEE 11073 family of standards, this standard addresses the definition and structuring of information that is communicated or referred to in communication between application entities.

This standard provides a common representation of all application entities present in the application processes within the various devices independent of the syntax.

The definition of association control and lower layer communication is outside the scope of this standard.

2. Normative references

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

CEN EN 1064, Medical informatics — Standard communication protocol — computer-assisted electrocardiography.[1]

CEN ENV 12052, Medical informatics — Medical imaging communication (MEDICOM).

IEEE Std 1073™, IEEE Standard for Medical Device Communications—Overview and Framework.[2]

[1]CEN publications are available from the European Committee for Standardization (CEN), 36, rue de Stassart, B-1050 Brussels, Belgium (http://www.cenorm.be).

[2]IEEE publications are available from the Institute of Electrical and Electronics Engineers, 445 Hoes Lane, Piscataway, NJ 08854, USA (http://www.standards.ieee.org/).

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IETF RFC 1155, Structure and Identification of Management Information for TCP/IP-Based Internets.[3]

ISO 639-1, Code for the representation of names of languages — Part 1: Alpha-2 code.[4]

ISO 639-2, Codes for the representation of names of languages — Part 2: Alpha-3 code.

ISO 3166-1, Codes for the representation of names of countries and their subdivisions — Part 1: Country codes.

ISO 3166-2, Codes for the representation of names of countries and their subdivisions — Part 2: Country subdivision code.

ISO 3166-3, Codes for the representation of names of countries and their subdivisions — Part 3: Code for formerly used names of countries.

ISO 8601, Data elements and interchange formats — Information interchange — Representation of dates and times.

ISO 15225, Nomenclature — Specification for a nomenclature system for medical devices for the purpose of regulatory data exchange.

ISO/IEC 646, Information technology — ISO 7-bit coded character set for information interchange.[5]

ISO/IEC 2022, Information technology — Character code structure and extension techniques.

ISO/IEC 5218, Information technology — Codes for the representation of human sexes.

ISO/IEC 7498-1, Information technology — Open systems interconnection — Basic reference model — Part 1: The basic model.

ISO/IEC 7498-2, Information processing systems — Open systems interconnection — Basic reference model — Part 2: Security architecture.

ISO/IEC 7498-3, Information processing systems — Open systems interconnection — Basic reference model — Part 3: Naming and addressing.

ISO/IEC 7498-4, Information processing systems — Open systems interconnection — Basic reference model — Part 4: Management framework.

ISO/IEC 8649, Information processing systems — Open systems interconnection — Service definition for the Association Control Service Element.

ISO/IEC 8650-1, Information technology — Open systems interconnection — Connection-Oriented Protocol for the Association Control Service Element — Part 1: Protocol.

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[3]Internet requests for comment (RFCs) are available from the Internet Engineering Task Force at http://www.ietf.org/.

[4]ISO publications are available from the ISO Central Secretariat, Case Postale 56, 1 rue de Varembé, CH-1211, Genève 20, Switzerland/Suisse (http://www.iso.ch/). ISO publications are also available in the United States from the Sales Department, American National Standards Institute, 25 West 43rd Street, 4th Floor, New York, NY 10036, USA (http://www.ansi.org/).

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ISO/IEC 8650-2, Information technology — Open systems interconnection — Protocol Specification for Association Control Service Element — Part 2: Protocol Implementation Conformance Statements (PICS) proforma.

ISO/IEC 8824-1, Information technology — Abstract Syntax Notation One (ASN.1) — Part 1: Specification of basic notation.

ISO/IEC 8824-2, Information technology — Abstract Syntax Notation One (ASN.1) — Part 2: Information object specification.

ISO/IEC 8859-*n*, Information processing — 8-bit single-byte coded graphic character sets — Part 1 to Part 15: Various alphabets.

ISO/IEC 9545, Information technology — Open systems interconnection — Application layer structure.

ISO/IEC 9595, Information technology — Open systems interconnection — Common management information service definition.

ISO/IEC 9596-1, Information technology — Open systems interconnection — Common Management Information Protocol — Part 1: Specification.

ISO/IEC 10040, Information technology — Open systems interconnection — Systems management overview.

ISO/IEC 10164-1, Information technology — Open systems interconnection — Systems management — Part 1: Object management function.

ISO/IEC 10164-2, Information technology — Open systems interconnection — Systems management — Part 2: State management function.

ISO/IEC 10164-3, Information technology — Open systems interconnection — System management — Part 3: Attributes for representing relationships.

ISO/IEC 10164-4, Information technology — Open systems interconnection — Systems management — Part 4: Alarm reporting function.

ISO/IEC 10164-5, Information technology — Open systems interconnection — Systems management — Part 5: Event management function.

ISO/IEC 10164-6, Information technology — Open systems interconnection — Systems management — Part 6: Log control function.

ISO/IEC 10164-7, Information technology — Open systems interconnection — Systems management — Part 7: Security alarm reporting function.

ISO/IEC 10164-8, Information technology — Open systems interconnection — Systems management — Part 8: Security audit trail function.

ISO/IEC 10164-9, Information technology — Open systems interconnection — Systems management — Part 9: Objects and attributes for access control.

ISO/IEC 10164-10, Information technology — Open systems interconnection — Systems management — Part 10: Usage metering function for accounting purposes.

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ISO/IEC 10164-11, Information technology — Open systems interconnection — Systems management — Part 11: Metric objects and attributes.

ISO/IEC 10164-12, Information technology — Open systems interconnection — Systems management — Part 12: Test management function.

ISO/IEC 10164-13, Information technology — Open systems interconnection — Systems management — Part 13: Summarization function.

ISO/IEC 10164-14, Information technology — Open systems interconnection — Systems management — Part 14: Confidence and diagnostic test categories.

ISO/IEC 10165-1, Information technology — Open systems interconnection — Structure of management information — Part 1: Management information model.

ISO/IEC 10165-2, Information technology — Open systems interconnection — Structure of management information — Part 2: Definition of management information.

ISO/IEC 10646-1, Information technology — Universal multiple-octet coded character set (UCS) — Part 1: Architecture and basic multilingual plane.

ISO/IEEE 11073-10101, Health informatics — Point-of-care medical device communication — Part 10101: Nomenclature.

ISO/IEEE 11073-20101, Health informatics — Point-of-care medical device communication — Part 20101: Application profiles – Base standard.

NEMA PS 3, Digital imaging and communications in medicine (DICOM).[6]

3. Definitions

For the purpose of this standard, the following definitions apply. *The Authoritative Dictionary of IEEE Standards Terms*, Seventh Edition, should be referenced for terms not defined in this clause.

3.1 agent: Device that provides data in a manager-agent communicating system.

3.2 alarm: Signal that indicates abnormal events occurring to the patient or the device system.

3.3 alert: Synonym for the combination of patient-related physiological alarms, technical alarms, and equipment-user advisory signals.

3.4 alert monitor: Object representing the output of a device or system alarm processor and as such the overall device or system alarm condition.

3.5 alert status: Object representing the output of an alarm process that considers all alarm conditions in a scope that spans one or more objects.

3.6 archival: Relating to the storage of data over a prolonged period.

[6]NEMA publications are available from Global Engineering Documents, 15 Inverness Way East, Englewood, Colorado 80112, USA (http://global.ihs.com/).

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3.7 association control service element (ACSE): Method used to establish logical connections between medical device systems (MDSs).

3.8 channel: Umbrella object in the object model that groups together physiological measurement data and data derived from these data.

3.9 class: Description of one or more objects with a uniform set of attributes and services including a description of how to create new objects in the class.

3.10 communication controller: Part of a medical device system (MDS) responsible for communications.

3.11 communication party: Actor of the problem domain that participates in the communication in that domain.

3.12 communication role: Role of a party in a communication situation defining the party's behavior in the communication. Associated with a communication role is a set of services that the party provides to other parties.

3.13 data agent: As a medical device, a patient data acquisition system that provides the acquired data for other devices.

3.14 data format: Arrangement of data in a file or stream.

3.15 data logger: A medical device that is functioning in its capacity as a data storage and archival system.

3.16 data structure: Manner in which application entities construct the data set information resulting from the use of an information object.

3.17 dictionary: Description of the contents of the medical data information base (MDIB) containing vital signs information, device information, demographics, and other elements of the MDIB.

3.18 discrete parameter: Vital signs measurement that can be expressed as a single numeric or textual value.

3.19 domain information model (DIM): The model describing common concepts and relationships for a problem domain.

3.20 event; A change in device status that is communicated by a notification reporting service.

3.21 event report: Service [provided by the common medical device information service element (CMDISE)] to report an event relating to a managed object instance.

3.22 framework: A structure of processes and specifications designed to support the accomplishment of a specific task.

3.23 graphic parameter: Vital signs measurement that requires a number of regularly sampled data points in order to be expressed properly.

3.24 host system: Term used as an abstraction of a medical system to which measurement devices are attached.

3.25 information object: An abstract data model applicable to the communication of vital signs information and related patient data. The attributes of an information object definition describe its properties. Each

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information object definition does not represent a specific instance of real-world data, but rather a class of data that share the same properties.

3.26 information service element: Instances in the medical data information base (MDIB).

3.27 instance: The realization of an abstract concept or specification, e.g., object instance, application instance, information service element instance, virtual medical device (VMD) instance, class instance, operating instance.

3.28 intensive care unit (ICU): The unit within a medical facility in which patients are managed using multiple modes of monitoring and therapy.

3.29 interchange format: The representation of the data elements and the structure of the message containing those data elements while in transfer between systems. The interchange format consists of a data set of construction elements and a syntax. The representation is technology specific.

3.30 interoperability: Idealized scheme where medical devices of differing types, models, or manufacturers are capable of working with each other, whether connected to each other directly or through a communication system.

3.31 latency: In a communications scenario, the time delay between sending a signal from one device and receiving it by another device.

3.32 lower layers: Layer 1 to Layer 4 of the International Organization for Standardization (ISO)/open systems interconnection (OSI) reference model. These layers cover mechanical, electrical, and general communication protocol specifications.

3.33 manager: Device that receives data in a manager-agent communicating system.

3.34 manager-agent model: Communication model where one device (i.e., agent) provides data and another device (i.e., manager) receives data.

3.35 medical data information base (MDIB): The concept of an object-oriented database storing (at least) vital signs information.

3.36 medical device: A device, apparatus, or system used for patient monitoring, treatment, or therapy, which does not normally enter metabolic pathways. For the purposes of this standard, the scope of medical devices is further limited to patient-connected medical devices that provide support for electronic communications.

3.37 medical device system (MDS): Abstraction for system comprising one or more medical functions. In the context of this standard, the term is specifically used as an object-oriented abstraction of a device that provides medical information in the form of objects that are defined in this standard.

3.38 monitor: A medical device designed to acquire, display, record, and/or analyze patient data and to alert caregivers of events needing their attention.

3.39 object: A concept, an abstraction, or a thing with crisp boundaries and a meaning for the problem at hand.

3.40 object attributes: Data that, together with methods, define an object.

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3.41 object class: A descriptor used in association with a group of objects with similar properties (i.e., attributes), common behavior (i.e., operations), common relationships to other objects, and common semantics.

3.42 object diagram: Diagram showing connections between objects in a system.

3.43 object method: A procedure or process acting upon the attributes and states of an object class.

3.44 object-oriented analysis: Method of analysis where the problem domain is modelled in the form of objects and their interactions.

3.45 open system: A set of protocols allowing computers of different origins to be linked together.

3.46 operation: A function or transformation that may be applied to or by objects in a class (sometimes also called service).

3.47 problem domain; The field of health care under consideration in a modeling process.

3.48 protocol: A standard set of rules describing the transfer of data between devices. It specifies the format of the data and specifies the signals to start, control, and end the transfer.

3.49 scanner: An observer and "summarizer" of object attribute values.

3.50 scenario: A formal description of a class of business activities including the semantics of business agreements, conventions, and information content.

3.51 service: A specific behavior that a communication party in a specific role is responsible for exhibiting.

3.52 syntax (i.e., of an interchange format): The rules for combining the construction elements of the interchange format.

3.53 system: The demarcated part of the perceivable universe, existing in time and space, that may be regarded as a set of elements and relationships between these elements.

3.54 timestamp: An attribute or field in data that denotes the time of data generation.

3.55 top object: The ultimate base class for all other objects belonging to one model.

3.56 upper layers: Layer 5 to Layer 7 of the International Organization for Standardization (ISO)/open systems interconnection (OSI) reference model. These layers cover application, presentation, and session specifications and functionalities.

3.57 virtual medical device (VMD): An abstract representation of a medical-related subsystem of a medical device system (MDS).

3.58 virtual medical object (VMO): An abstract representation of an object in the Medical Package of the domain information model (DIM).

3.59 vital sign: Clinical information, relating to one or more patients, that is measured by or derived from apparatus connected to the patient or otherwise gathered from the patient.

3.60 waveform: Graphic data, typically vital signs data values varying with respect to time, usually presented to the clinician in a graphical form.

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4. Abbreviations and acronyms

ACSE	association control service element
ASN.1	Abstract Syntax Notation One
BCC	bedside communication controller
BER	basic encoding rules
BMP	basic multilingual plane
CMDIP	Common Medical Device Information Protocol
CMDISE	common medical device information service element
CMIP	Common Management Information Protocol
CMISE	common management information service element
DCC	device communication controller
DICOM	digital imaging and communications in medicine
DIM	domain information model
ECG	electrocardiogram
EEG	electroencephalogram
EBWW	eyeball and wristwatch
FSM	finite state machine
GMDN	Global Medical Device Nomenclature
GMT	Greenwich mean time
IANA	Internet Assigned Numbers Authority
ICS	implementation conformance statement
ICU	intensive care unit
ID	identifier or identification
LAN	local area network
LSB	least significant bit
MDIB	medical data information base
MDS	medical device system
MEDICOM	medical imaging communication
MIB or Mib	management information base
MOC	managed object class
OID	object identifier
OR	operating room
OSI	open systems interconnection
PC	personal computer
PDU	protocol data unit
PM	persistent metric
SCADA	supervisory control and data acquisition
SCP ECG	Standard Communications Protocol [for computer-assisted] Electrocardiography
SNMP	Simple Network Management Protocol
SNTP	Simple Network Time Protocol
UML	unified modeling language
UTC	coordinated universal time
VMD	virtual medical device
VMO	virtual medical object
VMS	virtual medical system

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5. General requirements

The ISO/IEEE 11073 family of standards is intended to enable medical devices to interconnect and interoperate with other medical devices and with computerized healthcare information systems in a manner suitable for the clinical environment.

The ISO/IEEE 11073 family is based on an object-oriented systems management paradigm. Data (e.g., measurement, state) is modeled in the form of information objects that can be accessed and manipulated using an object access service protocol.

The domain information model (DIM) defines the overall set of information objects and their attributes, methods, and access functions needed for medical device communication.

The top-level user requirements are defined in IEEE Std 1073,[7] which also defines the user scenarios covered by the ISO/IEEE 11073 family of standards.

As a part of the ISO/IEEE 11073 family of standards, the primary requirements for the DIM are as follows:

- Define an object-oriented model representing the relevant information (i.e., data) and functions (e.g., device controls) encountered in the problem domain of medical device communication, including measurement information, contextual data, device control methods, and other relevant aspects.
- Provide detailed specification of the information objects defined in the object-oriented model, including their attributes and methods.
- Define a service model for communicating medical devices that provides access to the information objects, their attributes, and their methods.
- Use the nomenclature defined in ISO/IEEE 11073-10101 to identify all data elements in the model.
- Be usable for the definition of data communication protocols as well as for the definition of file storage formats.
- Define conformance requirements.
- Be extensible and expandable to incorporate future needs in the defined modeling framework.

6. DIM

6.1 General

6.1.1 Modeling concept

The DIM is an object-oriented model that consists of objects, their attributes, and their methods, which are abstractions of real-world entities in the domain of (vital signs information communicating) medical devices.

The information model and the service model for communicating systems defined and used in this standard are conceptually based on the International Organization for Standardization (ISO)/open systems interconnection (OSI) system management model. Objects defined in the information model are considered managed (here, medical) objects. For the most part, they are directly available to management (i.e., access) services provided by the common medical device information service element (CMDISE) as defined in this standard.

[7]Information on references can be found in Clause 2.

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For communicating systems, the set of object instances available on any medical device that complies with the definitions of this standard forms the medical data information base (MDIB). The MDIB is a structured collection of managed medical objects representing the vital signs information provided by a particular medical device. Attribute data types, hierarchies, and behavior of objects in the MDIB are defined in this standard.

The majority of objects defined here represent generalized vital signs data and support information. Specialization of these objects is achieved by defining appropriate attributes. Object hierarchies and relations between objects are used to express device configuration and device capabilities.

Example: A generalized object is defined to represent vital signs in the form of a real-time waveform. A set of object attributes is used to specify a particular waveform as an invasive arterial blood pressure. The position in the hierarchy of all objects defines the subsystem that derives the waveform.

Figure 6.1 shows the relation between managed medical objects, MDIB, CMDISE, application processes, and communication systems.

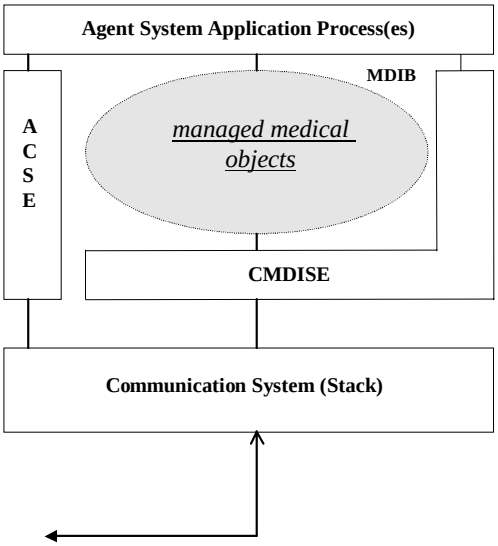

Figure 6.1—MDIB in communicating systems

In the case of communicating systems, managed medical objects are accessible only through services provided by CMDISE. The way that these objects are stored in the MDIB in any specific system and the way applications and the CMDISE access these objects are implementation issues and as such not normative.

In the case of a vital signs archived data format that complies with the definitions in this standard, object instances are stored, together with their dynamic attribute value changes, over a certain time period on archival media. Attribute data types and hierarchies of objects in the archival data format are again defined in this standard.

Figure 6.2 shows the relationship between managed medical objects, the data archive, and archive access services.

In the case of the archived data format, the way managed medical objects are stored on a medium is the subject of standardization. The access services are a local implementation issue and as such are not intended to be governed by this standard.

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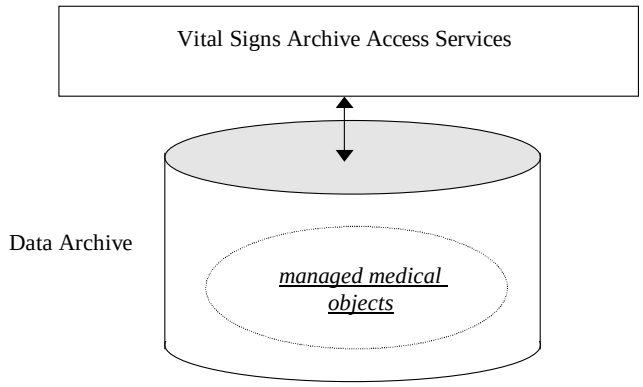

Figure 6.2—Managed medical objects in a vital signs archive

6.1.2 Scope of the DIM

6.1.2.1 General

Vital signs information objects that are defined in this standard encompass digitized biosignals that are derived by medical measurement devices used, for example, in anaesthesia, surgery, infusion therapy, intensive care, and obstetrical care.

Biosignal data within the scope of this standard include direct and derived, quantitative and qualitative measurements, technical and medical alarms, and control settings. Patient information relevant for the interpretation of these signals is also defined in the DIM.

6.1.2.2 Communicating systems

Communicating systems within the scope of this standard include physiological meters and analysers, especially systems providing real-time or continuous monitoring. Data processing capabilities are required for these systems.

Information management objects that provide capabilities and concepts for cost-effective communication (specifically data summarization objects) and objects necessary to enable real-time communication are also within the scope of the information model in this standard.

Interoperability issues, specifically lower communication layers, temporal synchronization between multiple devices, etc., are outside the scope of this standard.

6.1.2.3 Archived vital signs

Context information objects that describe the data acquisition process and organize a vital signs archive are within the scope of this standard.

6.1.3 Approach

For the object-oriented modeling, the unified modeling language (UML) technique is used. The domain is first subdivided into different packages, and this subdivision permits the organization of the model into smaller packages. Each package is then defined in the form of object diagrams. Objects are briefly introduced, and their relations and hierarchies are defined in the object diagram.

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For the object definitions, a textual approach is followed. Attributes are defined in attribute definition tables. Attribute data types are defined using Abstract Syntax Notation One (ASN.1). Object behavior and notifications generated by objects are also defined in definition tables. These definitions directly relate to the service model specified in Clause 8.

6.1.4 Extension of the model

It is expected that over time extensions of the model may be needed to account for new developments in the area of medical devices. Also, in special implementations, there may be a requirement to model data that are specific for a particular device or a particular application (and that are, therefore, not covered by the general model).

In some cases, it may be possible to use the concept of *external object relations*. Most objects defined in this standard provide an attribute group (e.g., the Relationship Attribute Group) that can be used to supply information about related objects that are not defined in the DIM. Supplying such information can be done by specifying a relation to an external object and assigning attributes to this relation (see 7.1.2.20).

In other cases, it may be necessary to define completely new objects or to add new attributes, new methods, or new events to already defined objects. These extensions are considered private or manufacturer-specific extensions. Dealing with these extensions is primarily a matter of an interoperability standard that is based on this standard on vital signs representation.

In general, in an interoperability format, objects, attributes, and methods are identified by nomenclature codes. The nomenclature code space (i.e., code values) leaves room for private extensions. As a general rule, an interoperability standard that is based on this DIM should be able to deal with private or manufacturer-specific extensions by ignoring objects, attributes, etc., with unknown identifiers (i.e., nomenclature codes).

6.2 Package diagram–overview

The package diagram organizes the problem domain into separate groups. It shows the major objects inside each package and defines the relationships between these packets.

The package diagram depicted in Figure 6.3 contains only a small subset of all objects defined in the DIM. Common base objects except the Top object are not shown in this diagram. Also, not all relations are shown between the different packages. Refer to the detailed package diagrams for more information.

The numbers in the packages refer to the corresponding subclauses in this clause about models and in Clause 7 about the object definitions.

The Top object is an abstract base class and at the same time the ultimate base class for all objects defined in the model. For editorial convenience, the modeling diagrams in this standard do not show this inheritance hierarchy.

The more detailed models for these packages are contained in 6.3 through 6.10.

6.3 Model for the Medical Package

The Medical Package deals with the derivation and representation of biosignals and contextual information that is important for the interpretation of measurements.

Figure 6.4 shows the object model of the Medical Package.

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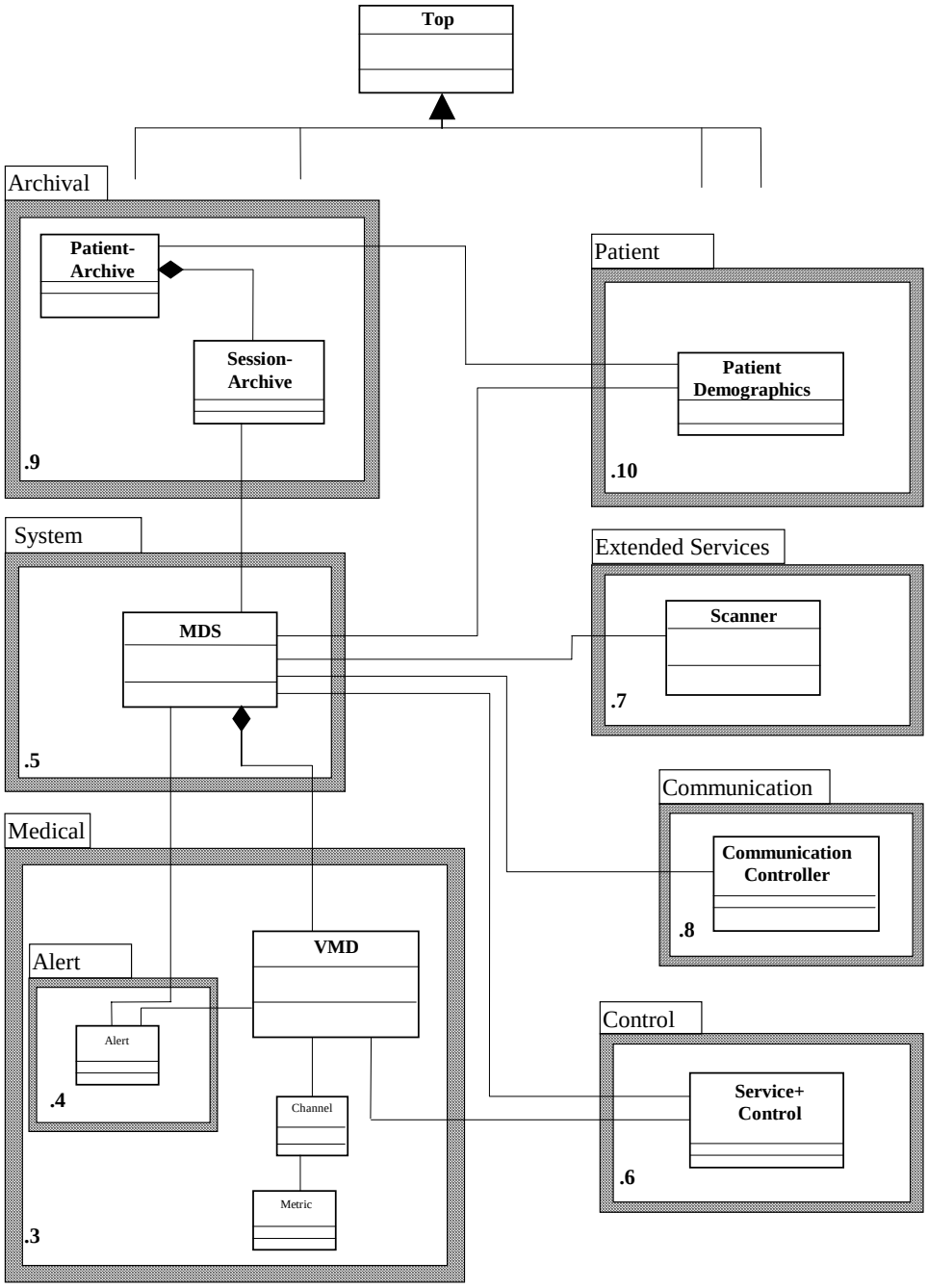

Figure 6.3—Packages of the DIM

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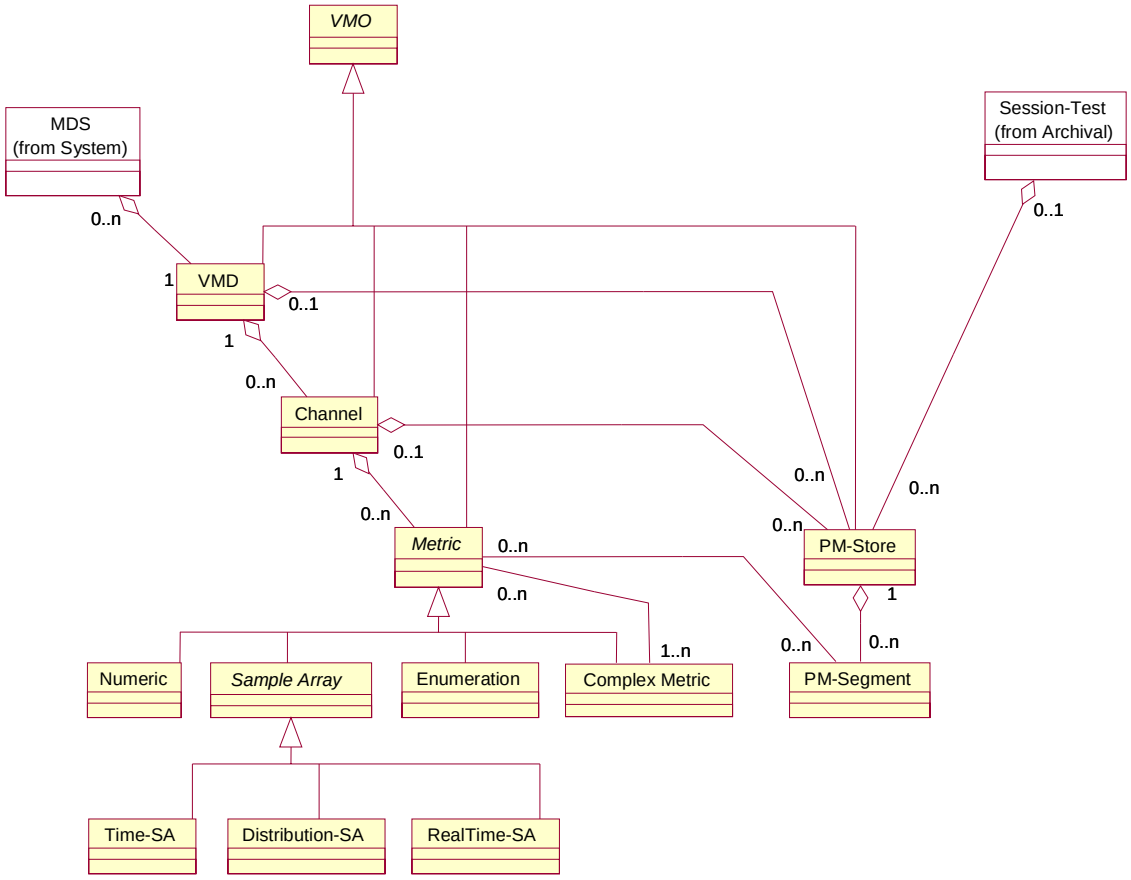

Figure 6.4—Medical Package model

NOTE—Instances of the Channel object and the PM-Store object shall be contained in exactly one superior object instance. Refer to the Alert Package for information about alarm-related objects.[8]

The Medical Package model contains the objects described in 6.3.1 through 6.3.13.

6.3.1 VMO (i.e., virtual medical object)

The VMO is the base class for all medical-related objects in the model. It provides consistent naming and identification across the Medical Package model.

As a base class, the VMO cannot be instantiated.

6.3.2 VMD (i.e., virtual medical device) object

The VMD object is an abstraction for a medical-related subsystem (e.g., hardware or even pure software) of a medical device. Characteristics of this subsystem (e.g., modes, versions) are captured in this object. At the same time, the VMD object is a container for objects representing measurement and status information.

[8]Notes in text, tables, and figures are given for information only, and do not contain requirements needed to implement the standard.

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Example: A modular patient monitor provides measurement modalities in the form of plug-in modules. Each module is represented by a VMD object.

6.3.3 Channel object

The Channel object is used for grouping Metric objects and, thus, allows hierarchical information organization. The Channel object is not mandatory for representation of Metric objects in a VMD.

Example: A blood pressure VMD may define a Channel object to group together all metrics that deal with the blood pressure (e.g., pressure value, pressure waveform). A second Channel object can be used to group together metrics that deal with heart rate.

6.3.4 Metric object

The Metric object is the base class for all objects representing direct and derived, quantitative and qualitative biosignal measurement, status, and context data.

Specializations of the Metric object are provided to deal with common representations (e.g., single values, array data, status indications) and presentations (e.g., on a display) of measurement data.

As a base class, the Metric object cannot be instantiated.

6.3.5 Numeric object

The Numeric object represents numerical measurements and status information, e.g., amplitude measures, counters.

Example: A heart rate measurement is represented by a Numeric object.

NOTE—A compound Numeric object is defined as an efficient model, for example, for arterial blood pressure, which usually has three associated values (i.e., systolic, diastolic, mean). The availability of multiple values in a single Numeric (or other Metric) object can be indicated in a special structure attribute in the Metric object.

6.3.6 Sample Array object

The Sample Array object is the base class for metrics that have a graphical, curve type presentation and, therefore, have their observation values reported as arrays of data points by communicating systems.

As a base class, the Sample Array object cannot be instantiated.

6.3.7 Real Time Sample Array object

The Real Time Sample Array object is a sample array that represents a real-time continuous waveform. As such, it has special requirements in communicating systems, e.g., processing power, low latency, high bandwidth. Therefore, it requires the definition of a specialized object.

Example: An electrocardiogram (ECG) real-time wave is represented as a Real Time Sample Array object.

6.3.8 Time Sample Array object

The Time Sample Array object is a sample array that represents noncontinuous waveforms (i.e., a wave snippet). Within a single observation (i.e., a single array of sample values), samples are equidistant in time.

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Example: Software for ST segment analysis may use the Time Sample Array object to represent snippets of ECG real-time waves that contain only a single QRS complex. Within this wave snippet, the software can locate the ST measurement points. It generates a new snippet, for example, every 15 s.

6.3.9 Distribution Sample Array object

The Distribution Sample Array object is a sample array that represents linear value distributions in the form of arrays containing scaled sample values. The index of a value within an observation array denotes a spatial value, not a time point.

Example: An electroencephalogram (EEG) application may use a Fourier transformation to derive a frequency distribution (i.e., a spectrum) from the EEG signal. It then uses the Distribution Sample Array object to represent that spectrum in the MDIB.

6.3.10 Enumeration object

The Enumeration object represents status information and/or annotation information. Observation values may be presented in the form of normative codes (that are included in the nomenclature defined in this standard or in some other nomenclature scheme) or in the form of free text.

Example: An ECG rhythm qualification may be represented as an Enumeration object. A ventilator may provide information about its current ventilation mode as an Enumeration object.

6.3.11 Complex Metric object

In special cases, the Complex Metric object can be used to group a larger number of strongly related Metric objects in one single container object for performance or for modeling convenience. The Complex Metric object is a composition of Metric objects, possibly recursive.

Example: A ventilator device may provide extensive breath analysis capabilities. For each breath, it calculates various numerical values (e.g., volumes, I:E ratio, timing information) as well as enumerated information (e.g., breath type classification, annotation data). For efficiency, all this information is grouped together in one Complex Metric object instance, which is updated upon each breath.

6.3.12 PM-Store (i.e., persistent metric) object

The PM-Store object provides long-term storage capabilities for metric data. It contains a variable number of PM-Segment objects that can be accessed only through the PM-Store object. Without further specialization, the PM-Store object is intended to store data of a single Metric object only.

Example: A device stores the numerical value of an invasive blood pressure on a disk. It uses the PM-Store object to represent this persistent information. Attributes of the PM-Store object describe the sampling period, the sampling algorithm, and the storage format. When the label of the pressure measurement is changed (e.g., during a wedge procedure), the storage process opens a new PM-Segment to store the updated context data (here: the label).

6.3.13 PM-Segment object

The PM-Segment object represents a continuous time period in which a metric is stored without any changes of relevant metric context attributes (e.g., scales, labels).

The PM-Segment object is accessible only through the PM-Store object (e.g., for retrieving stored data, the PM-Store object has to be accessed).

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6.4 Model for the Alert Package

The Alert Package deals with objects that represent status information about patient condition and/or technical conditions influencing the measurement or device functioning. Alert-related information is often subject to normative regulations and, therefore, requires special handling.

In the model, all alarm-related object-oriented items are identified by the term *alert*. The term *alert* is used in this standard as a synonym for the combination of patient-related physiological alarms, technical alarms, and equipment user-advisory signals.

An alarm is a signal that indicates abnormal events occurring to the patient or the device system. A physiological alarm is a signal that either indicates that a monitored physiological parameter is out of specified limits or indicates an abnormal patient condition. A technical alarm is a signal that indicates a device system is either not capable of accurately monitoring the patient's condition or no longer monitoring the patient's condition.

The model defines three different levels of alarming. These levels represent different sets of alarm processing steps, ranging from a simple context-free alarm event detection to an intelligent device system alarm process. This process is required to prioritize all device alarms, to latch alarms if needed (a latched alarm does not stop when the alarm condition goes away), and to produce audible and visual alarm indications for the user.

For consistent system-wide alarming, a particular medical device may provide either no alarming capability or exactly one level of alarming, which is dependent on the capabilities of the device. Each level is represented by one specific object class. In other words, either zero or one alarm object class (e.g., only Alert or only Alert Status or only Alert Monitor; no combinations) is instantiated in the device containment tree. Multiple instances of a class are allowed.

NOTE—Medical device alarming is subject to various national and international safety standards (e.g., IEC 60601 series, ISO 9703 series). Considering requirements of current safety standards, objects in this standard define information contents only. Any implementation shall, therefore, follow appropriate standards for dynamic alarming behavior.

Figure 6.5 shows the object model of the Alert Package.

NOTE—Instances of objects in the Alert Package area shall be contained in exactly one superior object.

The Alert Package model contains the objects described in 6.4.1 through 6.4.3.

6.4.1 Alert object

The Alert object stands for the status of a simple alarm condition check. As such, it represents a single alarm only. The alarm can be either a physiological alarm or a technical alarm condition of a related object [e.g., MDS (i.e., medical device system), VMD, Metric]. If a device instantiates an Alert object, it shall not instantiate the Alert Status or the Alert Monitor object. A single Alert object is needed for each alarm condition that the device is able to detect.

The Alert object has a reference to an object instance in the Medical Package to which the alarm condition relates.

NOTE—An Alert object instance is not dynamically created or deleted in cases where alarm conditions start or stop. Rather, an existing Alert object instance changes attribute values in these cases.

Example: An Alert object may represent the status of a process that checks for a limit violation physiological alarm of the heart rate signal. In the case of a violation of the limit, the object generates an event (i.e., attribute update) that represents this alarm condition in the form of attribute value changes.

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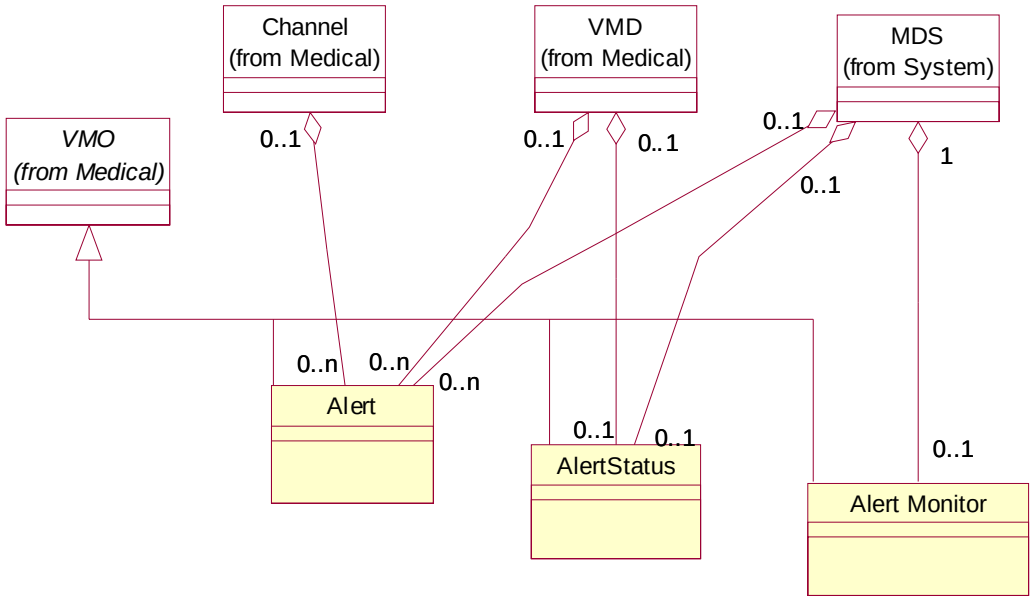

Figure 6.5—Alert Package model

6.4.2 Alert Status object

The Alert Status object represents the output of an alarm process that considers all alarm conditions in a scope that spans one or more objects. In contrast to the Alert object, the Alert Status object collects all alarm conditions related to a VMD object hierarchy or related to an MDS object and provides this information in list-structured attributes. Collecting all alarms together allows the implementation of first-level alarm processing where knowledge about the VMD or MDS can be used to prioritize alarm conditions and to suppress known false alarm indications.

For larger scale devices without complete alarm processing, the Alert Status object greatly reduces the overhead of a large number of Alert object instances.

If a device instantiates an Alert Status object, it shall not instantiate the Alert or the Alert Monitor object. Each VMD or MDS in the MDIB is able to contain at most one Alert Status object instance.

> **Example:** An ECG VMD derives a heart rate value. As the VMD is able to detect that the ECG leads are disconnected from the patient, its Alert Status object reports only a technical alarm and suppresses a heart rate limit violation alarm in this case.

6.4.3 Alert Monitor object

The Alert Monitor object represents the output of a device or system alarm processor. As such, it represents the overall device or system alarm condition and provides a list of all alarm conditions of the system in its scope. This list includes global state information and individual alarm state information that allows the implementation of a safety-standard-compliant alarm display on a remote system.

If a device instantiates an Alert Monitor object, it shall not instantiate the Alert or the Alert Status object. An MDS shall contain not more than one Alert Monitor object instance.

> **Example:** A patient-monitoring system provides alarm information in the form of an Alert Monitor object to a central station. Alert information includes the current global maximum severity of audible

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and visual alarm conditions on the monitor display as well as a list of active technical and physiological alarm conditions. The alarm processor operates in a latching mode where physiological alarm conditions are buffered until they are explicitly acknowledged by a user.

6.5 Model for the System Package

The System Package deals with the representation of devices that derive or process vital signs information and comply with the definitions in this standard.

Figure 6.6 shows the object model for the System Package.

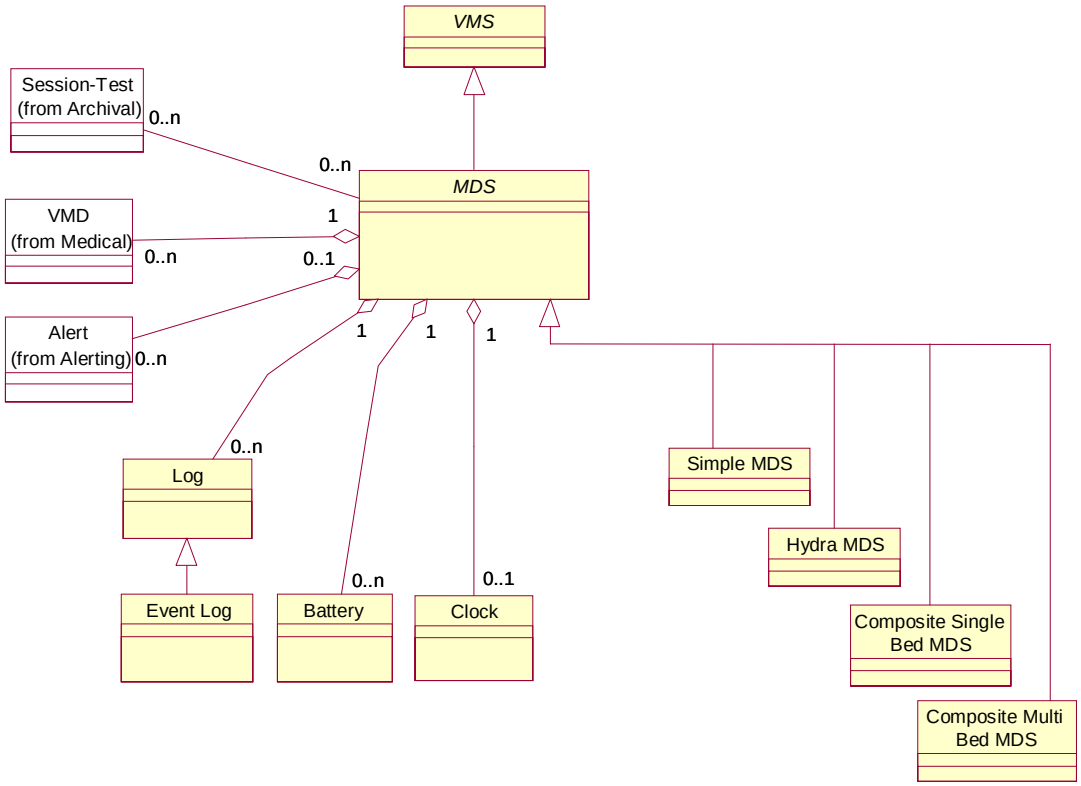

Figure 6.6—System Package model

The System Package model contains the objects described in 6.5.1 through 6.5.10.

6.5.1 VMS (i.e., virtual medical system) object

The VMS object is the abstract base class for all System Package objects in this model. It provides consistent naming and identification of system-related objects.

As a base class, the VMS object cannot be instantiated.

6.5.2 MDS object

The MDS object is an abstraction of a device that provides medical information in the form of objects that are defined in the Medical Package of the DIM.

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The MDS object is the top-level object in the device's MDIB and represents the instrument itself. Composite devices may contain additional MDS objects in the MDIB.

Further specializations of this class are used to represent differences in complexity and scope.

As a base class, the MDS object cannot be instantiated.

6.5.3 Simple MDS object

The Simple MDS object represents a medical device that contains a single VMD instance only (i.e., a single-purpose device).

6.5.4 Hydra MDS object

The Hydra MDS object represents a device that contains multiple VMD instances (i.e., a multipurpose device).

6.5.5 Composite Single Bed MDS object

The Composite Single Bed MDS object represents a device that contains (or interfaces with) one or more Simple or Hydra MDS objects at one location (i.e., a bed).

6.5.6 Composite Multiple Bed MDS object

The Composite Multiple Bed MDS object represents a device that contains (or interfaces with) multiple MDS objects at multiple locations (i.e., multiple beds).

6.5.7 Log object

The Log object is a base class that is a storage container for important local system notifications and events. It is possible to define specialized classes for specific event types.

As a base class, the Log object cannot be instantiated.

6.5.8 Event Log object

The Event Log object is a general Log object that stores system events in a free-text representation.

> **Example:** An infusion device may want to keep track of mode and rate changes by remote systems. When a remote operation is invoked, it creates an entry in its event log.

6.5.9 Battery object

For battery-powered devices, some battery information is contained in the MDS object in the form of attributes. If the battery subsystem is either capable of providing more information (i.e., a smart battery) or manageable, then a special Battery object is provided.

6.5.10 Clock object

The Clock object provides additional capabilities for handling date-related and time-related information beyond the basic capabilities of an MDS object. It models the real-time clock capabilities of an MDS object.

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The Clock object is used in applications where precise time synchronization of medical devices is needed. This object provides resolution and accuracy information so that applications can synchronize real-time data streams between devices.

6.6 Model for the Control Package

The Control Package contains objects that allow remote measurement control and device control.

The model for remote control defined in this standard provides the following benefits:

- A system that allows remote control is able to explicitly register which attributes or features can be accessed or modified by a remote system.
- For attributes that can be remotely modified, a list of possible legal attribute values is provided to the controlling system.
- It is not mandatory that a remote-controllable item correspond to an attribute of an medical object.
- Dependence of a controllable item on internal system states is modeled.
- A simple locking transaction scheme allows the handling of transient states during remote control.

At least two different uses of remote control are considered:

- Automatic control may be done by some processes running on the controlling device. Such a process has to be able to discover automatically how it can modify or access the controllable items to provide its function.
- It is also possible to use remote control to present some form of control interface to a human operator. For this use, descriptions of functions, and possibly help information, need to be provided.

The basic concept presented here is based on Operation objects. An Operation object allows modification of a virtual attribute. This virtual attribute may, for example, be a measurement label, a filter state (on/off), or a gain factor. The attribute is called *virtual* because it need not correspond to any attribute in other objects instantiated in the system.

Different specializations of the Operation object define how the virtual attribute is modified. A Select Item operation, for example, allows the selection of an item from a given list of possible item values for the attribute. A Set Value operation allows the setting of the attribute to a value from a defined range with a specific step width (i.e., resolution).

The idea is that the Operation object provides all necessary information about legal attribute values. Furthermore, the Operation object defines various forms of text string to support a human user of the operation. It also contains grouping information that allows logical grouping of multiple Operation objects together when they are presented as part of a human interface.

Operation objects cannot directly be accessed by services defined in the service model in Clause 8. Instead, all controls shall be routed through the SCO (i.e., service and control object). This object supports a simple locking mechanism to prevent side effects caused by simultaneous calls.

The SCO groups together all Operation objects that belong to a specific entity (i.e., MDS, VMD). The SCO also allows feedback to a controlled device, for example, for a visual indication that the device is currently remote-controlled.

Figure 6.7 shows the object model for the Control Package:

The Control Package model contains the objects described in 6.6.1 through 6.6.9.

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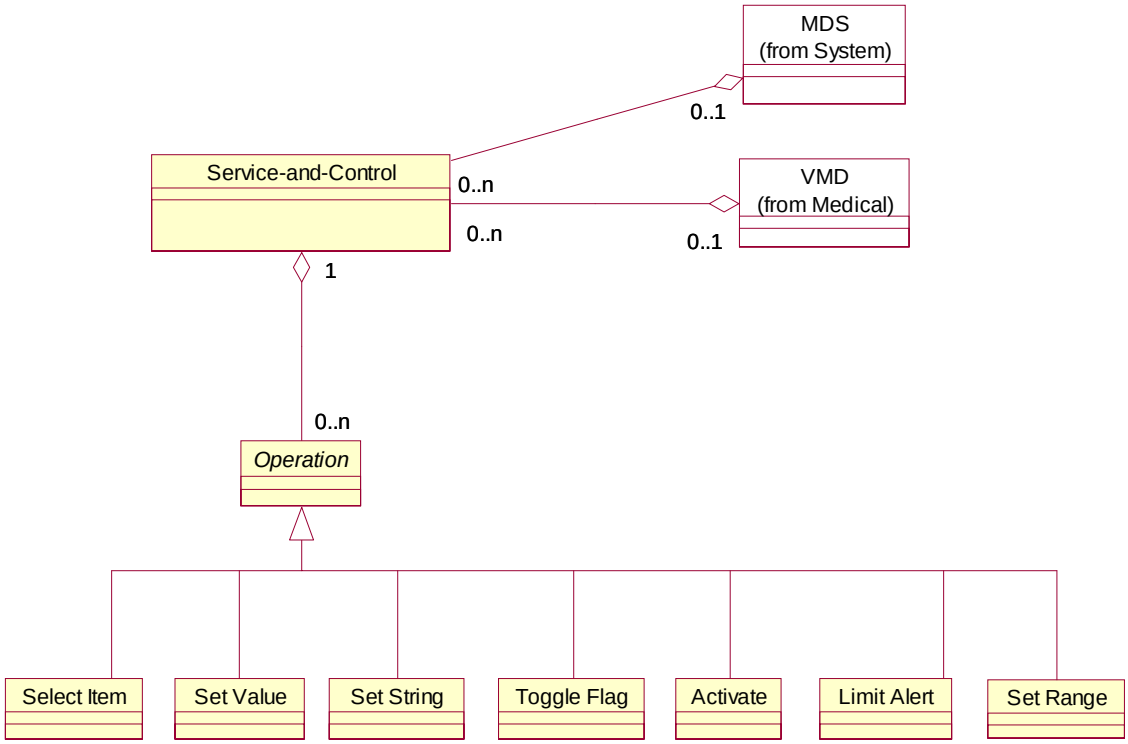

Figure 6.7—Control Package model

6.6.1 SCO

The SCO is responsible for managing all remote-control capabilities that are supported by a medical device.

Remote control in medical device communication is sensitive to safety and security issues. The SCO provides means for the following:

a) Simple transaction processing, which prevents inconsistencies when a device is controlled from multiple access points (e.g., local and remote) and during the processing of control commands.

b) State indications, which allows local and remote indication of ongoing controls.

6.6.2 Operation object

The Operation object is the abstract base class for classes that represent remote-controllable items. Each Operation object allows the system to modify some specific item (i.e., a virtual attribute) in a specific way defined by the Operation object. Operation objects are not directly accessible by services defined in the service model in Clause 8. All controls shall be routed through the SCO object (i.e., the parent) to allow a simple form of transaction processing.

The set of Operation objects instantiated by a particular medical device defines the complete remote control interface of the device. This way a host system is able to discover the remote control capabilities of a device in the configuration phase.

6.6.3 Select Item Operation object

The Select Item Operation object allows the selection of one item out of a given list.

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Example: The invasive pressure VMD may allow modification of its label. It uses a Select Item Operation object for this function. The list of legal values supplied by the operation may be, for example, {ABP, PAP, CVP, LAP}. By invoking the operation, a user is able to select one value out of this list.

6.6.4 Set Value Operation object

The Set Value Operation object allows the adjustment of a value within a given range with a given resolution.

Example: A measurement VMD may allow adjustment of a signal gain factor. It uses the Set Value Operation object for this function. The operation provides the supported value range and step width within this range.

6.6.5 Set String Operation object

The Set String Operation object allows the system to set the contents of an opaque string variable of a given maximum length and format.

Example: An infusion device may allow a remote system to set the name of the infused drug in free-text form to show it on a local display. It defines an instance of the Set String Operation object for this function. The operation specifies the maximum string length and the character format so that the device is able to show the drug name on a small display.

6.6.6 Toggle Flag Operation object

The Toggle Flag Operation object allows operation of a toggle switch (with two states, e.g., on/off).

Example: An ECG VMD may support a line frequency filter. It uses the Toggle Flag Operation object for switching the filter on or off.

6.6.7 Activate Operation object

The Activate Operation object allows a defined activity to be started (e.g., a zero pressure).

Example: The zero procedure of an invasive pressure VMD may be started with an Activate Operation object.

6.6.8 Limit Alert Operation object

The Limit Alert Operation object allows adjustment of the limits of a limit alarm detector and the switching of the limit alarm to on or off.

6.6.9 Set Range Operation object

The Set Range Operation object allows the selection of a value range by the simultaneous adjustment of a low and high value within defined boundaries.

Example: A measurement VMD may provide an analog signal input for which the signal input range can be adjusted with a Set Range Operation object.

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6.7 Model for the Extended Services Package

The Extended Services Package contains objects that provide extended medical object management services that allow efficient access to medical information in communicating systems. Such access is achieved by a set of objects that package attribute data from multiple objects in a single event message.

The objects providing extended services are conceptually derived from ISO/OSI system management services defined in the ISO/IEC 10164 family of standards (specifically Part 5 and Part 13). The definitions have been adapted to and optimized for specific needs in the area of vital signs communication between medical devices.

Figure 6.8 shows the object model for the Extended Services Package.

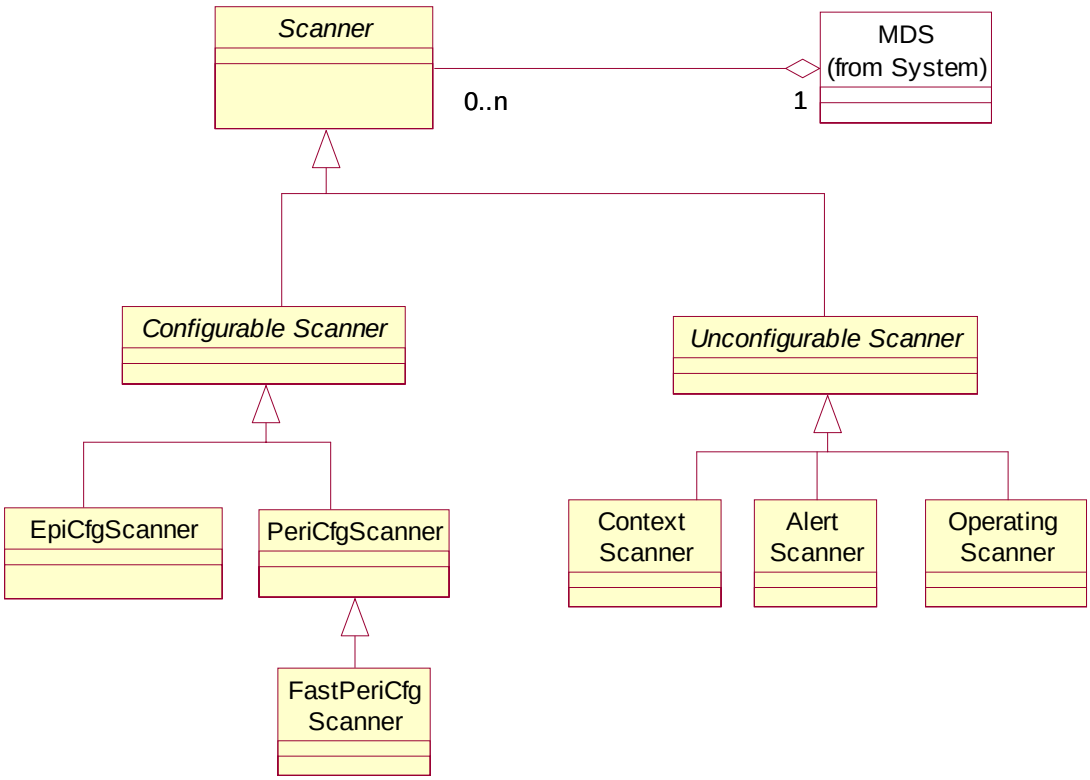

Figure 6.8—Extended Services Package model

The Extended Services Package model contains the objects described in 6.7.1 through 6.7.9.

6.7.1 Scanner object

A Scanner object is a base class that is an observer and “summarizer” of object attribute values. It observes attributes of managed medical objects and generates summaries in the form of notification event reports. These event reports contain data from multiple objects, which provide a better communication performance compared to separate polling commands (e.g., GET service) or multiple individual event reports from all object instances.

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Objects derived from the Scanner object may be instantiated either by the agent system itself or by the manager system (e.g., dynamic scanner creation by using the CREATE service).

As a base class, the Scanner object cannot be instantiated.

6.7.2 CfgScanner (i.e., configurable scanner) object

The CfgScanner object is a base class that has a special attribute (i.e., the ScanList attribute) that allows the system to configure which object attributes are scanned. The ScanList attribute may be modified either by the agent system (i.e., auto-configuration or pre-configuration) or by the manager system (i.e., full dynamic configuration by using the SET service).

A CfgScanner object may support different granularity for scanning:

a) Attribute group (i.e., a defined set of attributes): The ScanList attribute contains the identifiers (IDs) of attribute groups, and all attributes in the group are scanned.

b) Individual attribute: The ScanList attribute contains the IDs of all attributes that are scanned.

In order to deal efficiently with optional object attributes, the attribute group scan granularity is recommended for CfgScanner objects.

As a base class, the CfgScanner object cannot be instantiated.

6.7.3 EpiCfgScanner (i.e., episodic configurable scanner) object

The EpiCfgScanner object is responsible for observing attributes of managed medical objects and for reporting attribute changes in the form of unbuffered event reports.

The unbuffered event report is triggered only by object attribute value changes. If the EpiCfgScanner object uses attribute group scan granularity, the event report contains all attributes of the scanned object that belong to this attribute group if one or more of these attributes changed their value.

> **Example:** A medical device provides heart beat detect events in the form of an Enumeration object. A display application creates an instance of the EpiCfgScanner object and adds the observed value of the Enumeration object to the ScanList attribute. The scanner instance afterwards sends a notification when the Enumeration object reports a heart beat.

6.7.4 PeriCfgScanner (i.e., periodic configurable scanner) object

The PeriCfgScanner object is responsible for observing attributes of managed medical objects and for periodically reporting attribute values in the form of buffered event reports. A buffered event report contains the attribute values of all available attributes that are specified in the scan list, independent of attribute value changes.

If the scanner operates in a special superpositive mode, the buffered event report contains all value changes of attributes that occurred in the reporting period; otherwise, the report contains only the most recent attribute values.

> **Example:** A data logger creates an instance of the PeriCfgScanner object and configures the scanner so that it sends an update of the observed value attributes of all Numeric objects in the MDIB every 15 s.

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6.7.5 FastPeriCfgScanner (i.e., fast periodic configurable scanner) object

The FastPeriCfgScanner object is a specialized object class for scanning the observed value attribute of the Real Time Sample Array object. This special scanner object is further optimized for low-latency reporting and efficient communication bandwidth utilization, which is required to access real-time waveform data.

Example: A real-time display application (e.g., manager system) wants to display ECG waveforms. It creates a FastPeriCfgScanner object on the agent system (e.g., server device) and requests periodic updates of all ECG leads.

6.7.6 UcfgScanner (i.e., unconfigurable scanner) object

The UcfgScanner object is a base class that scans a predefined set of managed medical objects that cannot be modified. In other words, an UcfgScanner object typically is a reporting object that is specialized for one specific purpose.

As a base class, the UcfgScanner object cannot be instantiated.

6.7.7 Context Scanner object

The Context Scanner object is responsible for observing device configuration changes. After instantiation, the Context Scanner object is responsible for announcing the object instances in the device's MDIB. The scanner provides the object instance containment hierarchy and static object attribute values.

In case of dynamic configuration changes, the Context Scanner object sends notifications about new object instances or deleted object instances.

Example: A data logger creates an instance of the Context Scanner object in an agent MDIB to receive notifications about MDS configuration changes when new measurement modules are plugged in (i.e., new VMD instance) or when such a module is unplugged (i.e., VMD instance deleted).

6.7.8 Alert Scanner object

The Alert Scanner object is responsible for observing the alert-related attribute groups of objects in the Alert Package. As alarming in general is security-sensitive, the scanner is not configurable (i.e., all or no Alert objects are scanned).

The Alert Scanner object sends event reports periodically so that timeout conditions can be checked.

6.7.9 Operating Scanner object

The Operating Scanner object is responsible for providing all information about the operating and control system of a medical device.

In other words, the scanner maintains the configuration of Operation objects contained in SCOs (by sending CREATE notifications for Operation objects), it scans transaction-handling-related SCO attributes, and it scans Operation object attributes. Because SCOs and Operation objects may have dependencies, the scanner is not configurable.

6.8 Model for the Communication Package

The Communication Package deals with objects that enable and support basic communication.

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Figure 6.9 shows the object model for the Communication Package.

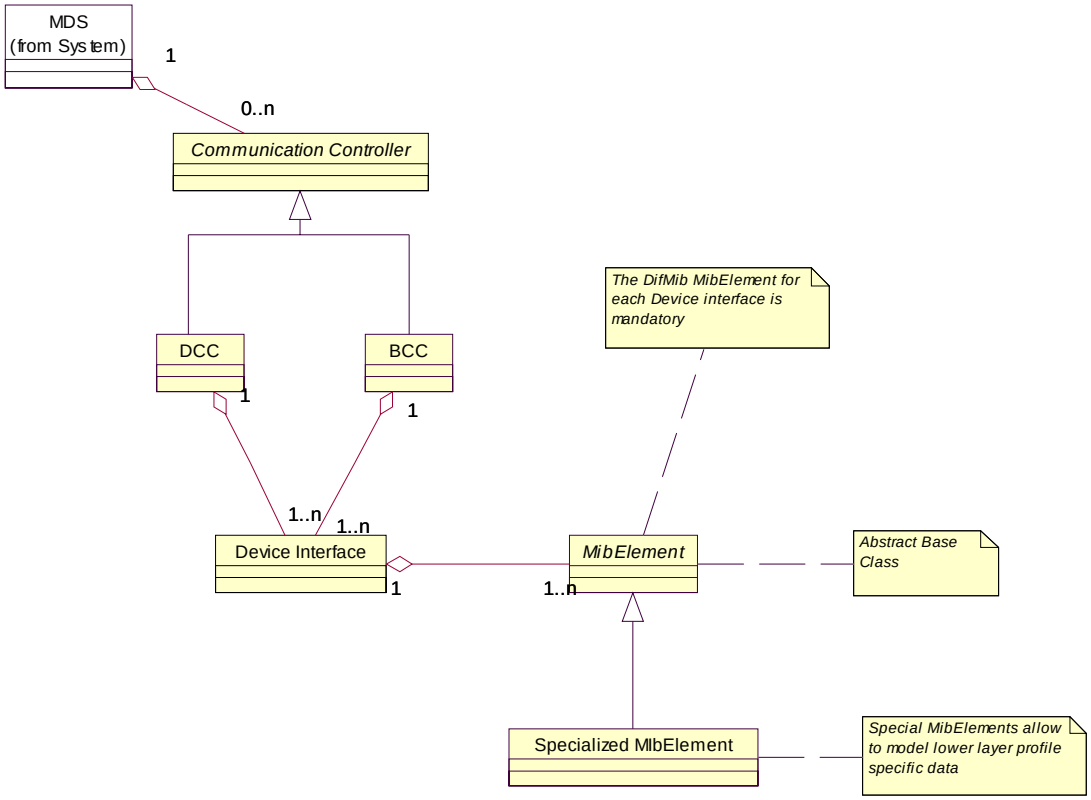

Figure 6.9—Communication Package model

The Communication Package model contains the objects described in 6.8.1 through 6.8.6.

6.8.1 Communication Controller object

The Communication Controller object represents the upper layer and lower layer communication profile of a medical device.

The Communication Controller object is the access point for retrieving Device Interface attributes and management information base element (MibElement) attributes for obtaining management information related to data communications.

As a base class, the Communication Controller object cannot be instantiated. Two instantiable specializations, however, are defined: BCC and DCC. A medical device MDIB contains either no Communication Controller object or one BCC object or one DCC object (depending on its role).

6.8.2 DCC (i.e., device communication controller) object

The DCC object is a Communication Controller object used by medical devices operating as agent systems (i.e., association responders).

The DCC object shall contain one or more Device Interface objects.

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6.8.3 BCC (i.e., bedside communication controller) object

The BCC object is a Communication Controller object used by medical devices operating as manager systems (i.e., association requestors).

The BCC object shall contain one or more Device Interface objects.

6.8.4 Device Interface object

The Device Interface object represents a particular interface, i.e., port. The port is either a logical or a physical end point of an association for which (e.g., statistical) data captured in the MibElement objects can be independently collected.

Both an agent system and a manager system can have multiple logical or physical ports, depending on the selected implementation of the lower layer communication system.

The Device Interface object is not accessible by CMDISE services. This object contains at least one MibElement object (i.e., the Device Interface MibElement object, which represents device interface properties), which can be accessed by a special method defined by the Communication Controller object.

6.8.5 MibElement object

The MibElement object contains statistics and performance data for one Device Interface object. The MibElement object is a base class for specialized MibElement objects only. It cannot be instantiated.

Various MibElement object types are defined to group management information in defined packages, which can be generic or dependent on specific transport profiles.

The MibElement object is not directly accessible. Its attributes can be accessed only through a Communication Controller object. The MibElement object is not part of the device's MDIB.

6.8.6 Specialized MibElement object

Management information for a communication link is dependent on the lower layers of the communication stack (i.e., lower layers profile).

This standard, however, defines only two generic MibElement objects:

— The mandatory Device Interface MibElement object, which describes properties of the device interface

— An optional general communication statistics MibElement object, which models typical communication statistics that are generally applicable

Specialized MibElement objects are defined in IEEE P1073.2.1.2.

6.9 Model for the Archival Package

The Archival Package deals with storage and representation of biosignals, status, and context information in an on-line or an off-line archive.

Figure 6.10 shows the object model of the Archival Package.

The Archival Package model contains the objects described in 6.9.1 through 6.9.7.

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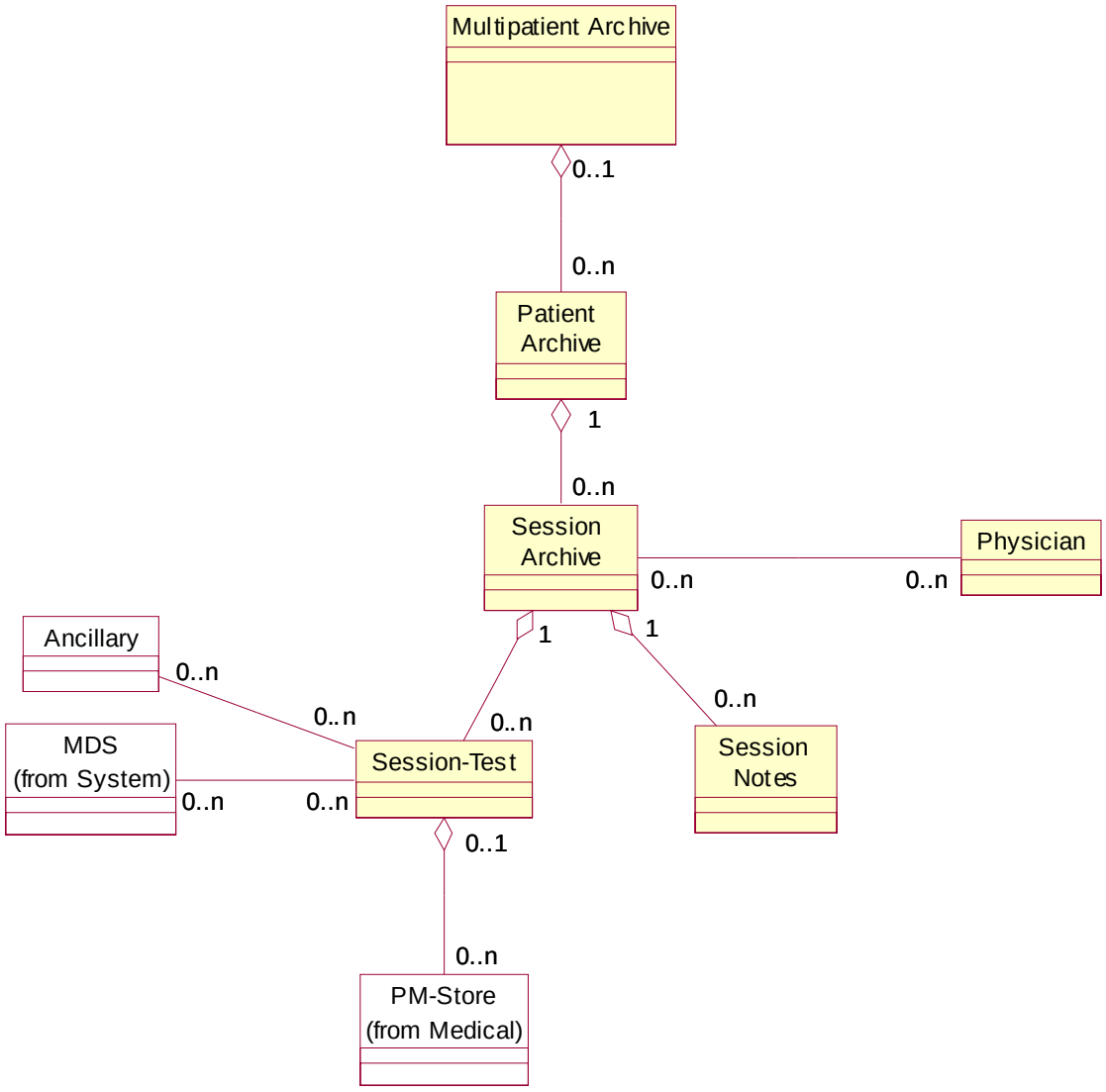

Figure 6.10—Archival Package model

6.9.1 Multipatient Archive object

The Multipatient Archive object groups together multiple Patient Archive ojbects referring to different patients.

Example: A drug study may be documented in the form of a Multipatient Archive object containing multiple Patient Archive objects that show how the drug affected the monitored vital signs.

6.9.2 Patient Archive object

The Patient Archive object groups patient-related information (e.g., vital signs data, treatment data, and patient demographics) together in a single archive object. This object relates to static (i.e., invariant) data in a Patient Demographics object only.

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Example: A hospital may store data about multiple visits of a single patient in a Patient Archive object that contains a number of Session Archive objects, each documenting vital signs information recorded during a specific visit in a hospital department.

6.9.3 Session Archive object

The Session Archive object represents a patient visit or a continuous stay in the a hospital or hospital department. Diagnostic treatments performed during this time period are represented by Session Test objects contained in the Session Archive object. The Session Archive object refers to dynamic (i.e., variant) data in a Patient Demographics object.

6.9.4 Physician object

The Physician object represents the physician responsible for the set of diagnostic and therapeutic activities during the time period represented by the Session Archive object.

6.9.5 Session Test object

The Session Test object contains vital signs information of a single patient that is recorded during a single examination or diagnostic treatment. This object contains vital signs metrics in form of PM-Store objects. It also may contain information about equipment that was used for recording (in the form of relations to MDS and Ancillary objects).

Example: Vital signs information recorded during a ECG stress test examination is organized in a Session Test object.

6.9.6 Session Notes object

The Session Notes object is a container for diagnostic data, patient care details, and treatment-related information in the form of textual data.

6.9.7 Ancillary object

The Ancillary object is not further defined in this standard. This object is present in the model to indicate that information from sources other than devices within the scope of this standard are permitted to be included in (or referenced by) the Session Test object.

Example: Image data that complies with the MEDICOM (CEN ENV 12052) or DICOM (NEMA PS 3) standard are permitted to be included in the Session Test object as ancillary data.

6.10 Model for the Patient Package

The Patient Package deals with all patient-related information that is relevant in the scope of this standard, but is not vital signs information modeled in the Medical Package.

Figure 6.11 shows the object model for the Patient Package:

The Patient Package model contains one object (see 6.10.1).

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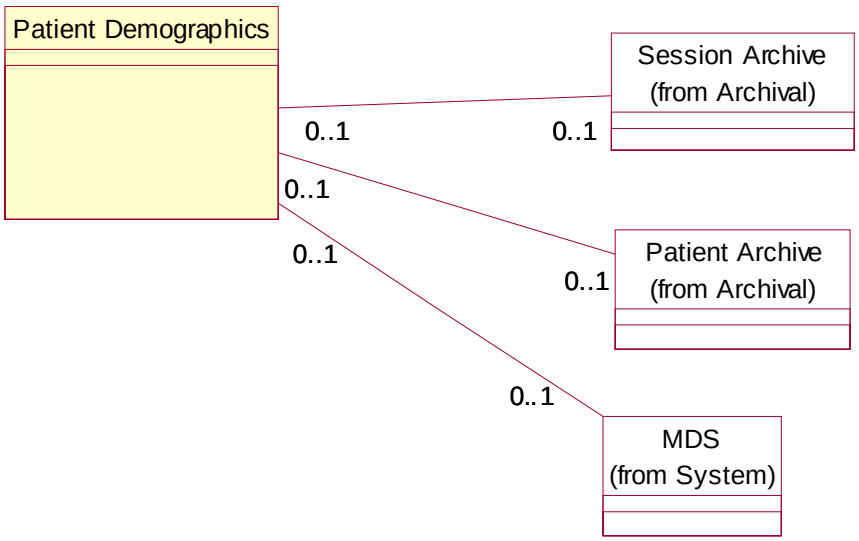

Figure 6.11—Patient Package model

6.10.1 Patient Demographics object

The Patient Demographics object stores patient census data.

This standard provides minimal patient information as typically required by medical devices. A complete patient record is outside the scope of this standard.

6.11 DIM—dynamic model

6.11.1 General

Subclause 6.11 defines global dynamic system behavior.

Note that dynamic object behavior resulting from invocation of object management services is part of the object definitions in Clause 7.

6.11.2 MDS communication finite state machine (FSM)

Figure 6.12 shows the MDS FSM for a communicating medical device that complies with the definitions in this standard. The FSM is used to synchronize the operational behavior of manager (i.e., client) systems and agent (i.e., server) systems.

After power-up, the device performs all necessary local initializations (i.e, boot phase) and ends up in the disconnected state, where it waits for connection events.

When a connection event is detected, the device tries to establish a logical connection (i.e, an association) with the other device. A manager (i.e., client) system is the association requester, and an agent (i.e, server) system is the association responder. Basic compatibility checks are performed in the associating state.

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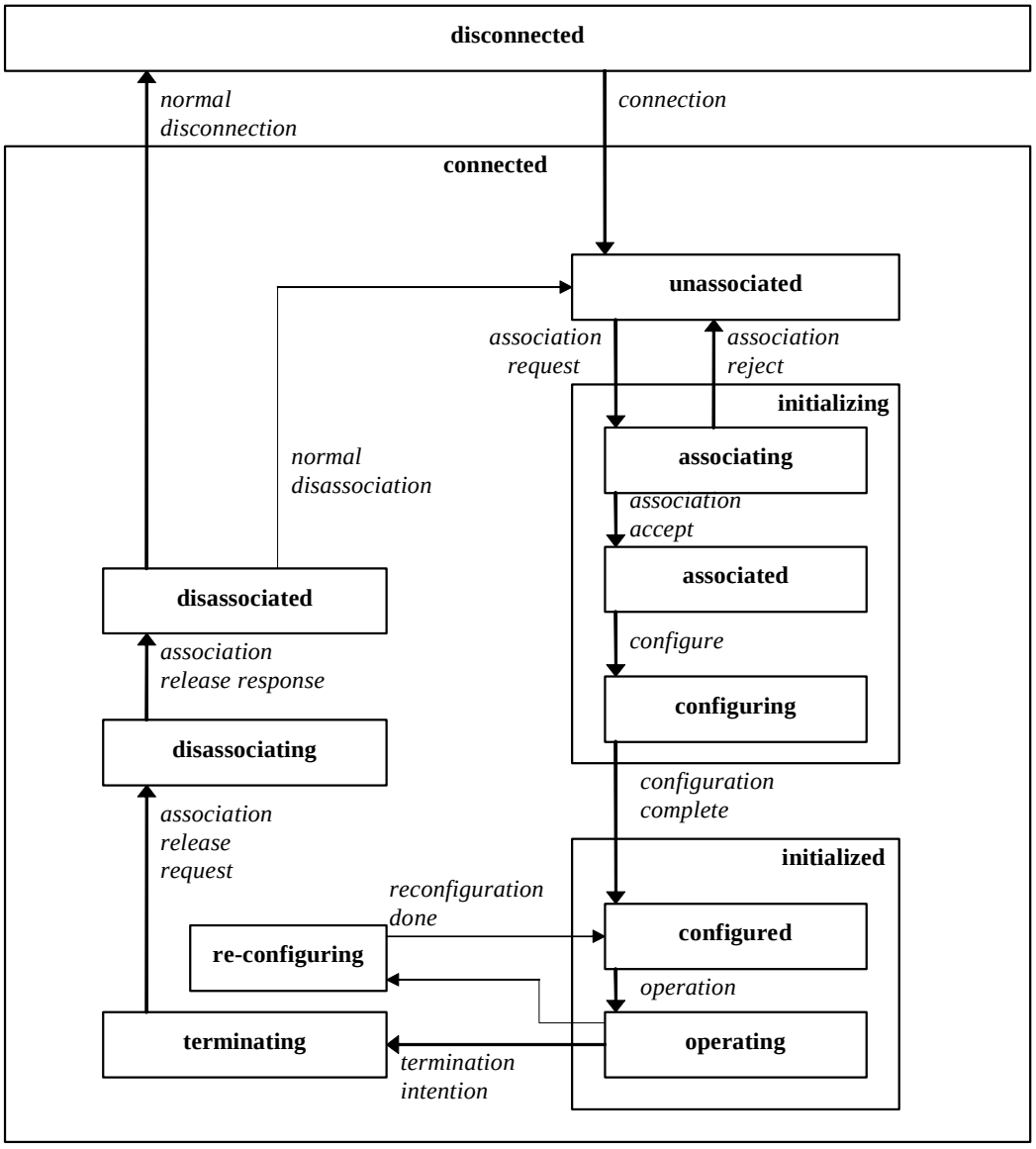

Figure 6.12—MDS FSM

After successful association, configuration data (i.e., the MDIB structure) is exchanged by the use of services and extended services (in particular, the Context Scanner object) as defined in this standard. Additional information (e.g., MDS attributes) is supplied that allows further compatibility and state checks.

After configuration, medical data are exchanged by using services and extended services as defined in this standard. Dynamic reconfiguration is allowed in the operating state. If the device or the type of reconfiguration does not allow dynamic handling in the operating state, a special “reconfiguring” state is provided.

If an event indicates an intention to disconnect, the disassociating state is entered.

The diagram does not show error events. Fatal error events take the state machine out of the operating state.

NOTE—This state machine describes the behavior of the MDS communication system only. Usually the device must perform its medical function independent of the communication system.

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The FSM is considered a part of the MDS object. The MDS Status attribute reflects the state of the machine. The MDS may announce state changes in the form of attribute change event reports.

Specific application profiles shall use this state machine as a general guideline, but they may define specific deviations to fulfill specific profile-dependent requirements or assumptions.

6.11.3 Communicating systems—startup object interaction diagram

Figure 6.13 presents the object interaction diagram that visualizes the startup phase after connecting two devices.

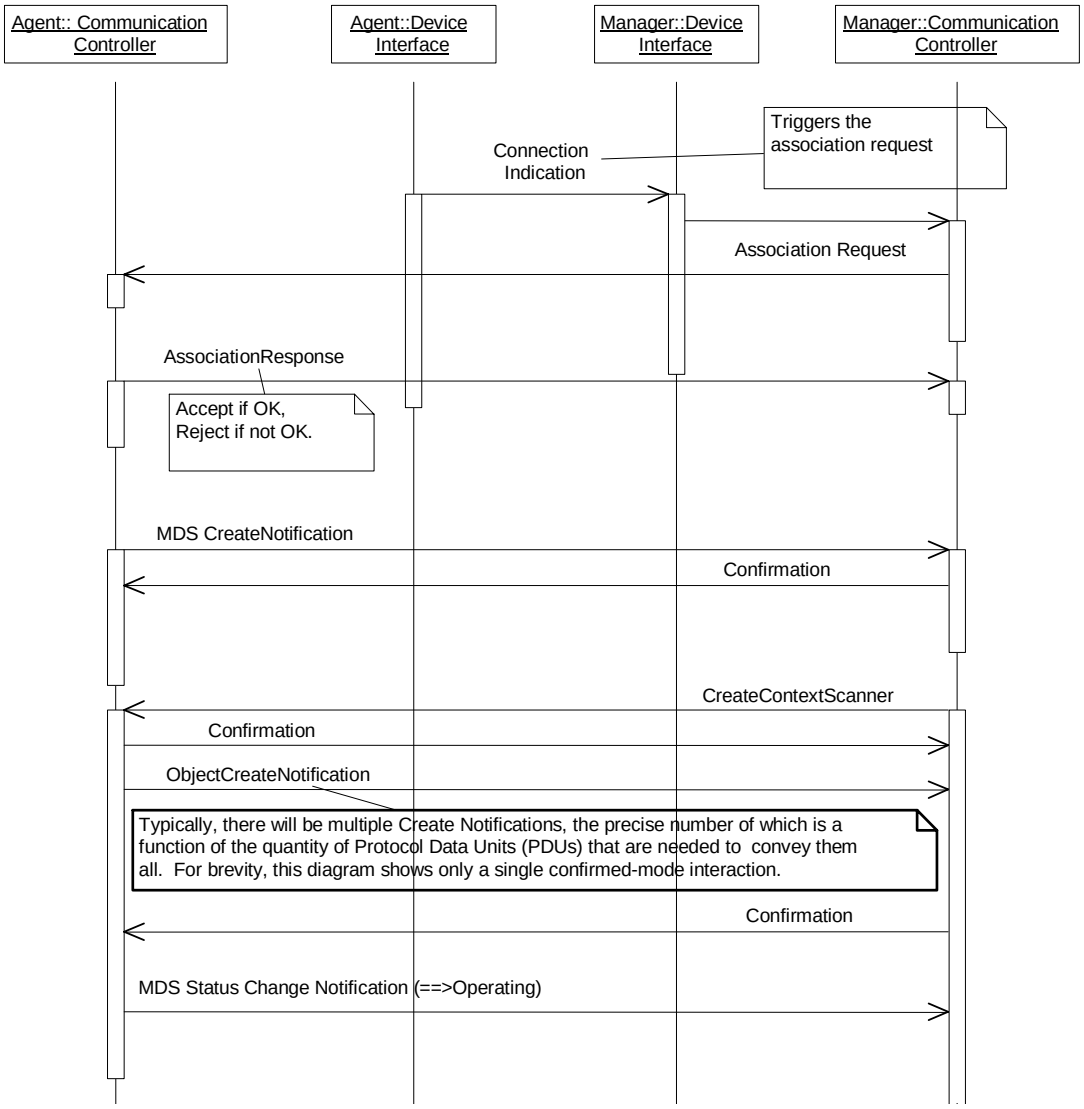

Figure 6.13—Startup after connection

It is assumed here that, conceptually, messages are exchanged between the Communication Controller objects (using the device interface).

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Some form of connection indication is necessary to make the manager system aware of a new agent on the network. This mechanism is dependent on the specific lower layer implementation; therefore, it is not further defined in this standard.

Specific application profiles shall use this interaction diagram as a general guideline, but they may define specific deviations to fulfill specific profile-dependent requirements or assumptions.

6.11.4 Communication Package—MibElement data access

Figure 6.14 presents the object interaction diagram that shows how a manager system accesses the MibElement data using the objects defined in the Communication Package (see 6.8).

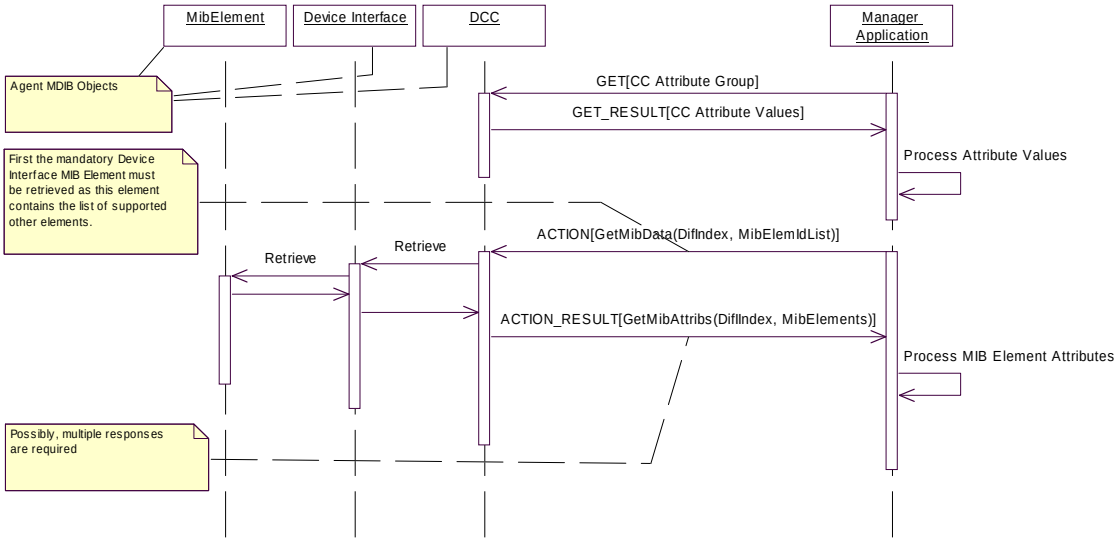

Figure 6.14—MibElement data access

The diagram assumes the following:

- An association is established between the agent and the manager.
- The configuration phase is finished, and the manager has an image of the agent's MDIB.
- The DCC object is part of the agent's MDIB.

The manager first uses the GET service to retrieve all DCC object attributes and their values. The attributes specify how many Device Interface objects exist.

The manager uses the ACTION service with the Communication Controller object-defined method to retrieve the attributes of the mandatory Device Interface MibElement object. The MibElement attribute variables specify if any additional MibElement objects are available for the interface.

If so, the manager can use the same ACTION command to retrieve the additional management information represented in the MibElement objects.

6.11.5 Dynamic object relations

This subclause deals with relations between managed medical objects (i.e., objects that are defined as managed objects in this standard).

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Generally, the relationships between object instances that are defined in the package models are dynamic.

> **Example:** A modular patient monitor is modeled as an MDS. Measurement modules are modeled as VMDs. If a new module is connected to the monitor, there is also a new relationship between the MDS and the new VMD instance.

Communicating agent systems (i.e., agents) use services defined in this standard to announce configuration change events to other connected systems. These manager systems (i.e., managers) modify their view of the agent MDIB.

Not only does a vital signs information archive have to update its configuration, but it also has to permanently store these connection and disconnection events.

> **Example:** An instance of the Session Archive object represents the stay of a patient in the intensive care unit (ICU). During that period, new devices are connected to the patient to increase the number of recorded vital signs. They are removed again as soon as the patient's condition stabilizes. The Session Archive object shall not delete recorded data when the recording device is disconnected.

Thus, in certain applications (e.g., archival applications), object instance relationships have associated information that must be captured.

When required, the relationships themselves can be considered to be special managed objects as shown in Figure 6.15.

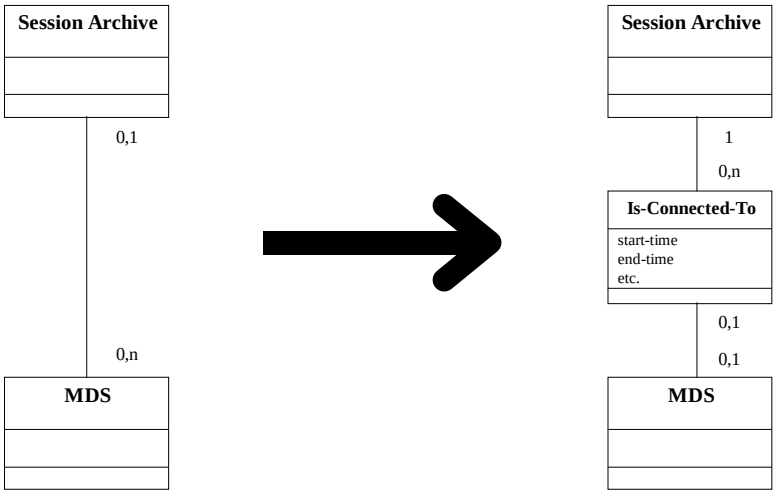

Figure 6.15—Example of a relationship represented by an object

The example in Figure 6.15 shows a relation between a Session Archive object and an MDS object. The relation is represented as an object. This object has attributes that provide information, for example, about time of connection and disconnection.

Modeling the relations as objects has the advantage that information can be defined in the form of attributes. It is not necessary to assign the attributes to one or both objects that are related.

How dynamic object relations are handled by systems that comply with the definitions in this standard is defined in 6.11.5.1 and 6.11.5.2.

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6.11.5.1 Dynamic object relations in communicating systems

Relations between object instances that are defined in the package models are considered configuration information. The Context Scanner object provides configuration information in the form of object create notifications and object delete notifications. No means for persistent storage of past (i.e., old) configuration information is defined for communicating systems.

Other relations between object instances (e.g., to reference a source signal in derived data) are specified in the form of attributes of the corresponding objects (e.g., the Vmo-Source-List attribute of the Metric object). Dynamic changes of these attributes are announced by attribute change notification events.

6.11.5.2 Dynamic object relations in archival systems

An archival system may need to provide persistent storage for configuration information. In this case, the corresponding relations are considered to be represented by objects, as shown in 6.11.5.

An archival system that uses a data format in compliance with the definitions in this standard has to provide means to store (i.e., archive) the attributes of dynamic relationship objects.

7. DIM object definitions

7.1 General

Clause 7 contains the object definitions for all objects in the DIM. The packages defined in the model are used to categorize objects. Attributes, behavior, and notifications are defined for each object class.

7.1.1 Notation

Each object is defined in a separate subclause (see 7.2 through 7.10). Further subclauses define attributes, behavior, and notifications for the objects.

The object is defined in a subclause as follows:

Object:	Defines the name of the object.
Description:	"Gives a short, informative textual description of the object."
Derived From:	Defines potential base classes of the object.
Name Binding:	Defines the attribute that uniquely identifies an instance of the object in a given context. For manageable objects, this definition is the Handle attribute and the context is the device system (i.e., single MDS context). See also 7.1.2.5.
Registered As:	Defines a term that is defined in the nomenclature to allow unique identification [e.g., object identifier (OID), code] of the object.

Each object attribute is defined in an attribute subclause. Tables define attribute names, unique attribute IDs, attribute data types, and certain qualifiers. The qualifiers have the following meaning:

M attribute is mandatory
O attribute is optional
C attribute is conditional; availability of attribute depends on a predefined condition

Unless otherwise noted, the attribute definition tables do not show inherited attributes again. In other words, the attribute lists of all base classes have to be checked for a complete list of object attributes.

Attributes are assigned to, or grouped together in. attribute groups so attributes can be classified according to their use (e.g., static context information, dynamic context information, value observations). The grouping also makes it possible to effectively deal with optional attributes: A GET service facilitates the retrieval of

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all members of the group so an application is able to determine which attributes are actually present in a particular object instance.

Attribute groups may be extensible. In other words, a derived object class is able to add additional members to an inherited attribute group.

Attribute groups are also defined in tables that specify group identification and the list of group members. Inherited attribute groups are not shown in the attribute group tables again unless these groups are extensible.

Special methods or functions that are provided by an object class are defined in a behavior subclause. These methods can be invoked by the CMDISE ACTION service.

Events generated by an object class (other than a generic attribute change notification) are defined in a notifications subclause. An object reports these events by using the CMDISE EVENT REPORT service.

7.1.2 Common data types

This subclause defines a set of ASN.1 data types that are used in the object definitions.

7.1.2.1 Integer and bit string data types

For representing integer numbers, the object definitions use fixed-size data types only. The bit string data type represents a bit field where each single bit has a defined meaning (i.e., flag fields). The following integer data types and bit string data types are used:

```
--
-- 8-bit unsigned integer
--
INT-U8 ::= INTEGER (0..255)
--
-- 8-bit signed integer
--
INT-I8 ::= INTEGER (-128..127)
--
-- 16-bit unsigned integer
--
INT-U16 ::= INTEGER (0..65535)
--
-- 16-bit signed integer
--
INT-I16 ::= INTEGER (-32768..32767)
--
-- 32-bit unsigned integer
--
INT-U32 ::= INTEGER (0..4294967295)
--
-- 32-bit signed integer
--
INT-I32 ::= INTEGER (-2147483648..2147483647)

--
-- 16-bit bit string
--
BITS-16 ::= BIT STRING (SIZE(16))
--
-- 32-bit bit string
--
BITS-32 ::= BIT STRING (SIZE(32))
```

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NOTES

1—When interpreting integer numbers, the representation (e.g., little endian versus big endian) has to be considered. Communicating systems negotiate this representation at association (i.e., transfer syntax). Archival data formats have to provide a mechanism to uniquely identify integer representation (e.g., a field in a specification header).

2—In the object definitions, integer and bit string data types with named constants or named bits also use the above notation for simplicity. The above notation is illegal ASN.1 syntax, but it can be easily transformed to the correct syntax.

7.1.2.2 Identification data type

All elements (e.g., classes, objects, measurement types) that need unique identification are assigned an OID. The set of valid OIDs for this standard is defined in ISO/IEEE 11073-10101. The nomenclature is split into a set of partitions, and each partition has its own range of 16-bit codes. In other words, the 16-bit code is context-sensitive.

The 16-bit identification data type is defined as follows:

```
--
-- OID type as defined in nomenclature
-- (do not confuse with ASN.1 OID)
--
OID-Type ::= INT-U16                    -- 16-bit integer type
```

For IDs that are not part of the standard nomenclature (i.e., private or manufacturer-specific codes), a special type is defined as follows:

```
--
-- Private OID
--
PrivateOid ::= INT-U16
```

7.1.2.3 Handle data type

The handle data type is used for efficient, locally unique identification of all managed medical object instances. (*Locally unique* means unique within one MDS context.) This data type is defined as follows:

```
--
-- handle
--
HANDLE ::= INT-U16
```

7.1.2.4 Instance number data type

The instance number data type is used to distinguish class or object instances of the same type or object instances that are not directly manageable (i.e., used, e.g., as the Name Binding attribute for Operation objects). This data type is defined as follows:

```
--
-- Instance Number
--
InstNumber ::= INT-U16
```

7.1.2.5 Global object identification

Handle and instance number data types must be unique inside one specific naming context (e.g., handles are unique within at least one MDS context). This uniqueness allows the identification of an object instance within its naming context by one single, small identifier.

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To address larger scale systems, a context ID field at the MDS level within an MDIB is added to the handle data type so that multiple device systems can be distinguished. This global handle data type is defined as follows:

```
--
-- MDS Context ID
--
MdsContext ::= INT-U16

--
-- Global handle allows identification of an object in a larger scale system
--
GLB-HANDLE ::= SEQUENCE {
    context-id                  MdsContext,
    handle                      HANDLE
}

--
-- Managed OID as a type for complete global object identification
--
ManagedObjectId ::= SEQUENCE {
    m-obj-class                 OID-Type,
    m-obj-inst                  GLB-HANDLE
}
```

Example: A medical device may interface with further medical devices (i.e., sub-devices). In the MDIB, this device may model these sub-devices as individual MDS objects with their own naming context. In this way, name space collisions (e.g., duplicate handle values, duplicate nomenclature codes) can be avoided without reassigning handle values. A manager system needs to interpret the MDS context IDs together with handle values to uniquely identify object instances within this composite MDIB. The context IDs are assigned when the MDIB is created by Context Scanner object create notifications.

Assumptions and possible restrictions about different naming contexts within an MDIB are profile dependent. They are, therefore, defined in the ISO/IEEE P11073-202xx series.

7.1.2.6 Type ID data type

The type ID data type is used in the VMOs and VMS objects to provide specific static information about the type of an object instance (e.g., blood pressure could be the type of a Numeric object). Codes defined in the nomenclature are used. The nomenclature contains a number of partitions, and code values are unique only within one partition. As the type ID data type should be context-free, the partition of the nomenclature code is also provided. This data type is defined as follows:

```
--
-- Type ID
--
TYPE ::= SEQUENCE {
    partition                   NomPartition,
    code                        OID-Type
}

--
-- The following nomenclature partitions exist
--
NomPartition ::= INT-U16 {
    nom-part-unspec(0),
    nom-part-obj(1),                    -- object-oriented partition
    nom-part-metric(2),                 -- metric [supervisory control and data acquisition
                                        -- (SCADA)] partition
    nom-part-alert(3),                  -- alerts/events partition
```

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```
    nom-part-dim(4),                -- dimensions partition
    nom-part-vattr(5),              -- virtual attribute partition for Operation objects
    nom-part-pgrp(6),               -- parameter group ID partition
    nom-part-sites(7),              -- measurement and body site locations
    nom-part-infrastruct(8),        -- infrastructure elements partition
    nom-part-fef(9)                 -- file exchange format partition
    nom-part-ecg-extn(10),          -- ECG extensions partition
    nom-part-ext-nom(256),          -- IDs of other nomenclatures and dictionaries
    nom-part-priv(1024)             -- private partition
}
```

7.1.2.7 Attribute value assertion data type

A number of services defined in the service model in Clause 8 provide access to object attributes (e.g., GET, SET). Typically, the attribute has to be identified by means of an attribute ID. The attribute data type itself is dependent on this ID. The attribute value assertion data type represents this ID-value pair and is defined as follows:

```
--
AVA-Type ::= SEQUENCE {
    attribute-id            OID-Type,
    attribute-value         ANY DEFINED BY attribute-id
}
```

7.1.2.8 Attribute list data type

Frequently, a list of attribute ID–attribute value pairs is needed. The attribute list data type is a special data type that is provided for this situation and is defined as follows:

```
--
AttributeList ::= SEQUENCE OF AVA-Type
```

7.1.2.9 Attribute ID list data type

Frequently, a list of attribute IDs is used. The attribute ID list data type is a special type that is provided for convenience and is defined as follows:

```
--
AttributeIdList ::= SEQUENCE OF OID-Type
```

7.1.2.10 Floating point type data type

For performance and efficiency, the object definitions use the floating point type data type, which is a special data type for representing floating point numbers. It is assumed that this data type is 32 bits. This data type is defined as follows:

```
--
-- 32-bit float type; the integer type is a placeholder only
--
FLOAT-Type ::= INT-U32
```

The concrete floating point number format is either explicitly negotiated at association or implicitly defined by the association application context.

7.1.2.11 Relative time data type

The relative time data type is a high-resolution time definition relative to some event (e.g., a synchronization event at startup). This data type is used to position events relative to each other. It is defined as follows:

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```
--
-- Relative time has a resolution of 125 µs [least significant bit (LSB)], which is sufficient for sampling rates
-- up to 8 kHz and spans time periods up to 6.2 days
--
RelativeTime ::= INT-U32
```

Note that the time accuracy is defined by the system itself.

7.1.2.12 High-resolution relative time data type

If either the resolution or the time span of the previously defined relative time data type is not sufficient, a high-resolution relative time data type is defined. The data type is 64 bits long. However, as there is no 64-bit integer data type defined, an opaque (i.e., string) data structure is used. The type is defined as follows:

```
--
-- 64-bit (8 byte) high-resolution time, the LSB represents 1 µs
--
HighResRelativeTime ::= OCTET STRING (SIZE(8))
```

Note that the time accuracy is defined by the system itself.

7.1.2.13 Absolute time data type

Absolute time data type specifies the time of day with at least a resolution of 1 s. For efficiency, the values in the structure are BCD-encoded (i.e., 4-bit nibbles). The year 1996, for example, is represented by the hexadecimal value 0x19 in the century field and the hexadecimal value 0x96 in the year field. This format can easily be converted to character-based or integer-based representations. The absolute time data type is defined as follows:

```
--
AbsoluteTime ::= SEQUENCE {
    century             INT-U8,
    year                INT-U8,
    month               INT-U8,
    day                 INT-U8,
    hour                INT-U8,
    minute              INT-U8,
    second              INT-U8,
    sec-fractions       INT-U8      -- 1/10 and 1/100 of second if available
}
```

7.1.2.14 Date data type

The date data type is used to specify a certain calendar date. For ease of transformation, the data type has the same encoding (i.e., BCD) as the absolute time data type. The date data type is defined as follows:

```
--
Date ::= SEQUENCE {
    century             INT-U8,
    year                INT-U8,
    month               INT-U8,
    day                 INT-U8
}
```

7.1.2.15 Operational state data type

The operational state data type defines if a certain object or other property is enabled or disabled. The definitions are derived from ISO/IEC 10164-2 and are as follows:

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```
--
OperationalState ::= INT-U16 {
    disabled(0),
    enabled(1),
    notAvailable(2)
}
```

7.1.2.16 Administrative state data type

The administrative state data type defines if a certain object is locked or unlocked. The definitions are derived from ISO/IEC 10164-2 and are as follows:

```
--
AdministrativeState ::= INT-U16 {
    locked(0),
    unlocked(1),
    shuttingDown(2)
}
```

7.1.2.17 Color data type

The color data type represents the basic RGB colors and is defined as follows:

```
--
SimpleColour ::= INT-U16 {              -- RGB
    col-black(0),                       -- 000
    col-red(1),                         -- 100
    col-green(2),                       -- 010
    col-yellow(3),                      -- 110
    col-blue(4),                        -- 001
    col-magenta(5),                     -- 101
    col-cyan(6),                        -- 011
    col-white(7)                        -- 111
    }
```

7.1.2.18 Locale data type

The locale data type shall be used to specify language and encoding information for data types that represent human-readable text strings. This data type is defined as follows:

```
--
Locale ::= SEQUENCE {
    language            INT-U32,    -- from ISO 639-1 or ISO 629-2, see below for encoding
    country             INT-U32,    -- from ISO 3166-1, ISO 3166-2, or ISO 3166-3, see below
                                    -- for encoding
    charset             CharSet,    -- format of character encoding
    str-spec            StringSpec
}

--
-- Charset names correspond to Internet Assigned Numbers Authority (IANA), the numeral constants are the
-- IANA MIBenum values for registered charsets
--
CharSet ::= INT-U16 {
    charset-unspec(0),
    charset-iso-10646-ucs-2(1000),  -- ISO 10646 two-octet character encoding scheme,
                                    -- big endian
    charset-iso-10646-ucs-4(1001),  -- ISO 10646 four-octet character encoding scheme,
                                    -- big endian
    charset-iso-8859-1(4),          -- encoding according to ISO/IEC 8859 Part 1
    charset-iso-8859-2(5),          -- encoding according to ISO/IEC 8859 Part 2
```

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```
        charset-iso-8859-3(6),              -- encoding according to ISO/IEC 8859 Part 3
        charset-iso-8859-4(7),              -- encoding according to ISO/IEC 8859 Part 4
        charset-iso-8859-5(8),              -- encoding according to ISO/IEC 8859 Part 5
        charset-iso-8859-6(9),              -- encoding according to ISO/IEC 8859 Part 6
        charset-iso-8859-7(10),             -- encoding according to ISO/IEC 8859 Part 7
        charset-iso-8859-8(11),             -- encoding according to ISO/IEC 8859 Part 8
        charset-iso-8859-9(12),             -- encoding according to ISO/IEC 8859 Part 9
        charset-iso-8859-10(13),            -- encoding according to ISO/IEC 8859 Part 10
        charset-iso-8859-13(109),           -- encoding according to ISO/IEC 8859 Part 13
        charset-iso-8859-14(110),           -- encoding according to ISO/IEC 8859 Part 14
        charset-iso-8859-15(111),           -- encoding according to ISO/IEC 8859 Part 15
        charset-iso-2022-kr(37),            -- encoding according to RFC 1557
                                            -- (Korean Character Encoding)
        charset-ks-c-5601(36),              -- encoding according to Korean Industrial Standard,
                                            -- KSC 5601-1987
        charset-iso-2022-jp(39),            -- encoding according to RFC 1468
                                            -- (Japanese Character Encoding)
        charset-iso-2022-jp-2(40),          -- encoding according to RFC 1554
                                            -- (Japanese Character Encoding)
        charset-jis-x0208(63),              -- encoding according to JIS X0208:1983,1990
        charset-iso-2022-cn(104),           -- encoding according to RFC 1922
                                            -- (Chinese Character Encoding)
        charset-gb-2312(2025)               -- encoding according to Chinese Graphic
                                            -- Character Set, GB 2312:1980
    }

    StringSpec ::= SEQUENCE {
        str-max-len             INT-U16,    -- maximum string length
        str-flags               StringFlags -- specific flags for string representation and coding
    }

    StringFlags ::= BITS-16 {
        str-flag-nt(0)                      -- strings are null terminated
    }
```

The field Locale::language shall represent the lowercase ISO/IEC 646 representation of a two-character language ID code from ISO 639-1 or ISO 639-2. For processing convenience, the language ID is stored in a 32-bit integer field. The first octet of the code is stored in the most significant byte of this field. Unused octets in the field are filled with NULL bytes.

Example:

Language:	“English”
Language identifier:	“en”
Encoding:	65 6E 00 00_h

The field Locale::country shall represent the uppercase ISO/IEC 646 representation of a two-character country ID code from ISO 3166-1, ISO 3166-2, or ISO 3166-3. For processing convenience, the country ID is stored in a 32-bit integer field. The first octet of the code is stored in the most significant byte of this field. Unused octets of the field are filled with NULL bytes.

The country code can be used to distinguish between certain aspects of the same language used in different countries, e.g., English in the United States versus English in the United Kingdom.

If no specific country is defined, this field shall be set to 0.

Example:

Country:	“United States”
Country identifier:	“US”
Encoding:	55 53 00 00_h

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The field Locale::charset denotes the encoding scheme of the characters used in string data types representing readable text.

For interoperability, the character encoding scheme iso-10646-ucs-2 is recommended. This encoding scheme corresponds to ISO/IEC 10646 with a 2-octet (i.e., 16-bit per character) big-endian encoding, representing the basic multilingual plane (BMP). The character codes within ISO/IEC 10646 do not correspond directly with glyphs, i.e., the graphical representation of a character. Also the ISO/IEC 10646 is language independent. Other Locale::charset values may be more language dependent because they also specify a certain character repertoire.

7.1.2.19 External nomenclature reference data type

In certain cases, it is required to refer to standard coding systems (i.e., nomenclatures) that are outside the scope of this standard.

Example: The nomenclature defined in this standard does not define diagnostic codes or procedure codes. However, it is possible to reference a different coding system and provide the information in the form of an external code.

The external nomenclature reference data type is a special data type that is defined for this function as follows:

```
--
ExtNomenRef ::= SEQUENCE {
    nomenclature-id          OID-Type,          -- external nomenclature ID from external nomenclature
                                                -- partition
    nomenclature-code        ANY DEFINED BY nomenclature-id
}
```

7.1.2.20 External object relation list data type

In certain cases, managed medical objects defined in the DIM may have relations to other objects that are not defined in this standard (i.e., they are external to the definitions).

The external object relation list data type can be used to provide information about these objects and the particular relation. This data type is defined as follows:

```
--
-- ExtObjRelationList
--
ExtObjRelationList ::= SEQUENCE OF ExtObjRelationEntry

ExtObjRelationEntry ::= SEQUENCE {
    relation-type            OID-Type,
    related-object           OID-Type,
    relation-attributes      AttributeList
}
```

Example 1: In certain situations, it is necessary to record specific production information (e.g., serial number) of a transducer that is used to derive a measurement. The transducer in this standard is not defined as a managed medical object. Therefore, the VMD object instances use a relation entry to supply the information, e.g., {relation-type = is-connected; related-object = Transducer; relation-attributes = {model, “A-Model,” serial-number = “12345”}}.

Example 2: A certain numerical measurement value is manually validated by a nurse. A charting system keeps information about manual validations. The nurse is not modeled as an object in this standard. Therefore, the charting system uses a relation entry as an additional attribute of the Numeric object, e.g.,

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{relation-type = validated-by; related-object = Nurse; relation-attributes = {name, “C. Smith,” date, “041295”}}

The external object relation list data type is a very powerful concept to extend the information model without really defining additional objects.

7.2 Top object

Object: Top
Description: “The Top object is the common inheritance base for all objects in the DIM.”
Derived From: —
Name Binding: —
Registered As: MDC_MOC_TOP

7.2.1 Attributes

The Top object class defines the attributes in Table 7.1.

Table 7.1—Top object class attributes

Attribute name	Attribute ID	Attribute type	Remark	Qualifier
Class	MDC_ATTR_CLASS	OID-Type	Defines the ID of the class; IDs come from the object-oriented nomenclature partition.	n/a
Name-Binding	MDC_ATTR_NAME_ BINDING	OID-Type	Defines ID of Name Binding attribute, e.g., HANDLE; IDs come from the object-oriented nomenclature partition.	n/a

The Top object class does not define any attribute groups.

7.2.2 Behavior

The Top object does not define any special methods.

7.2.3 Notifications

The Top object defines the events in Table 7.2.

Table 7.2—Top object events

Event	Mode	Event ID	Event parameter	Event result
Attribute-Update	Confirmed/ Unconfirmed	MDC_NOTI_ATTR_ UPDATE	AttributeList	—

The attribute update notification allows all objects to communicate their attribute values with a generic event report. However, the use of this notification for systems with multiple object instances is not recommended. Instead, the Scanner objects should be used.

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7.3 Objects in the Medical Package

The definitions of objects in the Medical Package are given in 7.3.1 through 7.3.13.

7.3.1 VMO

Object: VMO
Description: "The VMO is the base class for all medical-related objects in the model. It provides consistent naming and identification across the Medical Package model. As a base class, the VMO cannot be instantiated."
Derived From: Top
Name Binding: Handle (the value of the Handle attribute is sufficient for unique identification of an instance of a VMO-derived object in a device system)
Registered As: MDC_MOC_VMO

7.3.1.1 Attributes

The VMO class defines the attributes in Table 7.3.

Table 7.3—VMO class attributes

Attribute name	Attribute ID	Attribute type	Remark	Qualifier
Type	MDC_ATTR_ID_ TYPE	TYPE	Defines a specific static type of this object, as defined in the object-oriented or metric nomenclature partition.	M
Handle	MDC_ATTR_ID_ HANDLE	HANDLE	Locally unique short-hand identification.	M
Label-String	MDC_ATTR_ID_ LABEL_STRING	OCTET STRING	Textual representation of type ID.	O
Ext-Obj-Relations	MDC_ATTR_EXT_ OBJ_RELATION	ExtObjRelation-List	Relations to objects that are not defined in the DIM.	O

The VMO class defines in Table 7.4 the attribute groups or extensions to inherited attribute groups.

Table 7.4—VMO class attribute groups

Attribute group	Attribute group ID	Group elements
VMO Static Context Group (extensible attribute group)	MDC_ATTR_GRP_VMO_ STATIC	from VMO: Type, Handle
VMO Dynamic Context Group (extensible attribute group)	MDC_ATTR_GRP_VMO_ DYN	from VMO: Label-String
Relationship Attribute Group	MDC_ATTR_GRP_ RELATION	from VMO: Ext-Obj-Relations

Note that the Relationship Attribute Group is not shown again in the definitions of derived classes.

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7.3.1.2 Behavior

The VMO does not define any special methods.

7.3.1.3 Notifications

The VMO does not generate any special notifications.

7.3.2 VMD object

Object: VMD
Description: "The VMD object is an abstraction of a medical-related subsystem (e.g., hardware or even pure software) of a medical device."
Derived From: VMO
Name Binding: Handle (VMO inherited)
Registered As: MDC_MOC_VMO_VMD

7.3.2.1 Attributes

The VMD object class defines the attributes in Table 7.5.

Table 7.5—VMD object class attributes

Attribute name	Attribute ID	Attribute type	Remark	Qualifier
VMD-Status	MDC_ATTR_VMD_ STAT	VMDStatus	Example: on.	M
VMD-Model	MDC_ATTR_ID_ MODEL	SystemModel	Manufacturer and model number.	O
Instance-Number	MDC_ATTR_ID_ INSTNO	InstNumber	If multiple instances of the same VMD exist, this attribute helps to order the sequence.	O
Production-Specification	MDC_ATTR_ID_ PROD_SPECN	ProductionSpec	Serial numbers and revisions; only present if VMD represents an independent subsystem.	O
Compatibility-Id	MDC_ATTR_ID_ COMPAT	INT-U32	Static for manufacturer use.	O
Parameter-Group	MDC_ATTR_ID_ PARAM_GRP	OID-Type	Example: cardiovascular.	O
Position	MDC_ATTR_ID_ POSN	INT-U16	Example: slot number `0xffff` marks an invalid or unknown position.	O
Operating-Hours	MDC_ATTR_TIME_ PD_OP_HRS	INT-U32		O
Operation-Cycles	MDC_ATTR_CYC_OP	INT-U32	Example: number of measure-ments taken.	O

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Table 7.5—VMD object class attributes *(continued)*

Attribute name	Attribute ID	Attribute type	Remark	Qualifier
Measurement-Principle	MDC_ATTR_MSMT_PRINCIPLE	MsmtPrinciple	Describes the physical principle of the measurement.	O
Locale	MDC_ATTR_LOCALE	Locale	Defines charset and language of printable string attributes in this VMD and contained objects.	O

NOTE—Identification and revision attributes are not needed if the VMD does not represent a hardware component.

The VMD object class defines in Table 7.6 the attribute groups or extensions to inherited attribute groups.

Table 7.6—VMD object class attribute groups

Attribute group	Attribute group ID	Group elements
VMO Static Context Group (extensible attribute group)	MDC_ATTR_GRP_VMO_STATIC	from VMO: Type, Handle from VMD: Parameter-Group, Instance-Number, Compatibility-Id, Measurement-Principle, Locale
VMO Dynamic Context Group (extensible attribute group)	MDC_ATTR_GRP_VMO_DYN	from VMO: Label-String from VMD: Vmd-Status
VMD Application Attribute Group	MDC_ATTR_GRP_VMD_APPL	from VMD: Position, Operating-Hours, Operation-Cycles
VMD Production Attribute Group	MDC_ATTR_GRP_VMD_PROD	from VMD: Vmd-Model, Production-Specification

NOTE—A separate attribute group is defined for VMD static attributes that are needed only in special applications.

The following type definitions apply:

```
--
-- VMD status indication bits; all bits 0 indicate that VMD is operational
--
VMDStatus ::= BITS-16 {
     vmd-off(0),
     vmd-not-ready(1),                  -- e.g., for an infusion pump that is not ready
     vmd-standby(2),                    -- e.g., for device powered, but not active
     vmd-transduc-discon(8),            -- transducer disconnected
     vmd-hw-discon(9)                   -- measurement hardware disconnected
}
--
-- Physical principle of the measurement (multiple bits may be set)
--
MsmtPrinciple ::= BITS-16 {
     msp-other(0),
     msp-chemical(1),
```


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```
        msp-electrical(2),
        msp-impedance(3),
        msp-nuclear(4),
        msp-optical(5),
        msp-thermal(6),
        msp-biological(7),
        msp-mechanical(8),
        msp-acoustical(9),
        msp-manual(15)
    }
```

7.3.2.2 Behavior

The VMD object does not define any special methods.

7.3.2.3 Notifications

The VMD object does not generate any special notifications.

7.3.3 Channel object

Object: Channel
Description: "The Channel object is used for grouping Metric objects and, thus, allows hierarchical information organization."
Derived From: VMO
Name Binding: Handle (VMO inherited)
Registered As: MDC_MOC_VMO_CHAN

7.3.3.1 Attributes

The Channel object class defines the attributes in Table 7.7.

Table 7.7—Channel object class attributes

Attribute name	Attribute ID	Attribute type	Remark	Qualifier
Channel-Id	MDC_ATTR_CHAN_ ID	OID-Type	Dynamic identification.	O
Channel-Status	MDC_ATTR_CHAN_ STAT	ChannelStatus	Example: Transducer Disconnected.	O
Physical-Channel-No	MDC_ATTR_CHAN_ NUM_PHYS	INT-U16	Provides a reference to a particular hardware channel, e.g., A/D.	O
Logical-Channel-No	MDC_ATTR_CHAN_ NUM_LOGICAL	INT-U16	Dynamic channel numbering.	O
Parameter-Group	MDC_ATTR_ID_ PARAM_GRP	OID-Type	Static group of metrics, e.g., cardiovascular.	O
Measurement-Principle	MDC_ATTR_MSMT_ PRINCIPLE	MsmtPrinciple	Describes the physical principle of the measurement.	O
Color	MDC_ATTR_COLOR	SimpleColour	Useful to assign a common color to objects in one channel.	O

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The Channel object class defines in Table 7.8 the attribute groups or extensions to inherited attribute groups.

Table 7.8—Channel object class attribute groups

Attribute group	Attribute group ID	Group elements
VMO Static Context Group (extensible attribute group)	MDC_ATTR_GRP_VMO_STATIC	from VMO: Type, Handle from Channel: Parameter-Group, Physical-Channel-No, Measurement-Principle
VMO Dynamic Context Group (extensible attribute group)	MDC_ATTR_GRP_VMO_DYN	from VMO: Label-String from Channel: Channel-Id, Channel-Status, Color, Logical-Channel-No

The following type definitions apply:

```
--
-- Channel Status indication bits
--
ChannelStatus ::= BITS-16 {
    chan-off(0),
    chan-not-ready(1),
    chan-standby(2),
    chan-transduc-discon(8),
    chan-hw-discon(9)
}
```

7.3.3.2 Behavior

The Channel object does not define any special methods.

7.3.3.3 Notifications

The Channel object does not generate any special notifications.

7.3.4 Metric object

Object: Metric
Description: "The Metric object is the base class for all objects representing direct and derived, quantitative and qualitative biosignal measurement, status, and context data. It is a base class that is used for inheritance only."
Derived From: VMO
Name Binding: Handle (VMO inherited)
Registered As: MDC_MOC_VMO_METRIC

7.3.4.1 Attributes

The Metric object class defines the attributes in Table 7.9.

The Metric object class defines in Table 7.10 the attribute groups or extensions to inherited attribute groups.

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Table 7.9—Metric object class attributes

Attribute name	Attribute ID	Attribute type	Remark	Qualifier
Metric-Specification	MDC_ATTR_METRIC_SPECN	MetricSpec	Static; mandatory basic properties.	M
Max-Delay-Time	MDC_ATTR_DELAY_TIME_MAX	RelativeTime	Static; maximum delay to real time.	O
Metric-Status	MDC_ATTR_METRIC_STAT	MetricStatus		O
Measurement-Status	MDC_ATTR_MSMT_STAT	Measurement-Status	Usually part of an observed value.	O
Metric-Id-Partition	MDC_ATTR_METRIC_ID_PART	NomPartition	Identifies the nomenclature partition associated with the MetricId if it is different from the partition specified in the object's VMO::Type attribute.	O
Metric-Id	MDC_ATTR_ID_PHYSIO	OID-Type	Contains dynamic identification (e.g., a specific blood pressure label) compared to the static, generic ID in the Metric-Specification. OID is from VMO::Type or Metric-Id-Partition partition. Usually this attribute is part of an observed value, not an individual attribute.	O
Metric-Id-Ext	MDC_ATTR_ID_MSMT_EXT	ExtNomenRef	Dynamic identification of the metric in a different nomenclature or dictionary. Use of this attribute severely limits interoperability of applications.	O
Unit-Code	MDC_ATTR_UNIT_CODE	OID-Type	Example: mmHG;, usually part of observed value.	O
Unit-LabelString	MDC_ATTR_UNIT_LABEL_STRING	OCTET STRING	Textual representation of dimension.	O
Vmo-Source-List	MDC_ATTR_VMO_LIST_SRC	VmoSourceList	Indicates sources of this metric in the form of references to other metrics.	O
Metric-Source-List	MDC_ATTR_METRIC_LIST_SRC	MetricSourceList	Indicates sources of this metric in the form of a list of metric IDs.	O
Msmt-Site-List	MDC_ATTR_SITE_LIST_MSMT MDC_ATTR_SITE_LIST_MSMT_EXT	SiteList SiteListExt	Measurement sites, specified in internal or external nomenclature.	O
Body-Site-List	MDC_ATTR_SITE_LIST_BODY MDC_ATTR_SITE_LIST_BODY_EXT	SiteList SiteListExt	Body sites, specified in internal or external nomenclature.	O
Metric-Calibration	MDC_ATTR_METRIC_CALIB	MetricCalibration	Indicates type and last time of calibration.	O

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Table 7.9—Metric object class attributes *(continued)*

Attribute name	Attribute ID	Attribute type	Remark	Qualifier
Color	MDC_ATTR_COLOR	SimpleColour	Color for representation.	O
Measure-Mode	MDC_ATTR_MODE_MSMT	PrivateOid	Manufacturer-specific measurement information.	O
Measure-Period	MDC_ATTR_TIME_PD_MSMT	MetricMeasure	Measurement repetition time; not necessarily the same as update period.	O
Averaging-Period	MDC_ATTR_TIME_PD_AVG	MetricMeasure	Time period used to average values, e.g., a metric for the average flow of last hour.	O
Start-Time	MDC_ATTR_TIME_START	AbsoluteTime	Time when measurement activity was started, e.g., when infusion was started.	O
Stop-Time	MDC_ATTR_TIME_STOP	AbsoluteTime	Time when measurement activity was stopped.	O
Metric-Info-LabelString	MDC_ATTR_METRIC_INFO_LABEL_STRING	OCTET STRING	Textual attribute, e.g., to specify electrode displacements or other specific information about the measurement.	O
Substance	MDC_ATTR_ID_SUBSTANCE	ExtNomenRef	Substance to which a metric pertains; expressed in nomenclature that is defined outside of this standard.	O
Substance-Label-String	MDC_ATTR_ID_SUBSTANCE_LABEL_STRING	OCTET STRING	Textual attribute that identifies the substance.	O

Table 7.10—Metric object class attribute groups

Attribute group	Attribute group ID	Group elements
VMO Static Context Group (extensible attribute group)	MDC_ATTR_GRP_VMO_STATIC	from VMO: Type, Handle from Metric: Metric-Specification, Max-Delay-Time
VMO Dynamic Context Group (extensible attribute group)	MDC_ATTR_GRP_VMO_DYN	from VMO: Label-String from Metric: Vmo-Source-List, Metric-Source-List, Unit-Code, Unit-LabelString, Msmt-Site-List, Body-Site-List, Metric-Status, Measure-Period, Averaging-Period, Start-Time, Stop-Time, Measure-Mode, Metric-Calibration, Color, Measurement-Status, Metric-Id, Metric-Id-Ext, Metric-Info-LabelString, Substance, Substance-LabelString
Metric Observed Value Group (extensible attribute group)	MDC_ATTR_GRP_METRIC_VAL_OBS	from Metric: Metric-Id-Partition

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The following type definitions apply:

```
--
-- Metric-Status attribute
--
MetricStatus ::= BITS-16 {
    metric-off(0),
    metric-not-ready(1),
    metric-standby(2),
    metric-transduc-discon(8),
    metric-hw-discon(9)
}

--
-- The Metric-Specification attribute defines all mandatory static properties of a Metric object
--
MetricSpec ::= SEQUENCE {
    update-period           RelativeTime,     -- minimum time between changes of observed value
    category                MetricCategory,
    access                  MetricAccess,
    structure               MetricStructure,
    relevance               MetricRelevance
}

--
-- Structure describes if the object represents a single value or multiple related values (e.g., an invasive blood
-- pressure could be compound when it represents a pulsatile pressure and derives systolic, diastolic, and
-- mean values)
--
MetricStructure ::= SEQUENCE {
    ms-struct               INT-U8 {
        simple(0),
        compound(1),                          -- multiple observed values, same dynamic context
        complex(2)                            -- multiple observed values, multiple dynamic contexts
        },
    ms-comp-no              INT-U8            -- maximum number of components in compound/complex
}

--
-- The MetricAccess bit field provides information on how it is possible to access the metric value and
-- when a new value is available
--
-- NOTES
-- 1--The avail-intermittent flag shall be set if the observed value is not always available
-- 2--Exactly one update mode bit (upd-) shall be set
-- 3--At least one access mode bit (acc-) shall be set
-- 4--It is possible to set scan option bits (sc-) only if the acc-scan bit is set
-- 5--If the acc-scan bit is set, at least one sc-opt bit shall be set
--
MetricAccess ::= BITS-16 {
    avail-intermittent(0),                    -- value is intermittently available
    upd-periodic(1),                          -- value is periodically (fixed period) updated
    upd-episodic(2),                          -- value is episodically updated
    msmt-noncontinuous(3),                    -- measurement is not continuous (e.g., NBP)
    acc-evrep(4),                             -- metric sends event report for observed value
    acc-get(5),                               -- metric supports explicit GET service
    acc-scan(6),                              -- metric observed value is able to be accessed via
                                              -- Scanner object
    gen-opt-sync(8),                          -- observed value shall be processed synchronously
    sc-opt-normal(10),                        -- scan option: value can be scanned with update period
    sc-opt-extensive(11),                     -- scan option: in update period multiple values may occur
    sc-opt-long-pd-avail(12),                 -- scan option: value may be scanned slow
                                              -- (superpositive-avg scan bit)
    sc-opt-confirm(13),                       -- scan option: scanner should operate in confirmed mode
```

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```
    sc-opt-refresh(14)                  -- scan option: a scan refresh operation is allowed
}

--
-- The metric category makes it possible to distinguish between measurements, settings, and calculations
--
MetricCategory ::= INT-U16 {
    mcat-unspec(0),
    auto-measurement(1),
    manual-measurement(2),
    auto-setting(3),
    manual-setting(4),
    auto-calculation(5),
    manual-calculation(6)
}

--
-- Metric relevance defines in what way the metric should be used (i.e., a value of 0 means normal)
--
MetricRelevance ::= BITS-16 {
    rv-unspec(0),                       -- relevance not specified; should normally not be used
    rv-internal(1),                     -- an internally used value only
    rv-store-only(2),                   -- only relevant for storage
    rv-no-recording(3),                 -- not relevant for recording
    rv-phys-ev-ind(4),                  -- metric represents a physiological trigger (not a value)
    rv-btb-metric(5),                   -- metric is calculated for each beat or breath,
                                        -- not time-averaged
    rv-app-specific(8),                 -- dedicated application required to interpret the metric
    rv-service(9)                       -- metric is intended for service or diagnostic purposes
}

--
-- The Metric-Calibration attribute defines calibration methods and times
-- NOTE--Multiple entries allowed
--
MetricCalibration ::= SEQUENCE OF MetricCalEntry

MetricCalEntry ::= SEQUENCE {
    cal-type            MetricCalType,
    cal-state           MetricCalState,
    cal-time            AbsoluteTime
}

MetricCalType ::= INT-U16 {
    cal-unspec(0),
    cal-offset(1),                      -- offset calibration
    cal-gain(2),                        -- gain calibration
    cal-two-point(3)                    -- two-point calibration
}

MetricCalState ::= INT-U16 {
    not-calibrated(0),
    cal-required(1),
    calibrated(2)
}

--
-- Ordered list of measurement sites, e.g., EEG electrode positions
--
SiteList ::= SEQUENCE OF OID-Type       -- entries are from body site nomenclature partition

--
-- Site list may also refer to external nomenclatures to specify measurement sites
--
```


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```
SiteListExt ::= SEQUENCE OF ExtNomenRef

--
-- Metric-Source-List attribute is an ordered list of metric OIDs
--
MetricSourceList ::= SEQUENCE OF OID-Type       -- OIDs from VMO::Type or Metric-Id-Partition partition

--
-- Vmo-Source-List attribute defines references to other VMO-derived objects that are used as sources
-- of this metric (this is an ordered list)
--
VmoSourceList ::= SEQUENCE OF VmoSourceEntry

VmoSourceEntry ::= SEQUENCE {
    vmo-type                OID-Type,       -- from object-oriented nomenclature partition
    glb-handle              GLB-HANDLE
}

--
-- Measurement-Status attribute defines the state of the measurement; used by derived classes
--
MeasurementStatus ::= BITS-16 {
    invalid(0),
    questionable(1),
    not-available(2),
    calibration-ongoing(3),
    test-data(4),
    demo-data(5),
    validated-data(8),                  -- relevant, e.g., in an archive
    early-indication(9),                -- early estimate of value
    msmt-ongoing(10),                   -- indicates that a new measurement is just being taken
                                        -- (episodic)
    msmt-state-in-alarm(14),            -- indicates that the metric has an active alarm condition
    msmt-state-al-inhibited(15)         -- metric supports alarming, and alarms are turned off
                                        -- (optional)
}

--
-- In a number of derived metrics, specification of ranges is necessary
-- A type for this is defined here in the base class
--
AbsoluteRange ::= SEQUENCE {
    lower-value             FLOAT-Type,
    upper-value             FLOAT-Type
}

--
-- Metric measure is used for attributes that have a value and a dimension
--
MetricMeasure ::= SEQUENCE {
    value                   FLOAT-Type,
    unit-code               OID-Type        -- from dimensions nomenclature partition
}
```

7.3.4.2 Behavior

The Metric object does not define any special methods.

7.3.4.3 Notifications

The Metric object does not emit any special notifications.

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7.3.5 Numeric object

Object: Numeric
Description: "The Numeric object represents numerical measurements and status information, e.g., amplitude measures, counters."
Derived From: Metric
Name Binding: Handle (VMO inherited)
Registered As: MDC_MOC_VMO_METRIC_NU

7.3.5.1 Attributes

The Numeric object class defines the attributes in Table 7.11.

Table 7.11—Numeric object class attributes

Attribute name	Attribute ID	Attribute type	Remark	Qualifier
Nu-Observed-Value	MDC_ATTR_NU_VAL_OBS	NuObsValue	Example: measurement value; should also contain validity information to be useful.	C[a]
Compound-Nu-Observed-Value	MDC_ATTR_NU_CMPD_VAL_OBS	NuObsValueCmp	Used when multiple values are represented in a single Numeric object. (Structure is compound.)	C
Absolute-Time-Stamp	MDC_ATTR_TIME_STAMP_ABS	AbsoluteTime	Time of observation (timestamp).	O
Relative-Time-Stamp	MDC_ATTR_TIME_STAMP_REL	RelativeTime		O
HiRes-Time-Stamp	MDC_ATTR_TIME_STAMP_REL_HI_RES	HighResRelativeTime	High-resolution timestamp.	O
Nu-Measure-Range	MDC_ATTR_NU_RANGE_MSMT	AbsoluteRange	Potential measurement range.	O
Nu-Physiological-Range	MDC_ATTR_NU_RANGE_PHYSIO	AbsoluteRange	Physiological reasonable range (note that this is not an alarming range).	O
Nu-Measure-Resolution	MDC_ATTR_NU_MSMT_RES	FLOAT-Type	Resolution of measurement; minimum difference between two observed values.	O
Display-Resolution	MDC_ATTR_DISP_RES	DispResolution	Used when different resolution is needed when value is displayed.	O
Accuracy	MDC_ATTR_NU_ACCUR_MSMT	FLOAT-Type	Maximum deviation of actual value from reported observed value (if it can be specified).	O

[a]Exactly one observed value type shall be present as defined by the Metric-Specification attribute.

The Numeric object class defines in Table 7.12 the attribute groups or extensions to inherited attribute groups.

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Table 7.12—Numeric object class attribute groups

Attribute group	Attribute group ID	Group elements
VMO Static Context Group (extensible attribute group)	MDC_ATTR_GRP_VMO_STATIC	from VMO: Type, Handle from Metric: Metric-Specification, Max-Delay-Time from Numeric:
VMO Dynamic Context Group (extensible attribute group)	MDC_ATTR_GRP_VMO_DYN	from VMO: Label-String from Metric: Vmo-Source-List, Metric-Source-List, Unit-Code, Unit-LabelString, Msmt-Site-List, Body-Site-List, Metric-Status, Measure-Period, Averaging-Period, Start-Time, Stop-Time, Measure-Mode, Metric-Calibration, Color, Measurement-Status, Metric-Id, Metric-Id-Ext, Metric-Info-LabelString, Substance, Substance-LabelString from Numeric: Nu-Measure-Range, Nu-Physiological-Range, Accuracy, Nu-Measure-Resolution, Display-Resolution
Metric Observed Value Group (extensible attribute group)	MDC_ATTR_GRP_METRIC_VAL_OBS	from Metric: Metric-Id-Partition from Numeric: Nu-Observed-Value, Compound-Nu-Observed-Value, Absolute-Time-Stamp, Relative-Time-Stamp, HiRes-Time-Stamp

The following type definitions apply:

```
--
-- Nu-Observed-Value attribute always includes identification, state, and dimension to ensure
-- consistency with minimal overhead
--
NuObsValue ::= SEQUENCE {
    metric-id               OID-Type,           -- from VMO::Type or Metric-Id-Partition partition
    state                   MeasurementStatus,
                                                -- defined in Metric base class
    unit-code               OID-Type,           -- from dimensions nomenclature partition
    value                   FLOAT-Type
}

--
-- Observed value for compound numerics
--
NuObsValueCmp ::= SEQUENCE OF NuObsValue

--
-- Display-Resolution attribute is the value representation on a display (may be lower resolution)
--
DispResolution ::= SEQUENCE {
    pre-point               INT-U8,             -- digits before decimal point
    post-point              INT-U8              -- digits after decimal point
}
```

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7.3.5.2 Behavior

The Numeric object does not define any special methods.

7.3.5.3 Notifications

The Numeric object does not generate any special notifications.

7.3.6 Sample Array object

Object: Sample Array
Description: "The Sample Array object is the base class for metrics that have a graphical, curve type presentation and, therefore, have their observation values reported as arrays of data points by communicating systems."
Derived From: Metric
Name Binding: Handle (VMO inherited)
Registered As: MDC_MOC_VMO_METRIC_SA

7.3.6.1 Attributes

The Sample Array object class defines the attributes in Table 7.13.

Table 7.13—Sample Array object class attributes

Attribute name	Attribute ID	Attribute type	Remark	Qualifier
Sa-Observed-Value	MDC_ATTR_SA_VAL_OBS	SaObsValue	Example: array of measurement values.	C[a]
Compound-Sa-Observed-Value	MDC_ATTR_SA_CMPD_VAL_OBS	SaObsValueCmp		C
Sa-Specification	MDC_ATTR_SA_SPECN	SaSpec	Static description of sample array and sample types.	M
Compression	MDC_ATTR_COMPRES	PrivateOid	Defines potential compression algorithm.	O
Scale-and-Range-Specification	MDC_ATTR_SCALE_SPECN_I8 MDC_ATTR_SCALE_SPECN_I16 MDC_ATTR_SCALE_SPECN_I32	ScaleRangeSpec8 ScaleRange-Spec16 ScaleRange-Spec32	Defines mapping between samples and actual values as well as measurement range; type depends on sample size.	M
Sa-Physiological-Range	MDC_ATTR_SA_RANGE_PHYS_I8 MDC_ATTR_SA_RANGE_PHYS_I16 MDC_ATTR_SA_RANGE_PHYS_I32	ScaledRange8 ScaledRange16 ScaledRange32	For optimum display scaling, the physiologically meaningful range is specified.	O
Visual-Grid	MDC_ATTR_GRID_VIS_I8 MDC_ATTR_GRID_VIS_I16 MDC_ATTR_GRID_VIS_I32	SaVisualGrid8 SaVisualGrid16 SaVisualGrid32	Defines gridline positions on displays and recorders; type depends on sample size.	O

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Table 7.13—Sample Array object class attributes *(continued)*

Attribute name	Attribute ID	Attribute type	Remark	Qualifier
Sa-Calibration-Data	MDC_ATTR_SA_CALIB_I8 MDC_ATTR_SA_CALIB_I16 MDC_ATTR_SA_CALIB_I32	SaCalData8 SaCalData16 SaCalData32	Defines positions of calibration markers on display and recorders; type depends on sample size.	O
Filter-Specification	MDC_ATTR_FILTER_SPECN	SaFilterSpec		O
Filter-Label-String	MDC_ATTR_FILTER_LABEL_STRING	OCTET STRING	Text label of an active filter, e.g., ”Butterworth” or “Linear-Phase.”	O
Sa-Signal-Frequency	MDC_ATTR_SA_FREQ_SIG	SaSignal-Frequency	Maximum signal frequency.	O
Sa-Measure-Resolution	MDC_ATTR_SA_MSMT_RES	FLOAT-Type		O
Sa-Marker-List	MDC_ATTR_SA_MARKER_LIST_I8 MDC_ATTR_SA_MARKER_LIST_I16 MDC_ATTR_SA_MARKER_LIST_I32	MarkerListSaVal8 MarkerListSa-Val16 MarkerListSa-Val32		

[a]Exactly one observed value type shall be present as defined by the Metric-Specification attribute.

The Sample Array object class defines in Table 7.14 the attribute groups or extensions to inherited attribute groups.

Table 7.14—Sample Array object class attribute groups

Attribute group	Attribute group ID	Group elements
VMO Static Context Group (extensible attribute group)	MDC_ATTR_GRP_VMO_STATIC	from VMO: Type, Handle from Metric: Metric-Specification, Max-Delay-Time from Sample Array: Sa-Specification, Compression, Sa-Marker-List
VMO Dynamic Context Group (extensible attribute group)	MDC_ATTR_GRP_VMO_DYN	from VMO: Label-String from Metric: Vmo-Source-List, Metric-Source-List, Unit-Code, Unit-LabelString, Msmt-Site-List, Body-Site-List, Metric-Status, Measure-Period, Averaging-Period, Start-Time, Stop-Time, Measure-Mode, Metric-Calibration, Color, Measurement-Status, Metric-Id, Metric-Id-Ext, Metric-Info-LabelString, Substance, Substance-LabelString from Sample Array: Scale-and-Range-Specification, Sa-Physiological-Range, Visual-Grid, Sa-Calibration-Data, Filter-Specification, Filter-Label-String , Sa-Signal-Frequency, Sa-Measure-Resolution

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Table 7.14—Sample Array object class attribute groups *(continued)*

Attribute group	Attribute group ID	Group elements
Metric Observed Value Group (extensible attribute group)	MDC_ATTR_GRP_ METRIC_VAL_OBS	from Metric: Metric-Id-Partition from Sample Array: Sa-Observed-Value, Compound-Sa-Observed-Value

The following type definitions apply:

```
--
-- Sa-Observed-Value attribute
--
SaObsValue ::= SEQUENCE {
    metric-id                   OID-Type,           -- from VMO::Type or Metric-Id-Partition partition
    state                       MeasurementStatus,
                                                    -- defined in Metric object
    array                       OCTET STRING
}

--
-- Compound-Sa-Observed-Value attribute is the compound observed value
--
SaObsValueCmp ::= SEQUENCE OF SaObsValue

--
-- Sa-Specification attribute
--
SaSpec ::= SEQUENCE {
    array-size                  INT-U16,            -- number of samples per metric update period
    sample-type                 SampleType,
    flags                       SaFlags
}

--
-- Sample type describes one sample in the observed value array
--
SampleType ::= SEQUENCE {
    sample-size                 INT-U8,             -- e.g., 8 for 8-bit samples, 16 for 16-bit samples,
                                                    -- shall be divisible by 8
    significant-bits            INT-U8              -- defines significant bits in one sample
        { signed-samples(255)}                      -- if value is 255, the samples are signed; all bits are
                                                    -- significant; samples are interpreted in twos complement
}

--
-- SaFlags data type defines additional wave form properties
--
SaFlags ::= BITS-16 {
    smooth-curve(0),                                -- for optimum display, use a smoothing algorithm
    delayed-curve(1),                               -- curve is delayed (not real time)
    static-scale(2),                                -- ScaleRangeSpec does not change
    sa-ext-val-range(3)                             -- the nonsignificant bits in a sample are not 0,
                                                    -- e.g., when they are used for annotations or markers;
                                                    -- the receiver must apply a bit mask to extract the
                                                    -- significant bits from the sample
}

--
-- Specification of an applied signal filter
--
```


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```
SaFilterSpec ::= SEQUENCE OF SaFilterEntry

SaFilterEntry ::= SEQUENCE {
    filter-type             INT-U16 {other(0), low-pass(1), high-pass(2), notch(3) },
    filter-frequency        FLOAT-Type,
    filter-order            INT-I16,            -- e.g., -1: 6 dB/octet
}

--
-- Scale-and-Range-Specification attribute describes a relation between scaled values and absolute values;
-- depending on the sample size, multiple attribute types exist
--
-- NOTE--If a wave does not represent absolute values, the absolute value fields should contain a special value;
-- if the Sa-Specification attribute indicates signed samples, the scaled values have to be interpreted as
-- signed values
--
ScaleRangeSpec8 ::= SEQUENCE {
    lower-absolute-value    FLOAT-Type,
    upper-absolute-value    FLOAT-Type,
    lower-scaled-value      INT-U8,
    upper-scaled-value      INT-U8
}

ScaleRangeSpec16 ::= SEQUENCE {
    lower-absolute-value    FLOAT-Type,
    upper-absolute-value    FLOAT-Type,
    lower-scaled-value      INT-U16,
    upper-scaled-value      INT-U16
}

ScaleRangeSpec32 ::= SEQUENCE {
    lower-absolute-value    FLOAT-Type,
    upper-absolute-value    FLOAT-Type,
    lower-scaled-value      INT-U32,
    upper-scaled-value      INT-U32
}

--
-- Visual-Grid attribute defines grid lines at different levels of grid lines; if the Sa-Specification attribute
-- indicates signed samples, the scaled values have to be interpreted as signed values
--
SaVisualGrid8 ::= SEQUENCE OF SaGridEntry8

SaGridEntry8 ::= SEQUENCE {
    absolute-value          FLOAT-Type,
    scaled-value            INT-U8,
    level                   INT-U8
}

SaVisualGrid16 ::= SEQUENCE OF SaGridEntry16

SaGridEntry16 ::= SEQUENCE {
    absolute-value          FLOAT-Type,
    scaled-value            INT-U16,
    level                   INT-U16
}

SaVisualGrid32 ::= SEQUENCE OF SaGridEntry32

SaGridEntry32 ::= SEQUENCE {
    absolute-value          FLOAT-Type,
    scaled-value            INT-U32,
    level                   INT-U16
}
```

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```
--
-- Sa-Calibration-Data attribute defines calibration markers on a display or on a recording strip; if the
-- Sa-Specification attribute indicates signed samples, the scaled values have to be interpreted as signed values
--
SaCalData8 ::= SEQUENCE {
    lower-absolute-value        FLOAT-Type,
    upper-absolute-value        FLOAT-Type,
    lower-scaled-value          INT-U8,
    upper-scaled-value          INT-U8,
    increment                   INT-U16,        -- scaled value for each step of the stair
    cal-type                    SaCalDataType
}

SaCalData16 ::= SEQUENCE {
    lower-absolute-value        FLOAT-Type,
    upper-absolute-value        FLOAT-Type,
    lower-scaled-value          INT-U16,
    upper-scaled-value          INT-U16,
    increment                   INT-U16,        -- scaled value for each step of the stair
    cal-type                    SaCalDataType
}

SaCalData32 ::= SEQUENCE {
    lower-absolute-value        FLOAT-Type,
    upper-absolute-value        FLOAT-Type,
    lower-scaled-value          INT-U32,
    upper-scaled-value          INT-U32,
    increment                   INT-U32,        -- scaled value for each step of the stair
    cal-type                    SaCalDataType
}

SaCalDataType ::= INT-U16 {
    bar(0),                                     -- display a calibration bar
    stair(1)                                    -- display a calibration stair
}

--
-- Sa-Signal-Frequency attribute specifies the signal frequency
--
SaSignalFrequency ::= {
    low-edge-freq               FLOAT-Type,
    high-edge-freq              FLOAT-Type      -- both in hertz
}

--
-- Sa-Physiological-Range attribute data types
-- If the Sa-Specification attribute indicates signed samples, the scaled values have to be interpreted as signed values

ScaledRange8 ::= SEQUENCE {
    lower-scaled-value          INT-U8,
    upper-scaled-value          INT-U8
}

 ScaledRange16 ::= SEQUENCE {
    lower-scaled-value          INT-U16,
    upper-scaled-value          INT-U16
}

ScaledRange32 ::= SEQUENCE {
    lower-scaled-value          INT-U32,
    upper-scaled-value          INT-U32
}
```


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```
--
-- Sa-Marker-List attribute allows the definition of special sample values to mark or annotate certain
-- conditions directly in the sample value; the special sample value may be a full value or a bit mask,
-- depending on the marker ID; in any case, the sample value may use bits outside the normal range
-- (as defined by the SampleType:: significant-bits) only if the SaFlags::sa-ext-val-range flag is set
--
MarkerListSaVal8 ::= SEQUENCE OF MarkerEntrySaVal8

MarkerEntrySaVal8 ::= SEQUENCE {
    marker-id           OID-Type,       -- from VMO::Type or Metric-Id-Partition partition
    marker-val          INT-U8,         -- a value or bit mask depending on marker-id
    unused              INT-U8          -- for alignment
}

MarkerListSaVal16 ::= SEQUENCE OF MarkerEntrySaVal16

MarkerEntrySaVal16 ::= SEQUENCE {
    marker-id           OID-Type,       -- from VMO::Type or Metric-Id-Partition partition
    marker-val          INT-U16         -- a value or bit mask depending on marker-id
}

MarkerListSaVal32 ::= SEQUENCE OF MarkerEntrySaVal32

MarkerEntrySaVal32 ::= SEQUENCE {
    marker-id           OID-Type,       -- from VMO::Type or Metric-Id-Partition partition
    marker-val          INT-U32         -- a value or bit mask depending on marker-id
}
```

7.3.6.2 Behavior

The Sample Array object does not define any special methods.

7.3.6.3 Notifications

The Sample Array object does not generate any special notifications.

7.3.7 Real Time Sample Array object

Object: Real Time Sample Array
Description: "The Real Time Sample Array object is a sample array that represents a real-time continuous waveform."
Derived From: Sample Array
Name Binding: Handle (VMO inherited)
Registered As: MDC_MOC_VMO_METRIC_SA_RT

7.3.7.1 Attributes

The Real Time Sample Array object class defines the attributes in Table 7.15.

Table 7.15—Real Time Sample Array object class attributes

Attribute name	Attribute ID	Attribute type	Remark	Qualifier
Sample-Period	MDC_ATTR_TIME_ PD_SAMP	RelativeTime	Example: in (parts of) milliseconds.	M
Sweep-Speed	MDC_ATTR_SPD_ SWEEP_DEFAULT	MetricMeasure	Example: millimeters per second.	O

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Table 7.15—Real Time Sample Array object class attributes *(continued)*

Attribute name	Attribute ID	Attribute type	Remark	Qualifier
Average-Reporting-Delay	MDC_ATTR_ REPORTING_DELAY _AVG	RelativeTime	Indicates the average time between when the first element in an array update was sampled and when the FastPeriCfg-Scanner event report was generated (i.e., the event report timestamp).	O
Sample-Time-Sync	MDC_ATTR_SAMPLE _TIME_SYNC	RelativeTime	Indicates the precise sample time of the first element in an array update. Optional if the Average-Reporting-Delay attribute is present; out of the scope of this standard otherwise.	C
HiRes-Sample-Time-Sync	MDC_ATTR_SAMPLE _TIME_SYNC_HIRES	HighRes-RelativeTime	Indicates the precise sample time of the first element in an array update. Optional if the Average-Reporting-Delay attribute is present; out of the scope of this standard otherwise.	C

NOTE—Together with the Average-Reporting-Delay attribute, the Sample-Time-Sync or HiRes-Sample-Time-Sync attribute can be used to accurately specify specific sample times. The Sample-Time-Sync and HiRes-Sample-Time-Sync attributes should be reported by an episodic scanner

— When reporting is first started and
— Periodically after that start at a frequency that ensures that time drift/clock skew will not compromise precise time correlation with a single waveform sample.

See also 6.7.5 for the definition of the FastPeriCfgScanner object class.

The Real Time Sample Array object class defines in Table 7.16 the attribute groups or extensions to inherited attribute groups.

Table 7.16—Real Time Sample Array object class attribute groups

Attribute group	Attribute group ID	Group elements
VMO Static Context Group (extensible attribute group)	MDC_ATTR_GRP_VMO_ STATIC	from VMO: Type, Handle from Metric: Metric-Specification, Max-Delay-Time from Sample Array: Sa-Specification, Compression, Sa-Marker-List from Real Time Sample Array: Sample-Period, Sweep-Speed, Average-Reporting-Delay

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Table 7.16—Real Time Sample Array object class attribute groups *(continued)*

Attribute group	Attribute group ID	Group elements
VMO Dynamic Context Group (extensible attribute group)	MDC_ATTR_GRP_VMO_DYN	from VMO: Label-String from Metric: Vmo-Source-List, Metric-Source-List, Unit-Code, Unit-LabelString, Msmt-Site-List, Body-Site-List, Metric-Status, Measure-Period, Averaging-Period, Start-Time, Stop-Time, Measure-Mode, Metric-Calibration, Color, Measurement-Status, Metric-Id, Metric-Id-Ext, Metric-Info-LabelString, Substance, Substance-LabelString from Sample Array: Scale-and-Range-Specification, Sa-Physiological-Range, Visual-Grid, Sa-Calibration-Data, Filter-Specification, Filter-Label-String, Sa-Signal-Frequency, Sa-Measure-Resolution From Real Time Sample Array: Sample-Time-Sync, HiRes-Sample-Time-Sync
Metric Observed Value Group (extensible attribute group)	MDC_ATTR_GRP_METRIC_VAL_OBS	from Metric: Metric-Id-Partition from Sample Array: Sa-Observed-Value, Compound-Sa-Observed-Value

No additional type definitions apply.

7.3.7.2 Behavior

The Real Time Sample Array object does not define any special methods.

7.3.7.3 Notifications

The Real Time Sample Array object does not generate any special notifications.

7.3.8 Time Sample Array object

Object: Time Sample Array
Description: "The Time Sample Array object is a sample array that represents noncontinuous waveforms (i.e., a wave snippet)."
Derived From: Sample Array
Name Binding: Handle (VMO inherited)
Registered As: MDC_MOC_VMO_METRIC_SA_T

7.3.8.1 Attributes

The Time Sample Array object class defines the attributes in Table 7.17.

The Time Sample Array object class defines in Table 7.18 the attribute groups or extensions to inherited attribute groups.

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Table 7.17—Time Sample Array object class attributes

Attribute name	Attribute ID	Attribute type	Remark	Qualifier
Absolute-Time-Stamp	MDC_ATTR_TIME_STAMP_ABS	AbsoluteTime	Time of observation (timestamp).	O
Relative-Time-Stamp	MDC_ATTR_TIME_STAMP_REL	RelativeTime		O
HiRes-Time-Stamp	MDC_ATTR_TIME_STAMP_REL_HI_RES	HighRes-RelativeTime	High-resolution timestamp.	O
Sample-Period	MDC_ATTR_TIME_PD_SAMP	RelativeTime	Example: in (parts of) milliseconds.	M
Sweep-Speed	MDC_ATTR_SPD_SWEEP_DEFAULT	MetricMeasure	Example: millimeters per second.	O
Tsa-Marker-List	MDC_ATTR_TSA_MARKER_LIST	MarkerListRelTim	Marks positions in wave snippets.	O

Table 7.18—Time Sample Array object class attribute groups

Attribute group	Attribute group ID	Group elements
VMO Static Context Group (extensible attribute group)	MDC_ATTR_GRP_VMO_STATIC	from VMO: Type, Handle from Metric: Metric-Specification, Max-Delay-Time from Sample Array: Sa-Specification, Compression, Sa-Marker-List from Time Sample Array: Sample-Period, Sweep-Speed
VMO Dynamic Context Group (extensible attribute group)	MDC_ATTR_GRP_VMO_DYN	from VMO: Label-String from Metric: Vmo-Source-List, Metric-Source-List, Unit-Code, Unit-LabelString, Msmt-Site-List, Body-Site-List, Metric-Status, Measure-Period, Averaging-Period, Start-Time, Stop-Time, Measure-Mode, Metric-Calibration, Color, Measurement-Status, Metric-Id, Metric-Id-Ext, Metric-Info-LabelString, Substance, Substance-LabelString from Sample Array: Scale-and-Range-Specification, Sa-Physiological-Range, Visual-Grid, Sa-Calibration-Data, Filter-Specification, Filter-Label-String, Sa-Signal-Frequency, Sa-Measure-Resolution
Metric Observed Value Group (extensible attribute group)	MDC_ATTR_GRP_METRIC_VAL_OBS	from Metric: Metric-Id-Partition from Sample Array: Sa-Observed-Value, Compound-Sa-Observed-Value from Time Sample Array: Absolute-Time-Stamp, Relative-Time-Stamp, HiRes-Time-Stamp, Tsa-Marker-List

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The following type definitions apply:

```
--
-- Tsa-Marker-List attribute can be used to mark certain time points in the wave snippet; the first sample
-- is at relative time 0
--
MarkerListRelTim ::= SEQUENCE OF MarkerEntryRelTim

MarkerEntryRelTim ::= SEQUENCE {
    marker-id                   OID-Type,       -- from VMO::Type or Metric-Id-Partition partition
    marker-time                 RelativeTime
}
```

7.3.8.2 Behavior

The Time Sample Array object does not define any special methods.

7.3.8.3 Notifications

The Time Sample Array object does not generate any special notifications.

7.3.9 Distribution Sample Array object

Object: Distribution Sample Array
Description: "The Distribution Sample Array object is a sample array that represents linear value distributions in the form of arrays containing scaled sample values. The index of a value within an observation array denotes a spatial value, not a time point. Thus, the observed value array can be considered an *x-y* coordinate system where the *y* axis is specified by the attributes inherited from the Metric object and the *x* axis is specified by attributes defined in the Distribution Sample Array object."
Derived From: Sample Array
Name Binding: Handle (VMO inherited)
Registered As: MDC_MOC_VMO_METRIC_SA_D

7.3.9.1 Attributes

The Distribution Sample Array object class defines the attributes in Table 7.19.

Table 7.19—Distribution Sample Array object class attributes

Attribute name	Attribute ID	Attribute type	Remark	Qualifier
Absolute-Time-Stamp	MDC_ATTR_TIME_STAMP_ABS	AbsoluteTime	Time of observation (timestamp).	O
Relative-Time-Stamp	MDC_ATTR_TIME_STAMP_REL	RelativeTime		O
HiRes-Time-Stamp	MDC_ATTR_TIME_STAMP_REL_HI_RES	HighRes-RelativeTime	High-resolution timestamp.	O
Distribution-Range-Specification	MDC_ATTR_RANGE_DISTRIB	DsaRangeSpec	Maps array index to absolute value.	M
x-Unit-Code	MDC_ATTR_UNIT_CODE_X	OID-Type	Applies to *x* axis.	O

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Table 7.19—Distribution Sample Array object class attributes *(continued)*

Attribute name	Attribute ID	Attribute type	Remark	Qualifier
x-Unit-Label-String	MDC_ATTR_UNIT_LABEL_STRING_X	OCTET STRING	Applies to *x* axis.	O
Dsa-Marker-List	MDC_ATTR_DSA_MARKER_LIST	MarkerListIndex	User to mark positions in Distribution Sample Array object samples	O

The Distribution Sample Array object class defines in Table 7.20 the attribute groups or extensions to inherited attribute groups.

Table 7.20—Distribution Sample Array object class attribute groups

Attribute group	Attribute group ID	Group elements
VMO Static Context Group (extensible attribute group)	MDC_ATTR_GRP_VMO_STATIC	from VMO: Type, Handle from Metric: Metric-Specification, Max-Delay-Time from Sample Array: Sa-Specification, Compression, Sa-Marker-List
VMO Dynamic Context Group (extensible attribute group)	MDC_ATTR_GRP_VMO_DYN	from VMO: Label-String from Metric: Vmo-Source-List, Metric-Source-List, Unit-Code, Unit-LabelString, Msmt-Site-List, Body-Site-List, Metric-Status, Measure-Period, Averaging-Period, Start-Time, Stop-Time, Measure-Mode, Metric-Calibration, Color, Measurement-Status, Metric-Id, Metric-Id-Ext, Metric-Info-LabelString, Substance, Substance-LabelString from Sample Array: Scale-and-Range-Specification, Sa-Physiological-Range, Visual-Grid, Sa-Calibration-Data, Filter-Specification, Filter-Label-String, Sa-Signal-Frequency, Sa-Measure-Resolution from Distribution Sample Array: Distribution-Range-Specification, x-Unit-Code, x-Unit-Label-String
Metric Observed Value Group (extensible attribute group)	MDC_ATTR_GRP_METRIC_VAL_OBS	from Metric: Metric-Id-Partition from Sample Array: Sa-Observed-Value, Compound-Sa-Observed-Value from Distribution Sample Array: Absolute-Time-Stamp, Relative-Time-Stamp, HiRes-Time-Stamp, Dsa-Marker-List

The following type definitions apply:

```
--
-- Distribution-Range-Specification attribute defines the absolute value for the first and last array
```


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```
-- element; a linear scale is assumed here unless a specific compression scheme is defined
-- (last-value - first-value)/no.of.array elements == step width
--
DsaRangeSpec ::= SEQUENCE {
    first-element-value         FLOAT-Type,
    last-element-value          FLOAT-Type
}

--
-- DSA-Marker-List attribute allows the annotation of samples by referencing the sample with an index
--
MarkerListIndex ::= SEQUENCE OF MarkerEntryIndex

MarkerEntryIndex ::= SEQUENCE {
    marker-id                   OID-Type,       -- from VMO::Type or Metric-Id-Partition partition
    marker-index                INT-U16
}
```

7.3.9.2 Behavior

The Distribution Sample Array object does not define any special methods.

7.3.9.3 Notifications

The Distribution Sample Array object does not generate any special notifications.

7.3.10 Enumeration object

Object: Enumeration
Description: "The Enumeration object represents status information and/or annotation information. Observation values may be presented in the form of normative codes (that are included in the nomenclature defined in this standard or in some other external nomenclature) or in the form of free text."
Derived From: Metric
Name Binding: Handle (VMO inherited)
Registered As: MDC_MOC_VMO_METRIC_ENUM

7.3.10.1 Attributes

The Enumeration object class defines the attributes in Table 7.21.

Table 7.21—Enumeration object class attributes

Attribute name	Attribute ID	Attribute type	Remark	Qualifier
Enum-Observed-Value	MDC_ATTR_VAL_ENUM_OBS	EnumObsValue	Either Enum-Observed-Value or Compound-Enum-Observed-Value shall be supported in one object instance.	C
Compound-Enum-Observed-Value	MDC_ATTR_VAL_ENUM_OBS_CMPD	EnumObsValueCmp	Either Enum-Observed-Value or Compound-Enum-Observed-Value shall be supported in one object instance.	C
Absolute-Time-Stamp	MDC_ATTR_TIME_STAMP_ABS	AbsoluteTime		O

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Table 7.21—Enumeration object class attributes *(continued)*

Attribute name	Attribute ID	Attribute type	Remark	Qualifier
Relative-Time-Stamp	MDC_ATTR_TIME_STAMP_REL	RelativeTime		O
HiRes-Time-Stamp	MDC_ATTR_TIME_STAMP_REL_HI_RES	HighRes-RelativeTime	High-resolution timestamp.	O
Enum-Measure-Range	MDC_ATTR_ENUM_RANGE_MSMT	EnumMsmtRange	List of supported observed value OIDs. Optional if the OID type (EnumVal::enum-obj-id) is used in the observed value; out of the scope of this standard otherwise.	C
Enum-Measure-Range-Bit-String	MDC_ATTR_ENUM_RANGE_MSMT_BIT_STRING	BITS-32	List of supported observed value bits in the bit string data type. Optional if the bit string type (EnumVal::enum-bit-str) is used in the observed value; out of the scope of this standard otherwise.	C
Enum-Measure-Range-Labels	MDC_ATTR_ENUM_RANGE_MSMT_LABELS	EnumMsmtRange Labels	Associates text strings with specific enumeration values.	O

The Enumeration object class defines in Table 7.22 the attribute groups or extensions to inherited attribute groups.

Table 7.22—Enumeration object class attribute groups

Attribute group	Attribute group ID	Group elements
VMO Static Context Group (extensible attribute group)	MDC_ATTR_GRP_VMO_STATIC	from VMO: Type, Handle from Metric: Metric-Specification, Max-Delay-Time, Enum-Measure-Range-Labels
VMO Dynamic Context Group (extensible attribute group)	MDC_ATTR_GRP_VMO_DYN	from VMO: Label-String from Metric: Vmo-Source-List, Metric-Source-List, Unit-Code, Unit-LabelString, Msmt-Site-List, Body-Site-List, Metric-Status, Measure-Period, Averaging-Period, Start-Time, Stop-Time, Measure-Mode, Metric-Calibration, Color, Measurement-Status, Metric-Id, Metric-Id-Ext, Metric-Info-LabelString, Substance, Substance-LabelString from Enumeration: Enum-Measure-Range, Enum-Measure-Range-Bits

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Table 7.22—Enumeration object class attribute groups *(continued)*

Attribute group	Attribute group ID	Group elements
Metric Observed Value Group (extensible attribute group)	MDC_ATTR_GRP_ METRIC_VAL_OBS	from Metric: Metric-Id-Partition from Enumeration: Enum-Observed-Value, Compound-Enum-Observed-Value, Absolute-Time-Stamp, Relative-Time-Stamp, HiRes-Time-Stamp

The following type definitions apply:

```
--
-- Enum-Observed-Value attribute
--
EnumObsValue ::= SEQUENCE {
     metric-id                 OID-Type,          -- from VMO::Type or Metric-Id-Partition partition
     state                     MeasurementStatus,
     value                     EnumVal            -- supports different value data types
}

-- The enumeration value data type is used to provide different specific observation data types as follows
-- (Note that the type of measurement is coded in the top level structure EnumObsVal::metric-id)
--
--      enum-obj-id:                              used to communicate a metric OID, e.g., as an annotation or
--                                                other event defined in the VMO::Type or Metric-Id-Partition
--                                                partition
--      enum-text-string:                         used to communicate a free text string (e.g., a status message)
--      enum-external-code:                       used to provide the code of an external nomenclature (e.g.,
--                                                could be used for procedure codes not covered in the
--                                                standard nomenclature)
--      enum-bit-str:                             for coding bit string values; the bit string data type must be
--                                                defined separately, e.g., in the nomenclature or in a
--                                                device-specific standard
--      enum-record-metric/oo:                    allows the identification of additional data types by a
--                                                nomenclature code from the VMO::Type or
--                                                Metric-Id-Partition partition; the appended data type must be
--                                                defined separately, e.g., in a device-specific standard
--      enum-numeral:                             used to provide numeral enumerated values that must be
--                                                defined separately, e.g., in a device-specific standard;
--                                                this type is not to be used for numeric measurements
--
EnumVal ::= CHOICE {
     enum-obj-id               [1] OID-Type,      -- from VMO::Type or Metric-Id-Partition partition
     enum-text-string          [2] OCTET STRING,
                                                  -- free text
     enum-external-code        [8] ExtNomenRef,
                                                  -- code defined in other coding system
     enum-bit-str              [16] BITS-32,      -- bit string
     enum-record-metric        [33] EnumRecordMetric,
                                                  -- record type defined by ID from VMO::Type or
                                                  -- Metric-Id-Partition partition
     enum-record-oo            [34] EnumRecordOo,
                                                  -- record type defined by ID from object-oriented
                                                  -- nomenclature partition
     enum-numeral              [64] INT-U32       -- enumerated integer value
}

--
-- Record data type with structure and contents defined by a nomenclature ID from the VMO::Type or
-- Metric-Id-Partition partition
```

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```
--
EnumRecordMetric ::= SEQUENCE {
    record-type-code        OID-Type,       -- from VMO::Type or Metric-Id-Partition partition
    record-data             ANY DEFINED BY record-type-code
}

--
-- Record data type with structure and contents defined by a nomenclature ID from the object-oriented
-- nomenclature partition
--
EnumRecordOo ::= SEQUENCE {
    record-type-code        OID-Type,       -- must be from object-oriented nomenclature partition
    record-data             ANY DEFINED BY record-type-code
}

--
-- Compound-Enum-Observed-Value attribute is the compound observed value
--
EnumObsValueCmp ::= SEQUENCE OF EnumObsValue

--
-- Enum-Measure-Range attribute defines the set of potential (i.e., legal) values of the Enum-Observed-Value
-- attribute (only allowed when EnumVal::enum-obj-id type is used)
--
EnumMsmtRange ::= SEQUENCE OF
                            OID-Type        -- from VMO::Type or Metric-Id-Partition partition

--
-- Enum-Measure-Range-Labels attribute defines both the set of potential (i.e., legal) values of the
-- Enum-Observed-Value attribute as well as a text label that can be associated with each enumeration value
--
EnumMsmtRangeLabels::= SEQUENCE OF EnumMsmtRangeLabel

EnumMsmtRangeLabel ::= SEQUENCE {
    value                   EnumVal,        -- specific enumeration setting
    label                   OCTET STRING    -- textual label associated with value
}
```

7.3.10.2 Behavior

The Enumeration object does not define any special methods.

7.3.10.3 Notifications

The Enumeration object does not generate any special notifications.

7.3.11 Complex Metric object

Object:	Complex Metric
Description:	"The Complex Metric object acts as a container object for other Metric objects, enabling reporting of the collection as a single semantic entity."
Derived From:	Metric
Name Binding:	Handle (VMO inherited)
Registered As:	MDC_MOC_VMO_METRIC_CMPLX

7.3.11.1 Attributes

The Complex Metric object class defines the attributes in Table 7.23.

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Table 7.23—Complex Metric object class attributes

Attribute name	Attribute ID	Attribute type	Remark	Qualifier
Cmplx-Metric-Info	MDC_ATTR_CMPLX_INFO	CmplxMetricInfo	Static attribute defining the object types used in the container.	M
Cmplx-Observed-Value	MDC_ATTR_CMPLX_VAL_OBS	CmplxObsValue		M
Cmplx-Dyn-Attr	MDC_ATTR_CMPLX_DYN_ATTR	CmplxDynAttr	Dynamic attributes of the individual objects within the Complex Metric object.	O
Cmplx-Static-Attr	MDC_ATTR_CMPLX_STATIC_ATTR	CmplxStaticAttr	Static attributes of the individual objects within the Complex Metric object.	O
Cmplx-Recursion-Depth	MDC_ATTR_CMPLX_RECURSION_DEPTH	INT-U16	Mandatory if the Complex Metric object contains further Complex Metric objects (e.g., recursion). If so, the attribute defines the maximum recursion depth.	C

The Complex Metric object class shall set the Metric::MetricSpec::structure::ms-struct::complex flag.

The Complex Metric object class defines in Table 7.24 the attribute groups or extensions to inherited attribute groups.

Table 7.24—Complex Metric object class attribute groups

Attribute group	Attribute group ID	Group elements
VMO Static Context Group (extensible attribute group)	MDC_ATTR_GRP_VMO_STATIC	from VMO: Type, Handle from Metric: Metric-Specification, Max-Delay-Time from Complex Metric: Cmplx-Metric-Info, Cmplx-Static-Attr, Cmplx-Recursion-Depth
VMO Dynamic Context Group (extensible attribute group)	MDC_ATTR_GRP_VMO_DYN	from VMO: Label-String from Metric: Vmo-Source-List, Metric-Source-List, Unit-Code, Unit-LabelString, Msmt-Site-List, Body-Site-List, Metric-Status, Measure-Period, Averaging-Period, Start-Time, Stop-Time, Measure-Mode, Metric-Calibration, Color, Measurement-Status, Metric-Id, Metric-Id-Ext, Metric-Info-LabelString, Substance, Substance-LabelString from Complex Metric: Cmplx-Dyn-Attr

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Table 7.24—Complex Metric object class attribute groups *(continued)*

Attribute group	Attribute group ID	Group elements
Metric Observed Value Group (extensible attribute group)	MDC_ATTR_GRP_ METRIC_VAL_OBS	from Metric: Metric-Id-Partition from Complex Metric: Cmplx-Observed-Value

The following type definitions apply:

```
--
-- Definitions for Cmplx-Metric-Info attribute
--

CmplxMetricInfo ::= SEQUENCE {
    max-mplex-obs           INT-U8,         -- maximum number of messages until all
                                            -- multiplexed elements are transmitted
                                            -- in the Metric Observed Value Group
    max-mplex-dyn           INT-U8,         -- maximum number of messages until all
                                            -- multiplexed elements are transmitted
                                            -- in the VMO Dynamic Context Group
    cm-elem-info-list       CmplxElemInfoList
}

CmplxElemInfoList ::= SEQUENCE OF CmplxElemInfo

CmplxElemInfo ::= SEQUENCE {
    class-id                OID-Type,
    max-inst                INT-U8,         -- number of objects from type class-id
    max-inst-comp           INT-U8,         -- number of compound objects from type class-id
    max-comp-no             INT-U8,         -- maximum number of elements within a compound object
    max-inst-mplex          INT-U8,         -- number of multiplexed objects within
                                            -- max-inst + max-inst-comp
    max-str-size            INT-U16         -- maximum string size
}

--
-- Cmplx-Observed-Value attribute, representing the hierarchy of contained Metric objects
--
CmplxObsValue ::= SEQUENCE {
    cm-obs-cnt              INT-U8,         -- sequence counter begins with 0 when a
                                            -- multiplex period begins
    cm-obs-flags            CmplxFlags,
    cm-obs-elem-list        CmplxObsElemList
}

CmplxFlags ::= BITS-U8 {
    cmplx-flag-reserved(0)                  -- for future extensions
}

CmplxObsElemList ::= SEQUENCE OF CmplxObsElem

CmplxObsElem ::= SEQUENCE {
    cm-elem-idx             INT-U8,
    cm-obs-elem-flgs        CmplxObsElemFlags,
    attributes              AttributeList
}

CmplxObsElemFlags ::= BITS-8 {
    cm-obs-elem-flg-mplex (0),              -- the element will be multiplexed
    cm-obs-elem-flg-is-setting (2),
```


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```
        cm-obs-elem-flg-updt-episodic (4),
        cm-obs-elem-flg-msmt-noncontinuous (5)
    }

    --
    -- Cmplx-Dyn-Attr with the dynamic context data of the hierarchy of contained Metric objects
    --
    CmplxDynAttr ::= SEQUENCE {
        cm-dyn-cnt              INT-U8,         -- sequence counter begins with 0 when a
                                                -- multiplex period begins
        unused                  INT-U8,
        cm-dyn-elem-list        CmplxDynAttrElemList
    }

    CmplxDynAttrElemList ::= SEQUENCE OF CmplxDynAttrElem

    CmplxDynAttrElem ::= SEQUENCE {
        cm-elem-idx-1           INT-U8,         -- allows the definition, with cm-elem-idx-2, of a range
                                                -- of elements where the dynamic attributes apply
        cm-elem-idx-2           INT-U8,
        attributes              AttributeList
    }

    --
    -- Cmplx-Static-Attr with the static context data of the hierarchy of contained Metric objects
    --
    CmplxStaticAttr ::= SEQUENCE {
        cm-static-elem-list     CmplxStaticAttrElemList
    }

    CmplxStaticAttrElemList ::= SEQUENCE OF CmplxStaticAttrElem

    CmplxStaticAttrElem ::= SEQUENCE {
        cm-elem-idx-1           INT-U8,         -- allows the defintion, with cm-elem-idx-2, of a range
                                                -- of elements where the static attributes apply
        cm-elem-idx-2           INT-U8,
        attributes              AttributeList   -- only static attributes as defined for metric specialization are
                                                -- allowed here (i.e., no VMO or Metric object attributes)
    }
```

7.3.11.2 Behavior

The Complex Metric object does not define any special methods.

7.3.11.3 Notifications

The Complex Metric object does not generate any special notifications.

7.3.12 PM-Store object

Object:	PM-Store
Description:	"The PM-Store object provides long-term storage capabilities for metric data. It contains a variable number of PM-Segment objects that can be accessed only through the PM-Store object."
Derived From:	VMO
Name Binding:	Handle
Registered As:	MDC_MOC_VMO_PMSTORE

7.3.12.1 Attributes

The PM-Store object class defines the attributes in Table 7.25.

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Table 7.25—PM-Store object class attributes

Attribute name	Attribute ID	Attribute type	Remark	Qualifier
Metric-Class	MDC_ATTR_METRIC_CLASS	OID-Type	Object class of stored metric(s).	M
Store-Sample-Algorithm	MDC_ATTR_METRIC_STORE_SAMPLE_ALG	StoSampleAlg	Method used to derive stored values from metric observed values.	O
Storage-Format	MDC_ATTR_METRIC_STORE_FORMAT	StorageFormat	Layout of stored data in PM-Segment objects.	M
Store-Capacity-Count	MDC_ATTR_METRIC_STORE_CAPAC_CNT	INT-U32	Maximum number of stored values.	O
Store-Usage-Count	MDC_ATTR_METRIC_STORE_USAGE_CNT	INT-U32	Actual number of stored values.	O
Operational-State	MDC_ATTR_OP_STAT	OperationalState	Indicates whether new samples are currently stored.	O
Sample-Period	MDC_ATTR_TIME_PD_SAMP	RelativeTime	Used if values are sampled periodically.	C
Number-Of-Segments	MDC_ATTR_NUM_SEG	INT-U16	Currently instantiated PM-Segment objects contained in the PM-Store object.	M

The PM-Store object class defines in Table 7.26 the attribute groups or extensions to inherited attribute groups.

Table 7.26—PM-Store object class attribute groups

Attribute group	Attribute group ID	Group elements
VMO Static Context Group (extensible attribute group)	MDC_ATTR_GRP_VMO_STATIC	from VMO: Type, Handle from PM-Store:
VMO Dynamic Context Group (extensible attribute group)	MDC_ATTR_GRP_VMO_DYN	from VMO: Label-String from PM-Store:
PM-Store Attribute Group	MDC_ATTR_GRP_PMSTORE	from PM-Store: Metric-Class, Store-Sample-Algorithm, Storage-Format, Store-Capacity-Count, Store-Usage-Count, Operational-State, Sample-Period, Number-Of-Segments

The following type definitions apply:

```
--
-- The storage type defines the structure of the Segment-Data attribute in all contained PM-Segment objects
--      1..255:                 range for normative formats
--      32768..65535:           range for private formats
```


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```
--      other:                  reserved
--
StorageFormat ::= INT-U16 {
     sto-t-nos(0),
     sto-t-gen(1),                          -- implies general format (i.e., PM-Segment object;
                                            -- see 7.3.13)
     sto-t-nu-opt(2),                       -- implies optimized Numeric object format
     sto-t-rtsa-opt(3)                      -- implies optimized Real Time Sample Array object format
}

--
-- Store-Sample-Algorithm attribute describes how samples are derived
--
StoSampleAlg ::= INT-U16 {
     st-alg-nos(0),
     st-alg-moving-average(1),
     st-alg-recursive(2),
     st-alg-min-pick(3),
     st-alg-max-pick(4),
     st-alg-median(5)
}
```

7.3.12.2 Behavior

The PM-Store object defines the methods in Table 7.27.

Table 7.27—PM-Store object methods

Action	Mode	Action ID	Action parameter	Action result
Clear-Segments	Confirmed	MDC_ACT_SEG_ CLEAR	SegmSelection	(empty)
Get-Segments	Confirmed	MDC_ACT_SEG_GET	SegmSelection	SegmentAttrList
Get-Segment-Info	Confirmed	MDC_ACT_SEG_GET_ INFO	SegmSelection	Segment-InfoList

The following additional type definitions are needed:

```
--
-- SegmSelection selects the PM-Segment objects that are subject to the method
--
SegmSelection ::= CHOICE {
     all-segments           [1] INT-U16,    -- if this type is chosen to select all segments, the actual
                                            -- contents of the field are "do not care" and should be 0
     segm-id-list           [2] SegmIdList,
     abs-time-range         [3] AbsTimeRange
}

--
-- SegmIdList selects PM-Segment objects by ID
--
SegmIdList ::= SEQUENCE OF InstNumber

--
-- The time range allows selection of PM-Segment objects by time period
--
AbsTimeRange ::= SEQUENCE {
     from-time              AbsoluteTime,
```

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```
    to-time                 AbsoluteTime
    }

--
-- Get-Segments method returns a list of PM-Segment attribute lists that include the Segment-Data
-- attribute; the instance number is used to identify each segment
--
SegmentAttrList ::= SEQUENCE OF SegmentAttr

SegmentAttr ::= SEQUENCE {
    seg-inst-no             InstNumber,
    seg-attr                AttributeList
}

--
-- Segment contents information as a result to the Get-Segment-Info returns all attributes of the PM-Segment
-- objects except the Segment-Data attribute; this is useful to get just information about the contents
--
SegmentInfoList ::= SEQUENCE OF SegmentInfo

SegmentInfo ::= SEQUENCE {
    seg-inst-no             InstNumber,
    seg-info                AttributeList
}
```

7.3.12.3 Notifications

The PM-Store object does not generate any special notifications.

7.3.13 PM-Segment object

Object:	PM-Segment
Description:	"The PM-Segment object represents a continuous time period in which a metric is stored without any changes of relevant metric context attributes (e.g., scales, labels). The PM-Segment object is contained in a PM-Store object and is not directly accessible by management services."
Derived From:	Top
Name Binding:	Instance Number (object not directly manageable; instance number unique within a single PM-Store instance)
Registered As:	MDC_MOC_PM_SEGMENT

7.3.13.1 Attributes

The PM-Segment object class defines the attributes in Table 7.28.

Table 7.28—PM-Segment object class attributes

Attribute name	Attribute ID	Attribute type	Remark	Qualifier
Instance-Number	MDC_ATTR_ID_ INSTNO	InstNumber		M
Metric-Id	MDC_ATTR_ID_ PHYSIO	OID-Type	ID of stored metric (from VMO::Type or Metric-Id-Partition partition).	M

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Table 7.28—PM-Segment object class attributes *(continued)*

Attribute name	Attribute ID	Attribute type	Remark	Qualifier
Metric-Id-Ext	MDC_ATTR_ID_ MSMT_EXT	ExtNomenRef	Dynamic identification of the metric in a different nomenclature or dictionary. Use of this attribute severely limits interoperability of applications.	O
Vmo-Global-Reference	MDC_ATTR_VMO_ REF_GLB	GLB-HANDLE	Reference to stored Metric object.	O
Segment-Start-Abs-Time	MDC_ATTR_TIME_ START_SEG	AbsoluteTime	Start time of segment.	O
Segment-End-Abs-Time	MDC_ATTR_TIME_ END_SEG	AbsoluteTime	End time of segment.	O
Segment-Usage-Count	MDC_ATTR_SEG_ USAGE_CNT	INT-U32	Actual (i.e., current) number of stored values.	O
Segment-Data	MDC_ATTR_SEG_ DATA_GEN MDC_ATTR_SEG_ DATA_NU_OPT MDC_ATTR_SEG_ DATA_RTSA_OPT	SegDataGen SegDataNuOpt SegDataRtsaOpt	Segment data stored in a format as specified in the PM-Store object.	M
Context Attributes	As defined for Metric-derived objects	Any attribute from Metric-derived objects that is member of either the VMO Static Context Group or the VMO Dynamic Context Group	Metric context attributes are allowed in this object without container. Attributes are identified by their OID. This reference to attributes is an editorial convenience. There is no need to copy all attributes from the various objects to the PM-Segment object. Copying attributes is not a hidden form of inheritance.	

The PM-Segment object class defines no attribute groups.

The following type definitions apply:

```
--
-- General segment data format; each stored value is one attribute list
-- NOTE--This format may be very storage-intensive
--
SegDataGen ::= SEQUENCE OF AttributeList

--
-- Optimized Numeric object format for periodically acquired numerics; only the actual value is stored
--
SegDataNuOpt ::= SEQUENCE OF FLOAT-Type

--
-- Optimized Real Time Sample Array object format; a consecutive array of samples
--
SegDataRtsaOpt ::= OCTET STRING
```

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7.3.13.2 Behavior

The PM-Segment object does not define any special methods.

7.3.13.3 Notifications

The PM-Segment object does not generate any special notifications.

7.4 Objects in the Alert Package

The definitions of objects in the Alert Package are given in 7.4.1 through 7.4.3.

7.4.1 Alert object

Object: Alert
Description: "The Alert object stands for the status of a simple alarm condition check. As such, it represents a single alarm only. The alarm can be either a physiological alarm or a technical alarm condition of a related object (e.g., MDS, VMD, Metric)."
Derived From: VMO
Name Binding: Handle
Registered As: MDC_MOC_VMO_AL

7.4.1.1 Attributes

The Alert object class defines the attributes in Table 7.29.

Table 7.29—Alert object class attributes

Attribute name	Attribute ID	Attribute type	Remark	Qualifier
Alert-Condition	MDC_ATTR_AL_ COND	AlertCondition		M
Limit-Specification	MDC_ATTR_AL_ LIMIT	LimitSpecEntry	Relevant for limit alarms only.	O
Vmo-Reference	MDC_ATTR_VMO_ REF	HANDLE		O

NOTE—The VMO inherited type field defines if the Alert represents a technical or physiological alarm.

The Alert object class defines in Table 7.30 the attribute groups or extensions to inherited attribute groups.

Table 7.30—Alert object class attribute groups

Attribute group	Attribute group ID	Group elements
VMO Static Context Group (extensible attribute group)	MDC_ATTR_GRP_VMO_ STATIC	from VMO: Type, Handle from Alert: Vmo-Reference

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Table 7.30—Alert object class attribute groups *(continued)*

Attribute group	Attribute group ID	Group elements
VMO Dynamic Context Group (extensible attribute group)	MDC_ATTR_GRP_VMO_DYN	from VMO: Label-String from Alert: Limit-Specification
Alert Group	MDC_ATTR_GRP_AL	from Alert: Alert-Condition

The following type definitions apply:

```
--
-- Alert-Condition attribute is the status output of the process that is detecting the alert
--
AlertCondition ::= SEQUENCE {
    obj-reference           HANDLE,
    controls                AlertControls,
    alert-flags             AlertFlags,         -- supporting flags
    alert-source            OID-Type,           -- from metric or object-oriented nomenclature partition
    alert-code              OID-Type,           -- from events nomenclature partition
    alert-type              AlertType,          -- defines type and severity of condition
    alert-info-id           PrivateOid,         -- specific infomation can be appended; 0 if not used
    alert-info              ANY DEFINED BY alert-info-id
}
```

NOTE—The alert-code code comes from the events nomenclature partition. Entries (i.e., codes) in this partition are even. The last bit of the code is used to define from which nomenclature partition comes the al-source (in the Alert Monitor object; see 7.4.3.1). If the last bit is 0, the al-source comes from the metric nomenclature partition. If the last bit is 1 (1 is added to the base code in the events nomenclature), the al-source comes from the object-oriented nomenclature partition.

```
--
-- Alert controls define flags to communicate status information relevant for alarm processor; this structure is
-- reused in the Alert Status object
--
AlertControls ::= BITS-16 {
    ac-obj-off(0),                  -- the object supervised by the alert is off
    ac-chan-off(1),                 -- channel is off
    ac-all-obj-al-off(3),           -- all alerts supervising the referenced objects are off
    ac-alert-off(4),                -- this alert supervisor process is off
    ac-alert-muted(5)               -- this alert is temporarily muted by the user (e.g., on
                                    -- ventilators to allow physiotherapy or suction)
}

--
-- Alert flags give additional support information on how to process the condition; this structure is used by the
-- Alert Status object as well
--
AlertFlags ::= BITS-16 {
    local-audible(1),               -- indicates that the condition is audible at the local system
    remote-audible(2),              -- condition can be audible at remote (i.e., not suppressed)
    visual-latching(3),             -- visible latching of the condition is allowed
    audible-latching(4),            -- audio latching of the condition is allowed
    derived(6),
    record-inhibit(8)               -- do not start alarm recording
}
```

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```
--
-- Alert type is used to distinguish severity of technical and physiological alarms
--
AlertType ::= INT-U16 {
    no-alert(0),
    low-pri-t-al(1),                    -- low-priority technical alarm
    med-pri-t-al(2),                    -- medium-priority technical alarm
    hi-pri-t-al(4),                     -- high-priority technical alarm
    low-pri-p-al(256),                  -- awareness condition
    med-pri-p-al(512),                  -- prompt response required (i.e., abnormal condition)
    hi-pri-p-al(1024)                   -- immediate response required (i.e., emergency condition)
}

--
-- Limit-Specification attribute specifies the supervised limit range
--
LimitSpecEntry ::= SEQUENCE {
    object-handle       HANDLE,
    al-source-id        OID-Type,       -- typically the metric ID of the measurement
    unit-code           OID-Type,       -- from DIM partition
    lim-al-stat         CurLimAlStat,   -- see 7.6.8.1 for definition
    lim-al-val          CurLimAlVal     -- see 7.6.8.1 for definition
}
```

7.4.1.2 Behavior

The Alert object does not define any special methods.

7.4.1.3 Notifications

The Alert object does not generate any special notifications.

7.4.2 Alert Status object

Object: Alert Status
Description: "The Alert Status object represents the output of an alarm process that considers all alarm conditions in a scope that spans one or more objects. In contrast to the Alert object, the Alert Status object collects all alarm conditions related to a VMD object hierarchy or related to an MDS object and provides this information in list-structured attributes."
Derived From: VMO
Name Binding: Handle
Registered As: MDC_MOC_VMO_AL_STAT

7.4.2.1 Attributes

The Alert Status object class defines the attributes in Table 7.31.

Table 7.31—Alert Status object class attributes

Attribute name	Attribute ID	Attribute type	Remark	Qualifier
Alert-Capab-List	MDC_ATTR_AL_ STAT_AL_C_LIST	AlertCapabList	Capabilities of the Alert Status object.	M
Tech-Alert-List	MDC_ATTR_AL_ STAT_AL_T_LIST	AlertList	List of technical alert information.	O

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Table 7.31—Alert Status object class attributes *(continued)*

Attribute name	Attribute ID	Attribute type	Remark	Qualifier
Physio-Alert-List	MDC_ATTR_AL_ STAT_AL_P_LIST	AlertList	List of physiological alert information.	O
Limit-Spec-List	MDC_ATTR_AL_ LIMIT_SPEC_LIST	LimitSpecList	List of limit alarm ranges.	O

The Alert Status object class defines in Table 7.32 the attribute groups or extensions to inherited attribute groups.

Table 7.32—Alert Status object class attribute groups

Attribute group	Attribute group ID	Group elements
VMO Static Context Group (extensible attribute group)	MDC_ATTR_GRP_VMO_ STATIC	from VMO: Type, Handle from Alert Status: Alert-Capab-List
VMO Dynamic Context Group (extensible attribute group)	MDC_ATTR_GRP_VMO_ DYN	from VMO: Label-String from Alert Status: Limit-Spec-List
Alert Status Group	MDC_ATTR_GRP_AL_ STAT	from Alert Status: Tech-Alert-List, Physio-Alert-List

The following type definitions apply:

```
--
-- The alert list is used to communicate alarm conditions derived by the Alert Status object
--
AlertList ::= SEQUENCE OF AlertEntry

AlertEntry ::= SEQUENCE {
    obj-reference       HANDLE,
    instance            InstNumber,       -- to support multiple alarms of one object
    controls            AlertControls,
    alert-source        OID-Type,         -- from metric or object-oriented nomenclature partition
    alert-code          OID-Type,         -- from alerts nomenclature partition
    alert-type          AlertType,
    alert-info-id       PrivateOid,
    alert-info          ANY DEFINED BY alert-info-id
}
```

NOTE—The alert-code code comes from the events nomenclature partition. Entries (i.e., codes) in this partition are even. The last bit of the code is used to define from which nomenclature partition comes the al-source (in the Alert Monitor object; see 7.4.3.1). If the last bit is 0, the al-source comes from the metric nomenclature partition. If the last bit is 1 (1 is added to the base code in the events nomenclature), the al-source comes from the object-oriented nomenclature partition.

```
--
-- Alert Status object provides a capability list with entries for each supervised object in its scope
--
AlertCapabList ::= SEQUENCE OF AlertCapabEntry
```

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```
AlertCapabEntry ::= SEQUENCE {
    obj-reference               HANDLE,
    obj-class                   OID-Type,
    alert-group                 OID-Type,       -- allows grouping of Alert objects so that a processor can
                                                -- select to display only one from a given group (metric ID)
    al-rep-flags                BITS-16         -- defines how multiple alarms are communicated
        { dyn-inst-contents(1), rep-all-inst(2) },
    max-t-severity              AlertType,      -- most severe technical alarm
    max-t-obj-al                INT-U16,        -- maximum number of parallel technical alarms
                                                -- for this object
    max-p-severity              AlertType,      -- most severe physiological alarm
    max-p-obj-al                INT-U16         -- maximum number of parallel physiological alarms
                                                -- for this object
}

--
-- Limit-Spec-List attributed specifies the supervised limit ranges
--
LimitSpecList ::= SEQUENCE OF LimitSpecEntry
```

7.4.2.2 Behavior

The Alert Status object does not define any special methods.

7.4.2.3 Notifications

The Alert Status object does not generate any special notifications.

7.4.3 Alert Monitor object

Object: Alert Monitor
Description: "The Alert Monitor object represents the output of a device or system alarm processor. As such, it represents the overall device or system alarm condition and provides a list of all alarm conditions of the system in its scope. This list includes global state information and individual alarm state information that allows the implementation of a safety-standard-compliant alarm display on a remote system."
Derived From: VMO
Name Binding: Handle
Registered As: MDC_MOC_VMO_AL_MON

7.4.3.1 Attributes

The Alert Monitor object class defines the attributes in Table 7.33.

Table 7.33—Alert Monitor object class attributes

Attribute name	Attribute ID	Attribute type	Remark	Qualifier
Device-Alert-Condition	MDC_ATTR_DEV_AL_COND	DevAlert-Condition	Global device alert status.	M
Device-P-Alarm-List	MDC_ATTR_AL_MON_P_AL_LIST	DevAlarmList	Active physiological alarm list.	M
Device-T-Alarm-List	MDC_ATTR_AL_MON_T_AL_LIST	DevAlarmList	Active technical alarm list.	M

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Table 7.33—Alert Monitor object class attributes *(continued)*

Attribute name	Attribute ID	Attribute type	Remark	Qualifier
Device-Sup-Alarm-List	MDC_ATTR_AL_MON_S_AL_LIST	DevAlarmList	Suppressed physiological alarm list.	O
Limit-Spec-List	MDC_ATTR_AL_LIMIT_SPEC_LIST	LimitSpecList	List of limit alarm ranges.	O
Suspension-Period	MDC_ATTR_TIME_PD_AL_SUSP	RelativeTime	Remaining alarm suspend time.	O

The Alert Monitor object class defines in Table 7.34 the attribute groups or extensions to inherited attribute groups.

Table 7.34—Alert Monitor object class attribute groups

Attribute group	Attribute group ID	Group elements
VMO Static Context Group (extensible attribute group)	MDC_ATTR_GRP_VMO_STATIC	from VMO: Type, Handle from Alert Monitor:
VMO Dynamic Context Group (extensible attribute group)	MDC_ATTR_GRP_VMO_DYN	from VMO: Label-String from Alert Monitor: Limit-Spec-List
Alert Monitor Group	MDC_ATTR_GRP_AL_MON	from Alert Monitor: Device-Alert-Condition, Device-P-Alarm-List, Device-T-Alarm-List, Device-Sup-Alarm-List, Suspension-Period

The following type definitions apply:

```
--
-- Device-Alert-Condition attribute describes the global MDS alarm status
--
DevAlertCondition ::= SEQUENCE {
    device-alert-state      AlertState,
    al-stat-chg-cnt         AlStatChgCnt,    -- change counter marks state or active alerts change
    max-p-alarm             AlertType,
    max-t-alarm             AlertType,
    max-aud-alarm           AlertType        -- maximum severity of audible alarm
}

AlertState ::= BITS-16 {
    al-inhibited(0),                         -- off
    al-suspended(1),                         -- alert(ing) inactivated temporarily;
                                             -- alert condition acknowledged
    al-latched(2),                           -- specific alert is latched (or AlMon latches alert conditions)
    al-silenced-reset(3),                    -- (transition only); alert indication stopped, but
                                             -- alarming re-enabled
    al-dev-in-test-mode(5),                  -- device is in test mode; the alarms are not real patient alarms
    al-dev-in-standby-mode(6),               -- device is in standby mode
    al-dev-in-demo-mode(7)                   -- device is in demonstration mode, the alarms are not
                                             -- real patient alarms
```

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```
}

AlStatChgCnt ::= SEQUENCE {
    al-new-chg-cnt          INT-U8,     -- Device-Alert-Condition attribute changed
    al-stack-chg-cnt        INT-U8      -- alert stack (active alarm list attributes) changed
}

--
-- Device alarm list
--
DevAlarmList ::= SEQUENCE OF DevAlarmEntry

DevAlarmEntry ::= SEQUENCE {
    al-source               OID-Type,   -- from metric or object-oriented nomenclature partition
    al-code                 OID-Type,   -- from events nomenclature partition
    al-type                 AlertType,
    al-state                AlertState,
    object                  ManagedObjectId,
    alert-info-id           PrivateOid,
    alert-info              ANY DEFINED BY alert-info-id
}
```

NOTE—The al-code code comes from the events nomenclature partition. Entries (i.e., codes) in this partition are even. The last bit of the code is used to define from which nomenclature partition the al-source comes. If the last bit is 0, the al-source comes from the metric nomenclature partition. If the last bit is 1 (1 is added to the base code in the events nomenclature), the al-source comes from the object-oriented nomenclature partition.

7.4.3.2 Behavior

The Alert Monitor object does not define any special methods.

7.4.3.3 Notifications

The Alert Monitor object does not generate any special notifications.

7.5 Objects in the System Package

The definitions of objects in the System Package are given in 7.5.1 through 7.5.10.

7.5.1 VMS object

Object: VMS
Description: "The VMS object is the abstract base class for all System Package objects in this model. It provides consistent naming and identification of system-related objects."
Derived From: Top
Name Binding: Handle
Registered As: MDC_MOC_VMS

7.5.1.1 Attributes

The VMS object class defines the attributes in Table 7.35.

Table 7.35—VMS object class attributes

Attribute name	Attribute ID	Attribute type	Remark	Qualifier
Handle	MDC_ATTR_ID_ HANDLE	HANDLE	Name binding attribute.	M

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Table 7.35—VMS object class attributes *(continued)*

Attribute name	Attribute ID	Attribute type	Remark	Qualifier
System-Type	MDC_ATTR_SYS_ TYPE	TYPE	Examples: ventilator, monitor as defined in nomenclature.	M
System-Model	MDC_ATTR_ID_ MODEL	SystemModel	Model describes manufacturer and model number.	C
System-Id	MDC_ATTR_SYS_ID	OCTET STRING	Unique system ID, e.g., serial number.	C
Compatibility-Id	MDC_ATTR_ID_ COMPAT	INT-U32	For manufacturer use.	O
Nomenclature-Version	MDC_ATTR_NOM_ VERS	Nomenclature-Version	Version of nomenclature used by the system.	C
System-Capability	MDC_ATTR_SYS_ CAPAB	SystemCapability	Set of supported features; system specific.	O
System-Specification	MDC_ATTR_SYS_ SPECN	SystemSpec	Defines functional components.	O
Production-Specification	MDC_ATTR_ID_ PROD_SPECN	ProductionSpec	Component revisions, serial numbers, etc.	O
Ext-Obj-Relations	MDC_ATTR_EXT_ OBJ_RELATION	ExtObjRelation-List	Relations to objects that are not defined in the DIM.	O

NOTE—The conditional (C) VMS attributes are mandatory for the top-level VMS object instance (i.e., root object instance of the containment tree); they are optional otherwise.

The VMS object class defines in Table 7.36 the attribute groups or extensions to inherited attribute groups.

Table 7.36—VMS object class attribute groups

Attribute group	Attribute group ID	Group elements
System Identification Attribute Group (extensible attribute group)	MDC_ATTR_GRP_SYS_ ID	from VMS: System-Type, System-Model, System-Id, Compatibility-Id, Nomenclature-Version
System Application Attribute Group (extensible attribute group)	MDC_ATTR_GRP_SYS_ APPL	from VMS: System-Capability, System-Specification
System Production Attribute Group (extensible attribute group)	MDC_ATTR_GRP_SYS_ PROD	from VMS: Production-Specification
Relationship Attribute Group	MDC_ATTR_GRP_ RELATION	from VMS: Ext-Obj-Relations

Note that the Relationship Attribute Group is not shown again in the definitions of derived classes.

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The following type definitions apply:

```
--
-- System-Model attribute is specified by manufacturer and manufacturer-specific model number
--
SystemModel ::= SEQUENCE {
    manufacturer            OCTET STRING,
    model-number            OCTET STRING
}

--
-- System-Capability attribute is a top-level specification of implemented functions; (the following is
-- an example only)
--
SystemCapability ::= BITS-32 {
    sc-multiple-context(0),             -- indicates that system uses multiple naming contexts
    sc-dyn-configuration(1),            -- containment tree changes dynamically
    sc-dyn-scanner-create(2),           -- system allows host to create Scanner objects dynamically
    sc-auto-init-scan-list(3),          -- CfgScanner object supports automatic
                                        -- scan list initialization
    sc-auto-updt-scan-list(4)           -- CfgScanner object supports automatic scan list update
}

--
-- System-Specification attribute allows specific entries for system functional components
--
SystemSpec ::= SEQUENCE OF SystemSpecEntry

SystemSpecEntry ::= SEQUENCE {
    component-capab-id      PrivateOid,
    component-spec          ANY DEFINED BY component-capab-id
}

--
-- Production-Specification attribute deals with serial numbers, part numbers, revisions, etc.; note that a device
-- may have multiple components so the Production-Specification attribute should be a printable string defining
-- the component and the "number"
--
ProductionSpec ::= SEQUENCE OF ProdSpecEntry

ProdSpecEntry ::= SEQUENCE {
    spec-type               INT-U16 {
        unspecified(0),
        serial-number(1),
        part-number(2),
        hw-revision(3),
        sw-revision(4),
        fw-revision(5),
        protocol-revision(6),
        prod-spec-gmdn(7)               -- Global Medical Device Nomenclature[9]
        },
    component-id            PrivateOid,
    prod-spec               OCTET STRING
}

--
-- Nomenclature-Version attribute contains a part of the major version field (i.e., basic compatibility) and the
-- minor version (used to identified the latest used update); the major version part is coded as a bit field so that
-- systems supporting multiple versions can negotiate the version used within an association
--
```

[9]The Global Medical Device Nomenclature (GMDN) is based on ISO 15225 and was developed under the auspices of CEN TC257 SC1.

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```
NomenclatureVersion ::= SEQUENCE {
    nom-major-version       BITS-16 {       -- major version identifier
        majorVersion1(0),
        majorVersion2(1),
        majorVersion3(2),
        majorVersion4(3)
        },
    nom-minor-version       INT-U16         -- counter to identify minor updates
}
```

7.5.1.2 Behavior

The VMS object does not define any special methods.

7.5.1.3 Notifications

The VMS object does not generate any special notifications.

7.5.2 MDS object

Object: MDS
Description: "The MDS object is an abstraction of a device that provides medical information in the form of objects that are defined in the Medical Package of the DIM. Further specializations of this class are used to represent differences in complexity and scope. As a base class, the MDS object cannot be instantiated."
Derived From: VMS
Name Binding: Handle
Registered As: MDC_MOC_VMS_MDS

7.5.2.1 Attributes

The MDS object class defines the attributes in Table 7.37.

Table 7.37—MDS object class attributes

Attribute name	Attribute ID[a]	Attribute type	Remark	Qualifier[b]
Mds-Status	MDC_ATTR_VMS_MDS_STAT	MDSStatus	Device state according to MDS FSM.	C
Bed-Label	MDC_ATTR_ID_BED_LABEL	OCTET STRING	Printable string identifying system location.	O
Soft-Id	MDC_ATTR_ID_SOFT	OCTET STRING	Settable, e.g., hospital inventory number.	O
Operating-Mode	MDC_ATTR_MODE_OP	PrivateOid		O
Application-Area	MDC_ATTR_AREA_APPL	ApplicationArea		O
Patient-Type	MDC_ATTR_PT_TYPE	PatientType	May control algorithms, see 7.10.1.1 for definition of type.	O[c]
Date-and-Time	MDC_ATTR_TIME_ABS	AbsoluteTime	MDS maintains device time.	O
Relative-Time	MDC_ATTR_TIME_REL	RelativeTime		O

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Table 7.37—MDS object class attributes *(continued)*

Attribute name	Attribute ID[a]	Attribute type	Remark	Qualifier[b]
HiRes-Relative-Time	MDC_ATTR_TIME_REL_HI_RES	HighResRelativeTime		O
Power-Status	MDC_ATTR_POWER_STAT	PowerStatus	Either onBattery or onMains.	O[d]
Altitude	MDC_ATTR_ALTITUDE	INT-I16	Meters above or below sea level.	O
Battery-Level	MDC_ATTR_VAL_BAT_CHARGE	INT-U16	In % of capacity; undefined if value > 100.	O
Remaining-Battery-Time	MDC_ATTR_TIME_BATT_REMAIN	BatMeasure	See 7.5.9.1 for the definition of type; minutes are the recommended measurement unit.	O
Line-Frequency	MDC_ATTR_LINE_FREQ	LineFrequency	Frequency of mains; implicitly in hertz (typically either 50 Hz or 60 Hz)	O
Association-Invoke-Id	MDC_ATTR_ID_ASSOC_NO	INT-U16	Counter for number of associations on a given communications port; incremented with each association control service element (ACSE) association	O
Locale	MDC_ATTR_LOCALE	Locale	Defines charset and language of printable string attributes in this MDS and contained objects. Contained MDS or VMD objects may define different Locale attributes for their scope. The top-level MDS shall support this attribute.	C

[a]Some of the VMS and MDS attributes need to be exchanged during association as user information fields in the ACSE protocol. The ACSE user information fields should contain only VMS or MDS attributes.
[b]The conditional (C) MDS attributes are mandatory for the top-level MDS object instance (i.e., root object instance of the containment tree); they are optional otherwise.
[c]If MDS supports the Patient Demographics object, the MDS object should not contain this attribute to avoid conflicts
[d]If more information for battery-powered devices about the battery is needed (especially if the battery is manageable), a special Battery object should be used.

The MDS object class defines in Table 7.38 the attribute groups or extensions to inherited attribute groups.

Table 7.38—MDS object class attribute groups

Attribute group	Attribute group ID	Group elements
System Identification Attribute Group (extensible attribute group)	MDC_ATTR_GRP_SYS_ID	from VMS: System-Type, System-Model, System-Id, Compatibility-Id, Nomenclature-Version from MDS: Soft-Id, Association-Invoke-Id, Locale

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Table 7.38—MDS object class attribute groups *(continued)*

Attribute group	Attribute group ID	Group elements
System Application Attribute Group (extensible attribute group)	MDC_ATTR_GRP_SYS_APPL	from VMS: System-Capability, System-Specification from MDS: Mds-Status, Operating-Mode, Patient-Type, Date-and-Time, Power-Status, Battery-Level, Remaining-Battery-Time, Application-Area, Bed-Label, Relative-Time, HiRes-Relative-Time, Altitude, Line-Frequency
System Production Attribute Group (extensible attribute group)	MDC_ATTR_GRP_SYS_PROD	from VMS: Production-Specification

The following type definitions apply:

```
--
-- MDS state of one association/connection according to FSM
--
MDSStatus ::= INT-U16 {
     disconnected(0),        unassociated(1),        associating(2),        associated(3),
     configuring(4),         configured(5),          operating(6),          re-initializing(7),
     terminating(8),         disassociating(9),      disassociated(10),     re-configuring(11)
}

--
-- Application-Area attribute
--
ApplicationArea ::= INT-U16 {
     area-unspec(0),
     area-operating-room(1),
     area-intensive-care(2)
     }

--
-- Power-Status attribute defines whether the device is on battery or on mains; upper bits define the charging state
--
PowerStatus ::= BITS-16 {
     onMains(0),
     onBattery(1),
     chargingFull(8),
     chargingTrickle(9),
     chargingOff(10)
}

--
-- Line-Frequency attribute
--
LineFrequency ::= INT-U16 {
     line-f-unspec(0),
     line-f-50hz(1),
     line-f-60hz(2)
}
```

7.5.2.2 Behavior

The MDS object defines the methods in Table 7.39.

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Table 7.39—MDS object methods

Action	Mode	Action ID	Action parameter	Action result
Mds-Set-Status	Confirmed	MDC_ACT_SET_MDS_ STATE	MdsSetStateInvoke	MdsSetState-Result

The following type definitions apply:

```
--
-- MDS-Set-State method permits modification of the state of the MDS state machine e.g., to trigger a reset
-- (if supported by a device)
-- NOTE--Usage of the authorization type is implementation-specific, especially given the security and operational
-- coordination issues involved
--
MdsSetStateInvoke ::= SEQUENCE {
    new-state                   MDSStatus,
    authorization               INT-U32
}

MdsSetStateResult ::= MDSStatus
```

7.5.2.3 Notifications

The MDS object defines the events in Table 7.40.

Table 7.40—MDS object events

Event	Mode	Event ID	Event parameter	Event result
System-Error	Unconfirmed	MDC_NOTI_SYS_ERR	MdsErrorInfo	—
Mds-Create-Notification	Confirmed	MDC_NOTI_MDS_ CREAT	MdsCreateInfo	—
Mds-Attribute-Update	Confirmed	MDC_NOTI_MDS_ ATTR_UPDT	Mds-AttributeChange-Info	—

The following type definitions apply:

```
--
-- System-Error notification in case of system errors
--
MdsErrorInfo ::= SEQUENCE {
    error-type                  PrivateOid,
    error-info                  ANY DEFINED BY error-type
}

--
-- Mds-Create-Notification event is sent after association is established
--
MdsCreateInfo ::= SEQUENCE {
    class-id                    ManagedObjectId,
    attribute-list              AttributeList       -- attributes from the System Identification Attribute Group
                                                    -- and System Application Attribute Group
}
```


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```
--
-- MDS may report changes of attribute values
--
MdsAttributeChangeInfo ::= AttributeList
```

7.5.3 Simple MDS object

Object:	Simple MDS
Description:	"The Simple MDS object represents a medical device that contains a single VMD instance only (i.e., single-purpose device)."
Derived From:	MDS
Name Binding:	Handle
Registered As:	MDC_MOC_VMS_MDS_SIMP

This MDS specialization does not define any specialized attributes, methods, and notifications.

7.5.4 Hydra MDS object

Object:	Hydra MDS
Description:	"The Hydra MDS object represents a device that contains multiple VMD instances (i.e., multipurpose device)."
Derived From:	MDS
Name Binding:	Handle
Registered As:	MDC_MOC_VMS_MDS_HYD

This MDS specialization does not define any specialized attributes, methods, and notifications.

7.5.5 Composite Single Bed MDS object

Object:	Composite Single Bed MDS
Description:	"The Composite Single Bed MDS object represents a device that contains (or interfaces with) one or more Simple or Hydra MDS objects at one location (i.e., a bed)."
Derived From:	MDS
Name Binding:	Handle
Registered As:	MDC_MOC_VMS_MDS_COMPOS_SINGLE_BED

This MDS specialization does not define any specialized attributes, methods, and notifications.

7.5.6 Composite Multiple Bed MDS object

Object:	Composite Multiple Bed MDS
Description:	"The Composite Multiple Bed MDS object represents a device that contains (or interfaces with) multiple MDS objects at multiple locations (i.e., multiple beds)."
Derived From:	MDS
Name Binding:	Handle
Registered As:	MDC_MOC_VMS_MDS_COMPOS_MULTI_BED

This MDS specialization does not define any specialized attributes, methods, and notifications.

7.5.7 Log object

Object:	Log
Description:	"The Log object is a storage container for important local system notifications and events. Further specializations define specific event types that are stored in the Log object. The Log object is an abstract base class and cannot be instantiated."
Derived From:	Top

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Name Binding: Handle
Registered As: MDC_MOC_LOG

7.5.7.1 Attributes

The Log object class defines the attributes in Table 7.41.

Table 7.41—Log object class attributes

Attribute name	Attribute ID	Attribute type	Remark	Qualifier
Handle	MDC_ATTR_ID_ HANDLE	HANDLE	Name binding attribute.	M
Max-Log-Entries	MDC_ATTR_LOG_ ENTRIES_MAX	INT-U32	Maximum capacity of the Log object; GET service used to retrieve this attribute.	M
Current-Log-Entries	MDC_ATTR_LOG_ ENTRIES_CURR	INT-U32	Current used capacity of the Log object; GET service used to retrieve this attribute.	M
Log-Change-Count	MDC_ATTR_LOG_ CHANGE_COUNT	INT-U16	Incremented when log contents change.	O

NOTE—It is assumed that Log object entries are indexed from 0 to the Current-Log-Entries attribute value.

The Log object class does not define any attribute groups, and no additional type definitions are needed.

7.5.7.2 Behavior

The Log object defines the methods in Table 7.42.

Table 7.42—Log object methods

Action	Mode	Action ID	Action parameter	Action result
Clear-Log	Confirmed	MDC_ACT_CLEAR_ LOG	ClearLogRange-Invoke (optional)	ClearLog-RangeResult (optional)

The following type definitions apply:

```
--
-- Range of log entries to be deleted; if the parameter is not appended to the Clear-Log method, the complete log
-- shall be cleared unconditionally
--
ClearLogRangeInvoke ::= SEQUENCE {
    clear-log-option        ClearLogOption,
    log-change-count        INT-U16,        -- 0 if unconditional clear
    from-log-entry-index    INT-U32,
    to-log-entry-index      INT-U32
}
```


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```
ClearLogRangeResult ::= SEQUENCE {
    clear-log-result            ClearLogResult,
    log-change-count            INT-U16,        -- current change count after clear
    from-log-entry-index        INT-U32,        -- do not care if not successful
    to-log-entry-index          INT-U32,        -- do not care if not successful
    current-log-entries         INT-U32         -- updated number of entries in the log
}

--
-- Options that control the clear command
--
ClearLogOptions ::= BITS-16 {
    log-clear-if-unchanged(1)                   -- only perform this action if the log has not been changed;
                                                -- in other words, the evlog-change-count in the request
                                                -- is still current
}

--
-- Result of the clear log function
--
ClearLogResult ::= INT-U16 {
    log-range-cleared(0),                       -- successful operation
    log-changed-clear-error(1),                 -- the change count was wrong (i.e., log has been modified)
    log-change-counter-not-supported(2)         -- log does not support a change counter
}
```

NOTE—The processing of the change counter in the clear command prevents race conditions where log entries that were not yet retrieved by the client are inadvertently cleared.

7.5.7.3 Notifications

The Log object does not generate any special notifications.

7.5.8 Event Log object

Object: Event Log
Description: "The Event Log object is a general Log object that stores system events in a free-text or in a binary representation."
Derived From: Log
Name Binding: Handle
Registered As: MDC_MOC_LOG_EVENT

7.5.8.1 Attributes

The Event Log object class defines the attributes in Table 7.43.

Table 7.43—Event Log object class attributes

Attribute name	Attribute ID	Attribute type	Remark	Qualifier
Type	MDC_ATTR_ID_ TYPE	TYPE	Further specification of log entry format.	O
Event-Log-Entry-List	MDC_ATTR_EVENT_ LOG_ENTRY_LIST	EventLogEntry-List	Event entries; can be retrieved with GET service.	M
Event-Log-Info	MDC_ATTR_EVENT_ LOG_INFO	EventLogInfo	Static and dynamic specifications.	O

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The Event Log object class does not define any attribute groups.

The following type definitions apply:

```
--
-- Event-Log-Entry-List attribute
--
EventLogEntryList ::= SEQUENCE OF EventLogEntry

EventLogEntry ::= SEQUENCE {
    entry-number            INT-U32,        -- entry counter independent of the index number that is
                                            -- used for access
    abs-time                AbsoluteTime,   -- event time
    event-entry             OCTET STRING    -- free-text or binary event information; structure defined
                                            -- by the Type attribute
}

--
-- Event-Log-Info attribute
-- Bits 0 to 15 are reserved for static information; bits 16 to 31 are dynamically updated to reflect log status changes
-- If this attribute is not present, all bits are implicitly assumed 0
--
EventLogInfo ::= BITS-32 {
    ev-log-clear-range-sup(0),      -- supports to clear specified ranges (not just the entire log)
    ev-log-get-act-sup(1),          -- supports retrieving individual entries using the
                                    -- Get-Event-Log method (not just a simple GET service)
    ev-log-binary-entries(8),       -- log entries are binary, not free text
    ev-log-full(16),                -- log is full; cleared as soon as the log contains at least
                                    -- 1 free entry as a result of a clear action
    ev-log-wrap-detect(17)          -- set when the log is full and the first old entry is
                                    -- overwritten; cleared as soon as the log contains at least
                                    -- 1 free entry as a result of a clear action
}
```

7.5.8.2 Behavior

The Event Log object defines the methods in Table 7.44.

Table 7.44—Event Log object methods

Action	Mode	Action ID	Action parameter	Action result
Get-Event-Log-Entries	Confirmed	MDC_ACT_GET_ EVENT_LOG_ ENTRIES	GetEventLogEntry-Invoke	GetEventLog-EntryResult

The following type definitions apply:

```
--
-- Range of log entries to be retrieved
--
GetEventLogEntryInvoke ::= SEQUENCE {
    from-log-entry-index    INT-U32,
    to-log-entry-index      INT-U32
}

--
-- Reply containing the requested entries; depending on agent restrictions, the reply may contain only a part of the
-- requested entries; this situation must be checked by the manager
```


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```
--
GetEventLogEntryResult ::= SEQUENCE {
    log-change-count        INT-U16,        -- current log change counter (0 if not supported)
    from-log-entry-index    INT-U32,
    to-log-entry-index      INT-U32,
    entry-list              EventLogEntryList
}
```

7.5.8.3 Notifications

The Event Log object does not generate any special notifications.

7.5.9 Battery object

Object: Battery
Description: "For battery-powered devices, some battery information is contained in the MDS object in the form of attributes. If the battery subsystem is either capable of providing more information (i.e., smart battery) or manageable, then a special Battery object is provided."
Derived From: Top
Name Binding: Handle
Registered As: MDC_MOC_BATT

7.5.9.1 Attributes

The Battery object class defines the attributes in Table 7.45.

Table 7.45—Battery object class attributes

Attribute name	Attribute ID	Attribute type	Remark	Qualifier
Handle	MDC_ATTR_ID_ HANDLE	HANDLE	Name binding attribute.	M
Battery-Status	MDC_ATTR_BATT_ STAT	BatteryStatus		M
Production-Spec-ification	MDC_ATTR_ID_ PROD_SPECN	ProductionSpec	A smart battery system may have a serial number or version.	O
Capacity-Remaining	MDC_ATTR_CAPAC_ BATT_REMAIN	BatMeasure	Remaining capacity at current load (e.g., in milliAmpere-hours).	O
Capacity-Full-Charge	MDC_ATTR_CAPAC_ BATT_FULL	BatMeasure	Battery capacity after a full charge.	O
Capacity-Specified	MDC_ATTR_CAPAC_ BATT_SPECN	BatMeasure	Specified capacity of new battery.	O
Remaining-Battery-Time	MDC_ATTR_TIME_ BATT_REMAIN	BatMeasure		O
Voltage	MDC_ATTR_BATT_ VOLTAGE	BatMeasure	Present battery voltage.	O
Voltage-Specified	MDC_ATTR_BATT_ VOLTAGE_SPECN	BatMeasure	Specified battery voltage.	O

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Table 7.45—Battery object class attributes *(continued)*

Attribute name	Attribute ID	Attribute type	Remark	Qualifier
Current	MDC_ATTR_BATT_CURR	BatMeasure	Present current delivered by/to battery; negative if battery is charge.	O
Battery-Temperature	MDC_ATTR_TEMP_BATT	BatMeasure		O
Charge-Cycles	MDC_ATTR_BATT_CHARGE_CYCLES	INT-U32	Number of charge/discharge cycles.	O

The Battery object class defines in Table 7.46 the attribute groups or extensions to inherited attribute groups.

Table 7.46—Battery object class attribute groups

Attribute group	Attribute group ID	Group elements
Battery Attribute Group	MDC_ATTR_GRP_BATT	from Battery: (all)

The following type definitions apply:

```
--
-- Battery Status bit field
--
BatteryStatus ::= BITS-16 {
    batt-discharged(0),
    batt-full(1),                          -- > 95% of capacity
    batt-discharging(2),
    batt-chargingFull(8),
    batt-chargingTrickle(9),
    batt-malfunction(12),
    batt-needs-conditioning(13)            -- battery needs conditioning
}

--
-- All measures about the battery are values with their dimensions
--
BatMeasure ::= SEQUENCE {
    value                  FLOAT-Type,
    unit                   OID-Type        -- from dimensions nomenclature partition
}
```

7.5.9.2 Behavior

The Battery object does not define any special methods.

7.5.9.3 Notifications

The Battery object does not generate any special notifications.

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7.5.10 Clock object

Object: Clock
Description: "The Clock object provides additional date/time capability and status information beyond the information provided by the basic MDS object's time-related attributes. The Clock object does not imply any specific hardware or software support."
Derived From: Top
Name Binding: Handle
Registered As: MDC_MOC_CLOCK

7.5.10.1 Attributes

The Clock object class defines the attributes in Table 7.47.

Table 7.47—Clock object class attributes

Attribute name	Attribute ID	Attribute type	Remark	Qualifier
Handle	MDC_ATTR_ID_ HANDLE	HANDLE	Name binding attribute.	M
Time-Support	MDC_ATTR_TIME_ SUPPORT	TimeSupport	Indicates the time services provided by the device.	M
Date-Time-Status	MDC_ATTR_DATE_ TIME_STATUS	DateTimeStatus	General information about the functioning of time-support services. Mandatory if remote sync services are supported by the device [e.g., Simple Network Time Protocol (SNTP)]; optional otherwise.	C
Date-and-Time	MDC_ATTR_TIME_ ABS	AbsoluteTime	Current date/time setting.	O
ISO-Date-and-Time	MDC_ATTR_TIME_ ABS_ISO	AbsoluteTimeISO	Date and time string formatted in accordance with ISO 8601; provides for international coordinated universal time (UTC) coordination. Attribute is in wide use by computing systems; however, it is ASCII-based and thus less efficient than absolute time.	O
Relative-Time	MDC_ATTR_TIME_ REL	RelativeTime	Relative time (in 8 kHz ticks).	O
HiRes-Relative-Time	MDC_ATTR_TIME_ REL_HI_RES	HighRes-RelativeTime	High-resolution relative time (in 1 MHz ticks).	O
Ext-Time-Stamp-List	MDC_ATTR_TIME_ STAMP_LIST_EXT	ExtTimeStampList	Extended timestamp (which may be used individually elsewhere in data structures).	O
Absolute-Relative-Sync	MDC_ATTR_TIME_ ABS_REL_SYNC	Absolute-RelativeTimeSync	Provides a means of correlating between absolute time and relative time values.[a]	O
Time-Zone	MDC_ATTR_TIME_ ZONE	UTCTimeZone	Identifies the UTC local time zone offset [from Greenwich mean time (GMT)] and label.	O

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Table 7.47—Clock object class attributes *(continued)*

Attribute name	Attribute ID	Attribute type	Remark	Qualifier
Daylight-Savings-Transition	MDC_ATTR_TIME_DAYLIGHT_SAVINGS_TRANS	Daylight-SavingsTransition	Provides the settings for the next daylight savings time transition.	O
Cumulative-Leap-Seconds	MDC_ATTR_CUM_LEAP_SECONDS	INT-U32	Cumulative leap-seconds relative to January 1, 1900, 00:00:00.00. Format is +nn. For the entire year 2001, this value is +32.[b]	O
Next-Leap-Seconds	MDC_ATTR_NEXT_LEAP_SECOND	LeapSeconds-Transition	Specifies the settings for when the next leap-seconds transition shall occur and the next value.	O

[a]This attribute is periodically updated internally (e.g., once per minute) and thus does not reflect the actual time when read (e.g., using a GET service). The error between relative and absolute time should be as small as possible given system limitations (e.g., an atomic operation should be used if possible). The attribute should be updated frequently enough to minimize the error between the reported mapping and should be updated at a minimum of every 6 days, namely when the relative time would roll over to 0.
[b]When subtracted from SNTP seconds yields UTC seconds.

The Clock object class defines in Table 7.48 the attribute groups or extensions to inherited attribute groups.

Table 7.48—Clock object class attribute groups

Attribute group	Attribute group ID	Group elements
Clock Attribute Group	MDC_ATTR_GRP_CLOCK	from Clock: (all)

The following type definitions apply:

```
--
-- Time-Support attribute provides general information about time-related services that are provided by the device
-- Some of this information could be determined by examining the presence/absence of various attributes in a
-- containment tree; however, its presence here simplifies time management for device managers
--
-- NOTES
-- 1--If remote date/time synchronization is supported (e.g., SNTP), then either the Date-And-Time or
-- ISO-Date-And-Time attribute must also be supported
-- 2--If the device is also a server of time information (e.g., an SNTP server), this fact should be indicated
-- in the time protocol IDs
--
TimeSupport ::= SEQUENCE {
    time-capability          TimeCapability,
                                        -- Flags indicating general time support
    relative-resolution      INT-U32,   -- Time between actual ticks in microseconds; set to
                                        -- 0xFFFFFFFF if not defined or specified
    time-protocols           SEQUENCE OF TimeProtocolId
                                        -- List of external time protocols supported (e.g., SNTP)
}
```

NOTE—The relative-resolution type provides a means of correlating the 8 kHz frequency reported by the relative time value to the device's time sources from which it is being derived. For example, if the device's timer updates at 100 Hz or

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18.2 Hz [as is the case in older personal computers (PCs)], then the resolution and accuracy of the relative time would reflect this time source resolution and accuracy.

```
--
--Time capability
--
TimeCapability ::= BITS-32 {
    time-capab-real-time-clock(0),              -- the device includes hardware support for time
                                                -- (including battery power)
    time-capab-ebww(1),                         -- time can be set locally/manually
                                                --("eyeball and wristwatch" or "EBWW")
    time-capab-leap-second-aware(2),            -- supports adjustment of time for leap-seconds
                                                -- (SNTP-related)
    time-capab-time-zone-aware(3),              -- supports time zone-related attributes
    time-capab-internal-only(4),                -- date/time is used only internally to
                                                -- the device; not displayed to operator
    time-capab-time-displayed(5),               -- date/time can be displayed continually on the device
                                                -- versus in a menu
    time-capab-patient-care(6),                 -- date/time is used in critical patient
                                                -- care algorithms/protocols
    time-capab-rtsa-time-sync-annotations(7),   -- timestamp annotations supported for real-time waveform
                                                -- data (Real Time Sample Array objects)
    time-capab-rtsa-time-sync-high-precision(8), -- Real Time Sample Array objects support attributes for
                                                -- high precision sample timestamps
    time-capab-set-time-action-sup(16),         -- Clock object supports the set time action
    time-capab-set-time-zone-action-sup(17),    -- Clock object supports the set time zone action
    time-capab-set-leap-sec-action-sup(18),     -- Clock object supports the set leap-seconds action
    time-capab-set-time-iso-sup(19)             -- Clock object supports the set time ISO action
}

--
-- Time protocol ID indicates the time protocols that are supported/used by the device
--
TimeProtocolId ::= OID-Type                     -- from the infrastructure nomenclature partition

--
-- Timestamp ID (e.g., for SNTP timestamps)
--
TimeStampId ::= OID-Type                        -- from the infrastructure nomenclature partition

--
-- Extended timestamp (e.g., SNTP timestamp value)
--
ExtTimeStamp ::= SEQUENCE {
    time-stamp-id           TimeStampId,
    time-stamp              ANY DEFINED BY time-stamp-id
}

ExtTimeStampList ::= SEQUENCE OF ExtTimeStamp

--
-- Date-Time-Status attribute defines the current/active usage status for date and time in the device
--
DateTimeStatus ::= SEQUENCE {
    usage-status            DateTimeUsage,  -- flags indicating dynamic time usage
    clock-last-set          AbsoluteTime,   -- time the absolute time was last set
    clock-accuracy          FLOAT-Type,     -- decimal number indicating the accuracy or maximum
                                            -- error of the absolute time relative to a primary reference
                                            -- clock source (in seconds)
    active-sync-protocol    TimeProtocolId  -- protocol that is actively being used
                                            -- for time synchronization
}
```

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NOTES

1—If a time synchronization protocol is used that changes the time and date at a high frequency, the clock-last-set type value should be updated at a lower periodicity (e.g., once every 10 min or once an hour), so that communications bandwidth is not consumed unnecessarily.

2—In systems where time synchronization is not used (i.e., EBWW is source), the clock-accuracy type should be initialized to 2 or 3 min when the clock time is set and should be incremented periodically to reflect drift from an absolute external reference source. If NTP is used, clock-accuracy type initialization is equivalent to Root Dispersion + ½ Root Delay.

```
--
-- Date/time usage flags indicate dynamic usage status for date and time in the device; no bits set indicates
-- unknown/indeterminate status
--
DateTimeUsage ::= BITS-16 {
    dt-use-remote-sync(0),                  -- date/time is synchronized to an external source
    dt-use-operator-set(1),                 -- date/time set by operator (i.e., EBWW)
    dt-use-rtc-synced(2),                   -- date/time in the RTC has been synchronized to a
                                            -- remote time source
    dt-use-critical-use(3),                 -- date/time is actively being used in care delivery
                                            -- algorithms/protocols
    dt-use-displayed(4)                     -- date/time is actively being displayed to the operator
}

--
-- ISO-Date-and-Time attribute is an ASCII string that can provide additional information beyond the basic
-- date/time setting (e.g., UTC offset or device-local time zone indication); this attribute can be set
-- using the SET service (as can the Date-And-Time attribute)
-- Note that if both AbsoluteTime and AbsoluteTimeISO types are concurrently supported,
-- they shall reflect the same time (relative to their accuracy and resolution limitations)
-- Although not mandatory, it is highly recommended that all optional fields be included in the string
-- To simplify processing, the following constraints shall apply
-- (a) Only complete representations shall be used
-- (b) Only extended formats shall be used
-- (c) "Week date" and ordinal "day of the year" representations shall not be used; only calendar dates
-- (d) Decimal fractions shall be used only for partial seconds (e.g., not fractional hours)
-- (e) Per ISO 8601:2000(E), the representation of decimal fractions shall be in accordance with Section 5.3.1.3
-- (f) If known, UTC shall be communicated either using zulu (or Z) format or  the offset between local
-- and GMT/UTC time; specifying the time offset shall be used if known
-- (g) Specification of time intervals and recurring periods is beyond the use of this data type and shall
-- require a definition of a new data type if used (e.g., ISOTimeInterval ::= OCTET STRING); for example:
-- November 24, 2001, 3:45:32.65 P.M. in San Diego, California, USA, shall be represented by the following
-- string: 2001-11-24T15:45:32,65-08:00
--
AbsoluteTimeISO ::= OCTET STRING            -- ASCII text string that adheres to ISO 8601 format

--
-- SNTPTimeStamp, a 64-bit timestamp value that is provided by an SNTP time synchronization service
--
SNTPTimeStamp ::= SEQUENCE {
    seconds                 INT-U32,        -- Seconds since January 1, 1900 00:00
    fraction                INT-U32         -- Binary fraction of a second
}

--
-- Absolute-Relative-Sync attribute provides a means for correlating relative timestamps to the
-- device's date/time setting
-- NOTE--This attribute needs to be updated only periodically to account for drift between the various
-- time sources (e.g., once a minute)
--
AbsoluteRelativeTimeSync ::= SEQUENCE {
    absolute-time-mark      AbsoluteTime,   -- use of this data type limits resolution to 1/100 second
    relative-time-mark      RelativeTime,   -- resolution limited by 125 µs tick and resolution/accuracy
                                            -- settings for relative time service
    relative-rollovers      INT-U16,        -- number of times the relative time has "rolled over" from
```


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```
                                        -- its maximum value to 0
                                        -- NOTE--The relative time will roll over every 6.2 days
    hires-time-mark         HighResRelativeTime,
                                        -- defaults to 0x00000000 if not supported
    ext-time-marks          ExtTimeStampList -- list is empty if no extended timestamps are supported
}

--
-- Time-Zone attribute supports time zone information for UTC
--
UTCTimeZone ::= SEQUENCE {
    time-zone-offset-hours  INT-I8,         -- device's local time zone (i.e., at the point of care),
                                            -- relative to UTC
                                            -- format is +hh for time zones east of
                                            -- GMT and -hh for locations west of GMT
    time-zone-offset-minutes INT-U8,        -- minutes offset from GMT (if specified); format
                                            -- conventions are the same as the conventions for hours,
                                            -- only they are not signed (shall always be a positive value);
                                            -- default is NULL
    time-zone-label         OCTET STRING    -- device's local time zone label, e.g., PST or PDT; see
                                            -- device's Locale attribute for string encoding
}

--
-- Daylight-Savings-Transition attribute specifies the settings for the next transition to/from daylight savings time
--
DaylightSavingsTransition::= SEQUENCE {
    transition-date         AbsoluteTime,   -- device's local date/time when the daylight savings
                                            -- transition will occur
    next-offset             UTCTimeZone     -- new local time zone offset and label after transition date
                                            -- NOTE--May be same as previous value
}

--
-- Next-Leap-Seconds attribute specifies the settings for the next leap-seconds transition
--
LeapSecondsTransition::= SEQUENCE {
    transition-date         Date,           -- device's local date when the transition will occur;
                                            -- adjustment occurs at the end (i.e., 23:59:59Z) of
                                            -- the specified date
    next-cum-leap-seconds   INT-U32         -- next cumulative leap-seconds value (see
                                            -- Cumulative-Leap-Seconds in Table 7.47)
                                            -- NOTE--May be same as previous value
}
```

7.5.10.2 Behavior

The Clock object defines the methods in Table 7.49.

Table 7.49—Clock object methods

Action	Mode	Action ID	Action parameter	Action result
Set-Time	Confirmed	MDC_ACT_SET_TIME	SetTimeInvoke	None
Set-Time-Zone	Confirmed	MDC_ACT_SET_TIME_ZONE	SetTimeZoneInvoke	None

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Table 7.49—Clock object methods *(continued)*

Action	Mode	Action ID	Action parameter	Action result
Set-Leap-Seconds	Confirmed	MDC_ACT_SET_LEAP_SECONDS	SetLeapSeconds-Invoke	None
Set-Time-ISO	Confirmed	MDC_ACT_SET_TIME_ISO	AbsoluteTimeISO	None

NOTE—When setting the time with either Set-Time or Set-Time-ISO methods, all supported absolute timestamp attributes (i.e., Date-and-Time, ISO-Date-and-Time and possibly Ext-Time-Stamp-List) shall be updated consistently.

The following data types apply:

```
--
-- Date/time to be set
--
SetTimeInvoke ::= SEQUENCE {
    date-time                   AbsoluteTime,
    accuracy                    FLOAT-Type      -- accounts for manually set time (e.g., 2 min error); value
                                                -- is defined in seconds
}

--
-- Time zone information to be set
--
SetTimeZoneInvoke ::= SEQUENCE {
    time-zone                   UTCTimeZone,    -- current time zone to be used by device
    next-time-zone              DaylightSavingsTransition
                                                -- information for the next transition to/from daylight
                                                -- savings time
}

--
-- Cumulative leap-seconds information to be set
--
SetLeapSecondsInvoke ::= SEQUENCE {
    leap-seconds-cum            INT-I32,        -- cumulative leap-seconds, which when subtracted from
                                                -- S/NTP seconds yields UTC seconds
    next-leap-seconds           LeapSecondsTransition
                                                -- date of transition from previous to new cumulative
                                                -- leap-second value + new value
}
```

7.5.10.3 Notifications

The Clock object defines the events in Table 7.50.

Table 7.50—Clock object events

Event	Mode	Event ID	Event parameter	Event result
Clock-Date-Time-Status-Changed	Unconfirmed	MDC_NOTI_DATE_TIME_CHANGED	ClockStatus-UpdateInfo	—

The following data types apply:

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```
--
-- Clock status update information is sent, for example, when the relative time setting rolls over to 0 or when the
-- time is changed by the device operator
--
ClockStatusUpdateInfo ::= SEQUENCE {
    date-time-status        DateTimeStatus,    -- current clock/time usage status
    time-sync               AbsoluteRelativeTimeSync
                                               -- current time synchronization values
}
```

7.6 Objects in the Control Package

The definitions of objects in the Control Package are given in 7.6.1 through 7.6.9.

7.6.1 SCO

Object: SCO
Description: "The SCO is responsible for managing all remote control capabilities that are supported by a medical device. The SCO is the primary access point for invoking remote control functions. It contains all Operation objects and provides a means for transaction processing. All Operation object invoke commands shall be done through the SCO."
Derived From: VMO
Name Binding: Handle (VMO inherited)
Registered As: MDC_MOC_CNTRL_SCO

7.6.1.1 Attributes

The SCO class defines the attributes in Table 7.51.

Table 7.51—SCO class attributes

Attribute name	Attribute ID	Attribute type	Remark	Qualifier
Sco-Capability	MDC_ATTR_SCO_ CAPAB	ScoCapability	Static option flag field.	M
Sco-Help-Text-String	MDC_ATTR_SCO_ HELP_TEXT_STRING	OCTET STRING	Help text.	O
Vmo-Reference	MDC_ATTR_VMO_ REF	HANDLE	Reference to controlled item, if not the VMD.	O
Activity-Indicator	MDC_ATTR_INDIC_ ACTIV	ScoActivity-Indicator	Can be set by remote system to give feedback that system is under remote control.	O
Lock-State	MDC_ATTR_STAT_ LOCK	Administrative-State	If locked, no operation can be invoked.	M
Invoke-Cookie	MDC_ATTR_ID_ INVOK_COOKIE	INT-U32	Transaction ID assigned by invoke command.	M

The SCO class defines in Table 7.52 the attribute groups or extensions to inherited attribute groups.

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Table 7.52—SCO class attribute groups

Attribute group	Attribute group ID	Group elements
VMO Static Context Group (extensible attribute group)	MDC_ATTR_GRP_VMO_ STATIC	from VMO: Type, Handle from SCO: Sco-Help-Text-String, Sco-Capability
VMO Dynamic Context Group (extensible attribute group)	MDC_ATTR_GRP_VMO_ DYN	from VMO: Label-String from SCO: Activity-Indicator, Vmo-Reference
SCO Transaction Group	MDC_ATTR_GRP_SCO_ TRANSACTION	from SCO: Lock-State, Invoke-Cookie

The following type definitions apply:

```
--
-- Activity-Indicator attribute can be set by a remote system to indicate that remote control is active
--
ScoActivityIndicator ::= INT-U16 {
    act-ind-off(0),
    act-ind-on(1),
    act-ind-blinking(2)
}

--
-- Sco-Capability bits
--
ScoCapability ::= BITS-16 {
    act-indicator(0),          -- supports activity indicator
    sco-locks(1),              -- at least one operation sets the SCO lock flag
    sco-ctxt-help(8)           -- SCO supports context-dependent dynamic help
}
```

7.6.1.2 Behavior

In addition to the SET service, which can be used to modify the Activity-Indicator attribute, the SCO defines the methods in Table 7.53.

Table 7.53—SCO methods

Action	Mode	Action ID	Action parameter	Action result
Operation-Invoke	Confirmed	MDC_ACT_SCO_OP_ INVOKE	OperationInvoke	Operation-InvokeResult
Get-Ctxt-Help	Confirmed	MDC_ACT_GET_CTXT _HELP	CtxtHelpRequest	CtxtHelpResult

The following data types apply:

```
--
-- Operation-Invoke method has an additional security mechanism
--
OperationInvoke ::= SEQUENCE {
```


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```
    checksum                INT-I16,        -- 16-bit twos complement
    invoke-cookie           INT-U32,        -- arbitrary ID mirrored back in resulting updates
    op-elem-list            OpInvokeList
    }
```

NOTE—If check-summing is not used, the checksum field shall be 0. If calculated checksum is 0, the checksum field shall be –1. Checksum calculation is the 16-bit twos-complement sum of 16-bit words in the message starting at the address after the checksum field.

```
--
OpInvokeList ::= SEQUENCE OF OpInvokeElement

OpInvokeElement ::= SEQUENCE {
    op-class-id             OID-Type,       -- from object-oriented nomenclature partition
    op-instance-no          InstNumber,
    op-mod-type             OpModType,
    attributes              AttributeList
}

OpModType ::= INT-U16 {
    op-replace(0),                          -- normally replace value of virtual attribute
    op-setToDefault(3),                     -- set to default value if this is supported
    op-invokeAction(10),                    -- needed for singular action type of operations
    op-invokeActionWithArgs(15)             -- action with arguments
}

--
-- Result confirms reception (and execution) of operations
-- Updated attributes are communicated via normal update method (e.g., scanner) to avoid inconsistencies
--
OperationInvokeResult ::= SEQUENCE {
    invoke-cookie           INT-U32,
    result                  OpInvResult
}

OpInvResult ::= INT-U16 {
    op-successful(0),
    op-failure(1)
}

--
-- The following types allow the retrieval of dynamic help information that is SCO or Operation object
-- context-dependent (i.e., state-dependent)
--
CtxtHelpRequest ::= SEQUENCE {
    type                    OID-Type,       -- either Operation object class ID or SCO class ID
    op-instance-no          InstNumber      -- operation instance number (0 if SCO is addressed)
}

CtxtHelpResult ::= SEQUENCE {
    type                    OID-Type,       -- either Operation object class ID or SCO class ID
    op-instance-no          InstNumber,
    hold-time               RelativeTime,   -- how long to display help; 0 if not applicable
    help                    CtxtHelp
}

CtxtHelp ::= CHOICE {
    text-string             [1[ OCTET STRING,
    oid                     [8] OID-Type
}
```

7.6.1.3 Notifications

The SCO defines the events in Table 7.54.

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Table 7.54—SCO events

Event	Mode	Event ID	Event parameter	Event result
SCO-Operating-Request	Confirmed/ Unconfirmed	MDC_NOTI_SCO_OP_ REQ	ScoOperReqSpec (optional)	—
SCO-Operation-Invoke-Error	Confirmed/ Unconfirmed	MDC_NOTI_SCO_OP_ INVOK_ERR	ScoOperInvoke-Error	—

The following data types apply:

```
--
-- An operating request may append additional information
--
ScoOperReqSpec ::= SEQUENCE {
    op-req-id                PrivateOid,          -- device- or manufacturer-specific
    op-req-info              ANY DEFINED BY op-req-id
}

--
-- SCO-Operation-Invoke-Error notification
--
ScoOperInvokeError ::= SEQUENCE {
    invoke-cookie            INT-U32,
    op-error                 INT-U16 {
        op-err-unspec(0),
        checksum-error(1),
        sco-lock-violation(2),
        unknown-operation(3),
        invalid-value(4),
        invalid-mod-type(5)
        },
    failed-operation-list    SEQUENCE OF InstNumber
}
```

7.6.2 Operation object

Object: Operation
Description: "The Operation object is the abstract base class for classes that represent remote controllable items."
Derived From: Top
Name Binding: Instance-Number (not directly accessible by object management services; unique within a single SCO instance)
Registered As: MDC_MOC_CNTRL_OP

7.6.2.1 Attributes

The Operation object class defines the attributes in Table 7.55.

Table 7.55—Operation object class attributes

Attribute name	Attribute ID	Attribute type	Remark	Qualifier
Instance-Number	MDC_ATTR_ID_ INSTNO	InstNumber	Unique within SCO for operation identification.	M

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Table 7.55—Operation object class attributes *(continued)*

Attribute name	Attribute ID	Attribute type	Remark	Qualifier
Operation-Spec	MDC_ATTR_OP_ SPEC	OperSpec	Structure defining operation types and properties.	M
Operation-Text-Strings	MDC_ATTR_OP_ TEXT_STRING	OperTextStrings	Static description of operation.	O
Operation-Text-Strings-Dyn	MDC_ATTR_OP_ TEXT_STRING_DYN	OperTextStrings	Dynamic description of operation.	O
Vmo-Reference	MDC_ATTR_VMO_ REF	HANDLE	Reference to an object.	O
Operational-State	MDC_ATTR_OP_ STAT	OperationalState	Specifies whether operation is accessible.	O

The Operation object class defines in Table 7.56 the attribute groups or extensions to inherited attribute groups.

Table 7.56—Operation object class attribute groups

Attribute group	Attribute group ID	Group elements
Operation Static Context Group (extensible attribute group)	MDC_ATTR_GRP_OP_ STATIC_CTXT	from Operation: Operation-Spec, Operation-Texts
Operation Dynamic Context Group (extensible attribute group)	MDC_ATTR_GRP_OP_ DYN_CTXT	from Operation: Operational-State, Vmo-Reference

The following type definitions apply:

```
--
-- Operation-Spec attribute indicates what this operation really does
--
OperSpec ::= SEQUENCE {
    vattr-id            OID-Type,       -- ID of the virtual attribute that is changed by operation
    op-target           OID-Type,       -- from metric or object-oriented nomenclature partition
    options             OpOptions,      -- special options
    level               OpLevel,        -- range of importance
    grouping            OpGrouping      -- to describe relations between operations
}
```

NOTE—The vattr-id code comes from the virtual attribute nomenclature partition. Entries (i.e., codes) in this partition are even. The last bit of the code is used to define from which nomenclature partition the op-target code comes. If the last bit is 0, the op-target code comes from the metric nomenclature partition. If the last bit is 1 (1 is added to the base code in the virtual attribute nomenclature), the op-target code comes from the object-oriented nomenclature partition.

```
--
-- Operation texts
--
OperTextStrings ::= SEQUENCE {
    label               OCTET STRING,  -- the label string indicates the meaning of the operation
    help                OCTET STRING,  -- the help string may contain additional help for the user
```

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```
        confirm                 OCTET STRING  -- the confirm string is shown by manager to a user to
                                              -- reconfirm the operation (e.g., "do you really want to
                                              -- shut down?")
    }

    --
    -- Operation options
    --
    OpOptions ::= BITS-16 {
        needs-confirmation(0),
        supports-default(1),                  -- a default value is supported for the virtual attributes
        sets-sco-lock(2),                     -- needs transaction processing to avoid side effects
        is-setting(3),                        -- value preserved over system power fail
        op-dependency(6),                     -- operation has dependencies to others
                                              -- (always set if sets-sco-lock bit is set)
        op-auto-repeat(7),                    -- supports auto repeat
        op-ctxt-help(8)                       -- provides context-dependent help via SCO action
    }

    --
    -- Level
    --
    OpLevel ::= BITS-16 {
        op-level-basic(0),                    -- a normal operation
        op-level-advanced(1),                 -- an advanced operation
        op-level-professional(2),
        op-item-normal(8),                    -- operation modifies a normal user item
        op-item-config(9),                    -- operation modifies a configuration item
        op-item-service(10)                   -- operation modifies a service item (not
                                              -- used by regular operator)
    }

    --
    -- Field for grouping operations (i.e., defines logical relations); can be used to organize operations in a useful
    -- sequence on an operator interface (i.e., display)
    --
    OpGrouping ::= SEQUENCE {
        group                   INT-U8,
        priority                INT-U8
    }
```

7.6.2.2 Behavior

The Operation object does not define any special methods.

7.6.2.3 Notifications

The Operation object does not generate any special notifications.

7.6.3 Select Item Operation object

Object:	Select Item Operation
Description:	“The Select Item Operation object allows selection of one item out of a given list. The list can have different types.”
Derived From:	Operation
Name Binding:	Instance-Number (not directly accessible by object management services)
Registered As:	MDC_MOC_CNTRL_OP_SEL_IT

7.6.3.1 Attributes

The Select Item Operation object class defines the attributes in Table 7.57.

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Table 7.57—Select Item Operation object class attributes

Attribute name	Attribute ID	Attribute type	Remark	Qualifier
Selected-Item-Index	MDC_ATTR_INDEX_SEL	INT-U16	Index of current selection.	M
Nom-Partition	MDC_ATTR_ID_NOM_PARTITION	NomPartition	If entries in list are OIDs, specifies the nomenclature partition that is used.	C
Select-List	MDC_ATTR_LIST_SEL	SelectList	List of possible choices.	M

The Select Item Operation object class defines in Table 7.58 the attribute groups or extensions to inherited attribute groups.

Table 7.58—Select Item Operation object class attribute groups

Attribute group	Attribute group ID	Group elements
Operation Static Context Group (extensible attribute group)	MDC_ATTR_GRP_OP_STATIC_CTXT	from Operation: Operation-Spec, Operation-Texts from Select Item Operation: Nom-Partition
Operation Dynamic Context Group (extensible attribute group)	MDC_ATTR_GRP_OP_DYN_CTXT	from Operation: Operational-State, Vmo-Reference from Select Item Operation: Selected-Item-Index, Select-List

The following type definitions apply:

```
--
-- Select-List attribute defines valid selections
--
SelectList ::= CHOICE {
    oid-list                [1] SEQUENCE OF OID-Type,
    value-list              [3] SEQUENCE OF FLOAT-Type,
    value-u-list            [4] SEQUENCE OF SelectUValueEntry,
    string-list             [5] SEQUENCE OF OCTET STRING
}

--
-- Value with a unit/dimension code
--
SelectUValueEntry ::= SEQUENCE {
    value                   FLOAT-Type,
    m-units                 OID-Type        -- from dimensions nomenclature partition
}
```

7.6.3.2 Behavior

The Select Item Operation object does not define any special methods.

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7.6.3.3 Notifications

The Select Item Operation object does not generate any special notifications.

7.6.4 Set Value Operation object

Object: Set Value Operation
Description: "The Set Value Operation object allows the system to adjust a value within a given range with a given resolution."
Derived From: Operation
Name Binding: Instance-Number (not directly accessible by object management services)
Registered As: MDC_MOC_CNTRL_OP_SEL_VAL

7.6.4.1 Attributes

The Set Value Operation object class defines the attributes in Table 7.59.

Table 7.59—Set Value Operation object class attributes

Attribute name	Attribute ID	Attribute type	Remark	Qualifier
Current-Value	MDC_ATTR_VAL_ CURR	FLOAT-Type	Current value.	M
Set-Value-Range	MDC_ATTR_VAL_ RANGE	OpSetValueRange	Range of legal values.	M
Step-Width	MDC_ATTR_VAL_ STEP_WIDTH	OpValStepWidth	Allowed step width.	O
Unit-Code	MDC_ATTR_UNIT_ CODE	OID-Type	From dimensions nomencla-ture partition.	O

The Set Value Operation object class defines in Table 7.60 the attribute groups or extensions to inherited attribute groups.

Table 7.60—Set Value Operation object class attribute groups

Attribute group	Attribute group ID	Group elements
Operation Static Context Group (extensible attribute group)	MDC_ATTR_GRP_OP_ STATIC_CTXT	from Operation: Operation-Spec, Operation-Texts
Operation Dynamic Context Group (extensible attribute group)	MDC_ATTR_GRP_OP_ DYN_CTXT	from Operation: Operational-State, Vmo-Reference from Set Value Operation: Current-Value, Set-Value-Range, Unit-Code, Step-Width

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The following type definitions apply:

```
--
-- Set-Value-Range attribute defines range and minimum resolution
--
OpSetValueRange ::= SEQUENCE {
    minimum                 FLOAT-Type,
    maximum                 FLOAT-Type,
    resolution              FLOAT-Type
    }

--
-- Step-Width attribute is an ordered (in ascending order) array of ranges and corresponding minimum
-- step widths; the lower edge is defined in the minimum value of the range specification
--
OpValStepWidth ::= SEQUENCE OF StepWidthEntry

StepWidthEntry ::= SEQUENCE {
    upper-edge              FLOAT-Type,
    step-width              FLOAT-Type
}
```

7.6.4.2 Behavior

The Set Value Operation object does not define any special methods.

7.6.4.3 Notifications

The Set Value Operation object does not generate any special notifications.

7.6.5 Set String Operation object

Object: Set String Operation
Description: "The Set String Operation object is used to set the contents of a string type virtual attribute."
Derived From: Operation
Name Binding: Instance-Number (not directly accessible by object management services)
Registered As: MDC_MOC_CNTRL_OP_SET_STRING

7.6.5.1 Attributes

The Set String Operation object class defines the attributes in Table 7.61.

Table 7.61—Set String Operation object class attributes

Attribute name	Attribute ID	Attribute type	Remark	Qualifier
Current-String	MDC_ATTR_STRING_CURR	OCTET STRING	Current value of the string type virtual attribute.	C[a]
Set-String-Spec	MDC_ATTR_SET_STRING_SPEC	SetStringSpec	Properties of the string type virtual attribute.	M

[a]The Current-String attribute is out of the scope of this standard if the setstr-hidden-val flag is set in the specification attribute; it is mandatory otherwise.

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The Set String Operation object class defines in Table 7.62 the attribute groups or extensions to inherited attribute groups.

Table 7.62—Set String Operation object class attribute groups

Attribute group	Attribute group ID	Group elements
Operation Static Context Group (extensible attribute group)	MDC_ATTR_GRP_OP_ STATIC_CTXT	from Operation: Operation-Spec, Operation-Texts
Operation Dynamic Context Group (extensible attribute group)	MDC_ATTR_GRP_OP_ DYN_CTXT	from Operation: Operational-State, Vmo-Reference from Set String Operation: Current-String, Set-String-Spec

The following type definitions apply:

```
--
-- Set-String-Spec attribute
--
SetStringSpec ::= SEQUENCE {
    max-str-len          INT-U16,     -- maximum supported string length
    char-size            INT-U16,     -- character size in bits, e.g., 7, 8, or 16
    set-str-opt          SetStrOpt    -- special option bits
}

--
-- Options for the string
--
SetStrOpt ::= BITS-16 {
    setstr-null-terminated(0),        -- string is terminated with NULL character
    setstr-displayable(1),            -- string is displayable
    setstr-var-length(2),             -- string has variable length (up to maximum)
    setstr-hidden-val(3)              -- actual contents is hidden, e.g., for password entry
}
```

7.6.5.2 Behavior

The Set String Operation object does not define any special methods.

7.6.5.3 Notifications

The Set String Operation object does not generate any special notifications.

7.6.6 Toggle Flag Operation object

Object: Toggle Flag Operation
Description: "The Toggle Flag Operation object allows a switch to be toggled (with two states, e.g., on/off)."
Derived From: Operation
Name Binding: Instance-Number (not directly accessible by object management services)
Registered As: MDC_MOC_CNTRL_OP_TOG

7.6.6.1 Attributes

The Toggle Flag Operation object class defines the attributes in Table 7.63.

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Table 7.63—Toggle Flag Operation object class attributes

Attribute name	Attribute ID	Attribute type	Remark	Qualifier
Toggle-State	MDC_ATTR_STAT_ OP_TOG	ToggleState	Current state of toggle	M
Toggle-Label-Strings	MDC_ATTR_TOG_ LABELS_STRING	ToggleLabel-Strings		M

The Toggle Flag Operation object class defines in Table 7.64 the attribute groups or extensions to inherited attribute groups.

Table 7.64—Toggle Flag Operation object class attribute groups

Attribute group	Attribute group ID	Group elements
Operation Static Context Group (extensible attribute group)	MDC_ATTR_GRP_OP_ STATIC_CTXT	from Operation: Operation-Spec, Operation-Texts
Operation Dynamic Context Group (extensible attribute group)	MDC_ATTR_GRP_OP_ DYN_CTXT	from Operation: Operational-State, Vmo-Reference from Toggle Flag Operation: Toggle-State, Toggle-Label-Strings

The following type definitions apply:

```
--
-- Toggle-State attribute
--
ToggleState ::= INT-U16 {
    tog-state0(0),
    tog-state1(1)
}

--
-- Each state has a label
--

ToggleLabelStrings ::= SEQUENCE {
    lbl-state0                  OCTET STRING,
    lbl-state1                  OCTET STRING
    }
```

7.6.6.2 Behavior

The Toggle Flag Operation object does not define any special methods.

7.6.6.3 Notifications

The Toggle Flag Operation object does not generate any special notifications.

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7.6.7 Activate Operation object

Object: Activate Operation
Description: "The Activate Operation object allows a defined activity to be started (e.g., a zero pressure)."
Derived From: Operation
Name Binding: Instance-Number (not directly accessible by object management services)
Registered As: MDC_MOC_CNTRL_OP_ACTIV

7.6.7.1 Attributes

The Activate Operation object class does not define any additional attributes.

This object class defines in Table 7.65 the attribute groups or extensions to inherited attribute groups.

Table 7.65—Activate Operation object class attribute groups

Attribute group	Attribute group ID	Group elements
Operation Static Context Group (extensible attribute group)	MDC_ATTR_GRP_OP_ STATIC_CTXT	from Operation: Operation-Spec, Operation-Texts
Operation Dynamic Context Group (extensible attribute group)	MDC_ATTR_GRP_OP_ DYN_CTXT	from Operation: Operational-State, Vmo-Reference

No additional type definitions are needed.

7.6.7.2 Behavior

The Activate Operation object does not define any special methods.

7.6.7.3 Notifications

The Activate Operation object does not generate any special notifications.

7.6.8 Limit Alert Operation object

Object: Limit Alert Operation
Description: "The Limit Alert Operation object allows the limits of a limit alarm detector to be adjusted and the limit alarm to be switched on or off."
Derived From: Operation
Name Binding: Instance-Number (not directly accessible by object management services)
Registered As: MDC_MOC_CNTRL_OP_LIM

7.6.8.1 Attributes

The Limit Alert Operation object class defines the attributes in Table 7.66.

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Table 7.66—Limit Alert Operation object class attributes

Attribute name	Attribute ID	Attribute type	Remark	Qualifier
Alert-Op-Capability	MDC_ATTR_AL_OP_CAPAB	AlOpCapab	Indicates what can be switched on or off.	M
Alert-Op-State	MDC_ATTR_AL_OP_STAT	CurLimAlStat	Current on/off state; can be set by Operation-Invoke method.	M
Current-Limits	MDC_ATTR_LIMIT_CURR	CurLimAlVal	Current alarm limits; can be set by Operation-Invoke method.	M
Alert-Op-Text-String	MDC_ATTR_AL_OP_TEXT_STRING	AlOpTextString	Individual text for upper and lower limit.	O
Set-Value-Range	MDC_ATTR_VAL_RANGE	OpSetValueRange	Allowed range for limits.	M
Unit-Code	MDC_ATTR_UNIT_CODE	OID-Type	Dimension of values.	M
Metric-Id	MDC_ATTR_ID_PHYSIO	OID-Type	Measurement (i.e., Numeric object) to which the limit applies, from metric nomenclature partition.	M

The Limit Alert Operation object class defines in Table 7.67 the attribute groups or extensions to inherited attribute groups.

Table 7.67—Limit Alert Operation object class attribute groups

Attribute group	Attribute group ID	Group elements
Operation Static Context Group (extensible attribute group)	MDC_ATTR_GRP_OP_STATIC_CTXT	from Operation: Operation-Spec, Operation-Texts from Limit Alert Operation: Alert-Op-Capability, Alert-Op-Text-String
Operation Dynamic Context Group (extensible attribute group)	MDC_ATTR_GRP_OP_DYN_CTXT	from Operation: Operational-State, Vmo-Reference from Limit Alert Operation: Alert-Op-State, Current-Limits, Set-Value-Range, Unit-Code, Metric-Id

The following type definitions apply:

```
--
-- Alert operation static flags indicate which on/off flags are supported
--
AlOpCapab ::= BITS-16 {
    low-limit-sup(1),                   -- supports low limit
    high-limit-sup(2),                  -- supports high limit
    auto-limit-sup(5),                  -- supports automatic limits
    low-lim-on-off-sup(8),              -- supports to switch on/off low limit
    high-lim-on-off-sup(9),             -- supports to switch on/off high limit
    lim-on-off-sup(10)                  -- supports to switch on/off the complete alarm
}
```

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```
--
-- Alert-Op-State attribute defines the current limit alert state
-- NOTE--The bits refer to the limit alarm only, not to the global alert state of the metric
--
CurLimAlStat ::= BITS-16 {
    lim-alert-off(0),                   -- if this bit is set, all alerts (both high and low) are off
    lim-low-off(1),                     -- low-limit violation detection is off
    lim-high-off(2)                     -- high-limit violation detection is off
}

--
-- Current-Limits attribute
--
CurLimAlVal ::= SEQUENCE {
    lower                   FLOAT-Type,
    upper                   FLOAT-Type
}

--
-- Alert-Op-Text-String attribute assigns individual labels to upper and lower alarm limit
--
AlertOpTextString ::= SEQUENCE {
    lower-text              OCTET STRING,
    upper-text              OCTET STRING
}
```

7.6.8.2 Behavior

The Limit Alert Operation object does not define any special methods.

7.6.8.3 Notifications

The Limit Alert Operation object does not generate any special notifications.

7.6.9 Set Range Operation object

Object: Set Range Operation
Description: "The Set Range Operation object allows the system to adjust low and high values (i.e., a value range) within defined boundaries."
Derived From: Operation
Name Binding: Instance-Number (not directly accessible by object management services)
Registered As: MDC_MOC_CNTRL_OP_SET_RANGE

7.6.9.1 Attributes

The Set Range Operation object class defines the attributes in Table 7.68.

Table 7.68—Set Range Operation object class attributes

Attribute name	Attribute ID	Attribute type	Remark	Qualifier
Current-Range	MDC_ATTR_RANGE_CURR	CurrentRange	Current value.	M
Range-Op-Text	MDC_ATTR_RANGE_OP_TEXT_STRING	RangeOpText	Static attribute to define individual texts for upper and lower boundaries.	O

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Table 7.68—Set Range Operation object class attributes *(continued)*

Attribute name	Attribute ID	Attribute type	Remark	Qualifier
Set-Value-Range	MDC_ATTR_VAL_ RANGE	OpSetValueRange	Range of legal values.	M
Step-Width	MDC_ATTR_VAL_ STEP_WIDTH	OpValStepWidth	Allowed step width.	O
Unit-Code	MDC_ATTR_UNIT_ CODE	OID-Type	From dimensions nomencla-ture partition.	O

The Set Range Operation object class defines in Table 7.69 the attribute groups or extensions to inherited attribute groups.

Table 7.69—Set Range Operation object class attribute groups

Attribute group	Attribute group ID	Group elements
Operation Static Context Group (extensible attribute group)	MDC_ATTR_GRP_OP_ STATIC_CTXT	from Operation: Operation-Spec, Operation-Texts from Set Range Operation: Range-Op-Text
Operation Dynamic Context Group (extensible attribute group)	MDC_ATTR_GRP_OP_ DYN_CTXT	from Operation: Operational-State, Vmo-Reference from Set Value Operation: Current-Range, Set-Value-Range, Unit-Code, Step-Width

The following type definitions apply:

```
--
-- Current-Range attribute defines the current upper and lower range values
--
CurrentRange ::= SEQUENCE {
     lower                    FLOAT-Type,
     upper                    FLOAT-Type
     }

--
-- Range-Op-Text attribute assigns labels to the upper and lower boundaries
--
RangeOpText ::= SEQUENCE {
     low-text                 OCTET STRING,  -- printable label text for low value
     high-text                OCTET STRING   -- printable label text for high value
}
```

7.6.9.2 Behavior

The Set Range Operation object does not define any special methods.

7.6.9.3 Notifications

The Set Range Operation object does not generate any special notifications.

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7.7 Objects in the Extended Services Package

The definitions of objects in the Extended Services Package are given in 7.7.1 through 7.7.9.

7.7.1 Scanner object

Object: Scanner
Description: "A Scanner object is an observer and 'summarizer' of object attribute values. It observes attributes of managed medical objects and generates summaries in the form of notification event reports. The Scanner object class is an abstract class, it cannot be instantiated."
Derived From: Top
Name Binding: Handle
Registered As: MDC_MOC_SCAN

7.7.1.1 Attributes

The Scanner object class defines the attributes in Table 7.70.

Table 7.70—Scanner object class attributes

Attribute name	Attribute ID	Attribute type	Remark	Qualifier
Handle	MDC_ATTR_ID_ HANDLE	HANDLE	Scanners are identified by handles.	M
Instance-Number	MDC_ATTR_ID_ INSTNO	InstNumber	Shall be used when dynamic creation of scanner instances is allowed.	C
Operational-State	MDC_ATTR_OP_ STAT	OperationalState	Defines if scanner is active; can be set.	M

The Scanner object class defines in Table 7.71 the attribute groups or extensions to inherited attribute groups.

Table 7.71—Scanner object class attribute groups

Attribute group	Attribute group ID	Group elements
Scanner Attribute Group (extensible attribute group)	MDC_ATTR_GRP_SCAN	from Scanner: (all)

The attributes require no new type definitions.

7.7.1.2 Behavior

The Scanner object does not define any special methods.

Derived scanner specializations use the following common data types:

--

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```
-- List of objects for which scanned attributes are refreshed
-- If list is empty, all objects in the scan list are refreshed
-- If scanned-attribute is 0 (NOS), all attributes of that object that are scanned are refreshed
-- If the object-glb-handle is 0 (in all components), the specified attribute ID is refreshed for all objects
-- in the scan list
--
RefreshObjList ::= SEQUENCE OF RefreshObjEntry

RefreshObjEntry ::= SEQUENCE {
    object-glb-handle       GLB-HANDLE,
    scanned-attribute       OID-Type        -- attribute ID from object-oriented nomenclature partition
}
```

7.7.1.3 Notifications

Events are defined in derived scanner specializations.

However, most scanner specializations share a common event report data structure that is defined as follows:

```
--
-- A scanner may scan objects from multiple device contexts
-- For efficiency, scanned data that belongs to a single device context is grouped together
--
ScanReportInfo ::= SEQUENCE {
    scan-report-no          INT-U16,        -- counter for detection of missing events
    glb-scan-info           SEQUENCE OF SingleCtxtScan
}

SingleCtxtScan::= SEQUENCE {
    context-id              MdsContext,
    scan-info               SEQUENCE OF ObservationScan
}

ObservationScan ::= SEQUENCE {
    obj-handle              HANDLE,
    attributes              AttributeList
}
```

7.7.2 CfgScanner object

Object:	CfgScanner
Description:	"The CfgScanner object has a special attribute (i.e., the ScanList attribute) that is used to configure which object attributes are scanned. The CfgScanner object has the following properties: — It scans VMO-derived objects (mostly Metric, Channel, and VMD objects). — It contains a list of scanned objects/attributes that can be modified. The CfgScanner object is an abstract class; it cannot be instantiated."
Derived From:	Scanner
Name Binding:	Handle
Registered As:	MDC_MOC_SCAN_CFG

7.7.2.1 Attributes

The CfgScanner object class defines the attributes in Table 7.72.

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Table 7.72—CfgScanner object class attributes

Attribute name	Attribute ID	Attribute type	Remark	Qualifier
Scan-List	MDC_ATTR_SCAN_ LIST	ScanList	List of scanned objects and attributes; can be set.	M
Confirm-Mode	MDC_ATTR_ CONFIRM_MODE	ConfirmMode	Determines whether confirmed event reports are used.	M
Confirm-Timeout	MDC_ATTR_ CONFIRM_TIMEOUT	RelativeTime	Determines when a confirmed event report is resent in case of a missing response.	C
Transmit-Window	MDC_ATTR_TX_ WIND	INT-U16	Maximum number of not-yet-acknowledged event reports at one time.	C
Scan-Config-Limit	MDC_ATTR_SCAN_ CFG_LIMIT	ScanConfigLimit	Even a configurable scanner may restrict the way it can be configured.	O

The CfgScanner object class defines in Table 7.73 the attribute groups or extensions to inherited attribute groups.

Table 7.73—CfgScanner object class attribute groups

Attribute group	Attribute group ID	Group elements
Scanner Attribute Group (extensible attribute group)	MDC_ATTR_GRP_SCAN	(all)

The following type definitions apply:

```
--
-- Scan-List attribute determines which object attributes are observed
--
-- NOTES
-- 1--If the scan list is empty, an episodic scanner has to send empty event reports
-- 2--The scan list will typically contain attribute group IDs for specific objects
--
ScanList ::= SEQUENCE OF ScanEntry

ScanEntry ::= SEQUENCE {
     object-glb-handle          GLB-HANDLE,   -- works for all objects with name binding handle
     scanned-attribute          OID-Type      -- could also be attribute group ID
}

--
-- Confirm-Mode attribute defines if confirmed event reports or unconfirmed event reports are used
--
ConfirmMode ::= INT-U16 {
     unconfirmed(0),
     confirmed(1)
}
--
-- Even a configurable scanner may restrict the way it can be configured
-- If Scan-Config-Limit attribute is absent, the scanner is fully configurable
```


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```
--
ScanConfigLimit ::= BITS-16 {
    no-scan-delete(0),                  -- scanner cannot be deleted
    no-scan-list-mod(1),                -- scan list cannot be dynamically modified
    auto-init-scan-list(3),             -- scan list is automatically initialized after scanner create
    auto-updt-scan-list(4)              -- scan list is automatically updated in case of
                                        -- configuration change
}
```

7.7.2.2 Behavior

The CfgScanner object does not define any special methods.

7.7.2.3 Notifications

Events are defined in derived scanner specializations.

7.7.3 EpiCfgScanner object

Object:	EpiCfgScanner
Description:	"The EpiCfgScanner object is responsible for scanning attributes or attribute groups of objects and for reporting these attributes in episodic, unbuffered (i.e., on change only) event reports."
Derived From:	CfgScanner
Name Binding:	Handle
Registered As:	MDC_MOC_SCAN_CFG_EPI

7.7.3.1 Attributes

The EpiCfgScanner object class does not define attributes other than the attributes inherited from the Cfg-Scanner object.

The EpiCfgScanner object class uses the Scanner Attribute Group that is inherited from the CfgScanner object.

7.7.3.2 Behavior

The EpiCfgScanner object defines the methods in Table 7.74.

Table 7.74—EpiCfgScanner object methods

Action	Mode	Action ID	Action parameter	Action result
Refresh-Episodic-Data	Confirmed	MDC_ACT_REFR_EPI_DATA	RefreshObjList	none

The Refresh-Episodic-Data method triggers a refresh of all scanned attributes.

7.7.3.3 Notifications

The EpiCfgScanner object sends the notifications in Table 7.75.

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Table 7.75—EpiCfgScanner object notifications

Event	Mode	Event ID	Event parameter	Event result
Unbuf-Scan-Report	Confirmed/ Unconfirmed	MDC_NOTI_UNBUF_ SCAN_RPT	ScanReportInfo	—

NOTES

1—If the EpiCfgScanner scans attribute groups of an object and one or more of the attribute values in the group change, then the scanner reports all values of attributes in the group, even those that did not change their value. This is important so that attributes that are dynamically deleted from an object instance can be detected without a special notification.

2—If no attribute of an object changes its value, then no data of this object are included in the scan report (unless an explicit refresh phase was triggered).

3—Because an episodic scanner does not buffer any changes and does not have an update period specification attribute (which is not needed because updates are sent on value changes), attribute change notifications should be sent at a rate that ensures no data loss. For example, in order to ensure that no metric value changes more than once between scans of dynamic attribute groups, the episodic scanner should check for changes at a rate at least as fast as the the shortest MetricSpec::update-period of the metric instances in the scanner's scan list.

4—After instantiation of the scanner, all attribute values are considered changed so that the first scan report contains all attribute values of all objects.

7.7.4 PeriCfgScanner object

Object: PeriCfgScanner
Description: "The PeriCfgScanner object is responsible for scanning attributes and attribute groups of objects and for reporting these attributes in periodic event reports."
Derived From: CfgScanner
Name Binding: Handle
Registered As: MDC_MOC_SCAN_CFG_PERI

7.7.4.1 Attributes

The PeriCfgScanner object class defines the attributes in Table 7.76.

Table 7.76—PeriCfgScanner object class attributes

Attribute name	Attribute ID	Attribute type	Remark	Qualifier
Scan-Extensibility	MDC_ATTR_SCAN_ EXTEND	ScanExtend	Default is extensive.	M
Reporting-Interval	MDC_ATTR_SCAN_ REP_PD	RelativeTime	Period of reports.	M

The PeriCfgScanner object class defines in Table 7.77 the attribute groups or extensions to inherited attribute groups.

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Table 7.77—PeriCfgScanner object class attribute groups

Attribute group	Attribute group ID	Group elements
Scanner Attribute Group (extensible attribute group)	MDC_ATTR_GRP_SCAN	(all)

The attributes require the following new type definitions:

```
--
-- Scan-Extensibility attribute defines if the scanner includes all observations in the ScanReportInfo event
-- parameter or if it includes just the latest observation (i.e., superpositive)
--
ScanExtend ::= INT-U16 {
    extensive(0),                   -- all attribute changes in the scan period are included
    superpositive(1),               -- only the last attribute change is included
    superpositive-avg(2)            -- superpositive, but all values in period are averaged
}
```

7.7.4.2 Behavior

The PeriCfgScanner object does not define any special methods.

7.7.4.3 Notifications

The PeriCfgScanner object sends the notifications in Table 7.78.

Table 7.78—PeriCfgScanner object notifications

Event	Mode	Event ID	Event parameter	Event result
Buf-Scan-Report	Confirmed/ Unconfirmed	MDC_NOTI_BUF_ SCAN_RPT	ScanReportInfo	—

7.7.5 FastPeriCfgScanner object

Object: FastPeriCfgScanner
Description: "The FastPeriCfgScanner object is a specialized object class for scanning the observed value attribute of the Real Time Sample Array object. This special Scanner object is further optimized for low-latency reporting and efficient communication bandwidth utilization, which is required to access real-time waveform data."
Derived From: PeriCfgScanner
Name Binding: Handle
Registered As: MDC_MOC_SCAN_CFG_PERI_FAST

7.7.5.1 Attributes

The FastPeriCfgScanner object class does not define attributes other than the attributes inherited from the PeriCfgScanner object.

The FastPeriCfgScanner object class uses the Scanner Attribute Group that is inherited from the PeriCfg-Scanner object.

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7.7.5.2 Behavior

The FastPeriCfgScanner object does not define any special methods.

7.7.5.3 Notifications

The FastPeriCfgScanner object sends the notifications in Table 7.79.

Table 7.79—FastPeriCfgScanner object notifications

Event	Mode	Event ID	Event parameter	Event result
Fast-Buf-Scan-Report	Confirmed/ Unconfirmed	MDC_NOTI_FAST_ BUF_SCAN_RPT	FastScanReportInfo	—

The following type definitions apply:

```
--
-- Event report contains the observed values of scanned Real Time Sample Array objects
--
FastScanReportInfo ::= SEQUENCE {
    scan-report-no          INT-U16,
    glb-scan-info           SEQUENCE OF SingleCtxtFastScan
}

SingleCtxtFastScan ::= SEQUENCE {
    context-id              MdsContext,
    scan-info               SEQUENCE OF RtsaObservationScan
}

RtsaObservationScan ::= SEQUENCE {
    handle                  HANDLE,
    observation             SaObsValue
}
```

The FastPeriCfgScanner object is a dedicated scanner for Real Time Sample Array objects. For performance reasons, the sample arrays do not carry a separate timestamp in each observation scan structure. For time synchronization and timestamping of specific samples, two different methods can be supported:

a) The default method assumes that the timestamp provided by the EVENT REPORT service is the time of the first sample value in each RtsaObservationScan::SaObsValue data structure.

b) For higher precision time synchronization, Real Time Sample Array objects may support the Average-Reporting-Delay and Sample-Time-Sync attributes. The support for this method is signalled by the presence of the Time-Support::time-capability-time-capab-rtsa-time-sync-high-precision flag in the Clock object. If this method is used, the individual sample times are determined by these attributes and they are independent of the timestamp provided by the EVENT REPORT service.

7.7.6 UcfgScanner object

Object: UcfgScanner

Description: "The UcfgScanner object scans a predefined set of managed medical objects that cannot be modified. In other words, the UcfgScanner object typically is a reporting object that is specialized for one specific purpose. It has the following properties:

a) Scanner event reports are typically used in confirmed mode because the data they contain are not stateless.

b) The list of scanned objects/attributes is fixed (i.e., cannot be configured).

The UcfgScanner object is an abstract class; it cannot be instantiated."

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Derived From: Scanner
Name Binding: Handle
Registered As: MDC_MOC_SCAN_UCFG

7.7.6.1 Attributes

The UcfgScanner object class defines the attributes in Table 7.80.

Table 7.80—UcfgScanner object class attributes

Attribute name	Attribute ID	Attribute type	Remark	Qualifier
Confirm-Mode	MDC_ATTR_ CONFIRM_MODE	ConfirmMode	Default is confirmed mode.	O
Confirm-Timeout	MDC_ATTR_ CONFIRM_TIMEOUT	RelativeTime	Determines when a confirmed event report is resent in case of a missing response.	O
Transmit-Window	MDC_ATTR_TX_ WIND	INT-U16	Maximum number of not-yet-acknowledged event reports at one time.	O

The UcfgScanner object class defines in Table 7.81 the attribute groups or extensions to inherited attribute groups.

Table 7.81—UcfgScanner object class attribute groups

Attribute group	Attribute group ID	Group elements
Scanner Attribute Group (extensible attribute group)	MDC_ATTR_GRP_SCAN	(all)

7.7.6.2 Behavior

The UcfgScanner object does not define any special methods.

7.7.6.3 Notifications

Events are defined in derived scanner specializations.

7.7.7 Context Scanner object

Object: Context Scanner
Description: "The Context Scanner object is responsible for observing device configuration changes. After instantiation, the Context Scanner object is responsible for announcing the object instances in the device's MDIB. The scanner provides the object instance containment hierarchy and static object attribute values. In case of dynamic configuration changes, the Context Scanner object sends notifications about new object instances or deleted object instances."
Derived From: UcfgScanner
Name Binding: Handle
Registered As: MDC_MOC_SCAN_UCFG_CTXT

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7.7.7.1 Attributes

The Context Scanner object class defines the attributes in Table 7.82.

Table 7.82—Context Scanner object class attributes

Attribute name	Attribute ID	Attribute type	Remark	Qualifier
Context-Mode	MDC_ATTR_SCAN_ CTXT_MODE	ContextMode	Default is dynamic.	M

The Context Scanner object class uses the Scanner Attribute Group that is defined by the Scanner object.

The attributes require the following new type definitions:

```
--
-- Context-Mode attribute determines if the context scanner sends create notifications for the maximum set of
-- object instances in the MDIB (and requires no delete notifications) or for active objects only
--
ContextMode ::= INT-U16 {
    static-mode(0),
    dynamic-mode(1)
}
```

7.7.7.2 Behavior

The Context Scanner object defines the methods in Table 7.83.

Table 7.83—Context Scanner object methods

Action	Mode	Action ID	Action parameter	Action result
Refresh-Context	Confirmed	MDC_ACT_REFR_ CTXT	RefreshObjList	ObjCreateInfo (scan report no is 0)

The Refresh-Context method returns configuration information for all object instances currently in the MDIB.

7.7.7.3 Notifications

The Context Scanner object defines the events in Table 7.84.

Table 7.84—Context Scanner object events

Event	Mode	Event ID	Event parameter	Event result
Object-Create-Notification	Confirmed/ Unconfirmed	MDC_NOTI_OBJ_ CREAT	ObjCreateInfo	—
Object-Delete-Notification	Confirmed	MDC_NOTI_OBJ_DEL	ObjDeleteInfo	—

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The following type definitions apply:

```
--
-- Object-Create-Notification event contains type, ID, and attribute information about new object instances
-- in the MDIB
--
    ObjCreateInfo ::= SEQUENCE {
    scan-report-no              INT-U16,
    scan-report-info            SEQUENCE OF CreateEntry
}

--
-- A single new entry for one parent object, necessary to construct hierarchy in MDIB
--
CreateEntry ::= SEQUENCE {
    superior-object             ManagedObjectId,
    created-object              SEQUENCE OF CreatedObject
}

--
-- Now finally the new object itself
--
CreatedObject ::= SEQUENCE {
    class-id                    ManagedObjectId,
    attributes                  AttributeList
}

--
-- Object-Delete-Notification event implicitly deletes all child objects as well
--
ObjDeleteInfo ::= SEQUENCE {
    scan-report-no              INT-U16,
    object-list                 SEQUENCE OF ManagedObjectId
}
```

7.7.8 Alert Scanner object

Object: Alert Scanner
Description: "The Alert Scanner object is responsible for observing the alert-related attribute groups of objects in the Alert Package. As alarming in general is security-sensitive, the scanner is not configurable (i.e., all or no Alert objects are scanned). The Alert Scanner object sends event reports periodically so that timeout conditions can be checked."
Derived From: UcfgScanner
Name Binding: Handle
Registered As: MDC_MOC_SCAN_UCFG_ALSTAT

7.7.8.1 Attributes

The Alert Scanner object class defines the attributes in Table 7.85.

Table 7.85—Alert Scanner object class attributes

Attribute name	Attribute ID	Attribute type	Remark	Qualifier
Reporting-Interval	MDC_ATTR_SCAN_REP_PD	RelativeTime	Period of reports.	M

The Alert Scanner object class uses the Scanner Attribute Group that is defined by the Scanner object.

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The attributes require no new type definitions.

7.7.8.2 Behavior

The Alert Scanner object does not define any special methods.

7.7.8.3 Notifications

The Alert Scanner object defines the events in Table 7.86.

Table 7.86—Alert Scanner object events

Event	Mode	Event ID	Event parameter	Event result
Alert-Scan-Report	Confirmed/ Unconfirmed	MDC_NOTI_AL_STAT_ SCAN_RPT	ScanReportInfo	—

7.7.9 Operating Scanner object

Object: Operating Scanner
Description: "The Operating Scanner object is responsible for providing all information about the operating and control system of the medical device. This information mainly includes SCO-contained Operation objects, which are considered SCO properties, not separate managed medical objects. The operating scanner
— Sends CREATE events for Operation object instances
— Scans Operation object attributes together with attributes of the SCO Transaction Group (see 7.6.1.1)
— Provides a refresh mechanism for Operation object attributes."
Derived From: UcfgScanner
Name Binding: Handle
Registered As: MDC_MOC_SCAN_UCFG_OP

7.7.9.1 Attributes

The Operating Scanner object class does not define attributes other than the attributes inherited from the UcfgScanner object.

The Operating Scanner object class uses the Scanner Attribute Group that is defined by the Scanner object.

7.7.9.2 Behavior

The Operating Scanner object defines the methods in Table 7.87.

Table 7.87—Operating Scanner object methods

Action	Mode	Action ID	Action parameter	Action result
Refresh-Operation-Context	Confirmed	MDC_ACT_REFR_OP_ CTXT	RefreshObjList	OpCreateInfo (scan report no is 0)
Refresh-Operation-Attributes	Confirmed	MDC_ACT_REFR_OP_ ATTR	RefreshObjList	—

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NOTE—The RefreshObjList action parameter for the Refresh-Operation-Attributes method may identify both SCO attributes and Operation object attributes.

7.7.9.3 Notifications

The Operating Scanner object defines the events in Table 7.88.

Table 7.88—Operating Scanner object events

Event	Mode	Event ID	Event parameter	Event result
Oper-Create-Notification	Confirmed/ Unconfirmed	MDC_NOTI_OP_ CREAT	OpCreateInfo	—
Oper-Delete-Notification	Confirmed	MDC_NOTI_OP_DEL	OpDeleteInfo	—
Oper-Attribute-Update	Confirmed/ Unconfirmed	MDC_NOTI_OP_ATTR _UPDT	OpAttributeInfo	—

The following type definitions apply:

```
--
-- Support data types
--
OpElemAttr ::= SEQUENCE {
    op-class-id             OID-Type,
    op-instance-no          InstNumber,
    attributes              AttributeList
}

OpElemAttrList ::= SEQUENCE OF OpElemAttr

OpElem ::= SEQUENCE {
    op-class-id             OID-Type,
    op-instance-no          InstNumber
}

--
-- Create and delete operations
--
OpCreateInfo ::= SEQUENCE {
    scan-report-no          INT-U16,
    scan-info               SEQUENCE OF OpCreateEntry
}

OpCreateEntry ::= SEQUENCE {
    sco-glb-handle          GLB-HANDLE,
    created-op-list         OpElemAttrList
}

OpDeleteInfo ::= SEQUENCE {
    scan-report-no          INT-U16,
    deleted-op-list         SEQUENCE OF OpDeleteEntry
}

OpDeleteEntry ::= SEQUENCE {
    sco-glb-handle          GLB-HANDLE,
    deleted-op-list         SEQUENCE OF OpElem
}
```

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```
--
-- Report of Operation object attributes (from multiple contexts, if necessary)
--
OpAttributeInfo ::= SEQUENCE {
    scan-report-no          INT-U16,
    glb-scan-info           SEQUENCE OF SingleCtxtOperScan
}

SingleCtxtOperScan ::= SEQUENCE {
    context-id              MdsContext,
    scan-info               SEQUENCE OF OpAttributeScan
}

--
-- The scanned information contains SCO transaction attributes and Operation object attributes
--
OpAttributeScan ::= SEQUENCE {
    sco-handle              HANDLE,
    invoke-cookie           INT-U32,
    lock-state              AdministrativeState,
    op-elem-updt-list       OpElemAttrList
}
```

7.8 Objects in the Communication Package

The definitions of objects in the Communication Package are given in 7.8.1 through 7.8.7.

7.8.1 Communication Controller object

Object: Communication Controller
Description: "The Communication Controller object represents the upper layer and lower layer communication profile (i.e., the application profile, the format profile, and the transport profile) and provides access methods for obtaining management information related to data communications."
Derived From: Top
Name Binding: Handle
Registered As: MDC_MOC_CC (from object-oriented nomenclature partition)

7.8.1.1 Attributes

The Communication Controller object class defines the attributes in Table 7.89.

Table 7.89—Communication Controller object class attributes

Attribute name	Attribute ID	Attribute type	Remark	Qualifier
Handle	MDC_ATTR_ID_ HANDLE	Handle	ID for referencing the object	M
Capability	MDC_ATTR_CC_ CAPAB	CcCapability	Bit field indicating specific capabilities of the Communication Controller implementation.	M
CC-Type	MDC_ATTR_CC_ TYPE	CC-Oid	Could be used to specify variants, e.g., ISO/IEEE 11073, local area network (LAN), combinations..	O

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Table 7.89—Communication Controller object class attributes *(continued)*

Attribute name	Attribute ID	Attribute type	Remark	Qualifier
Number-Of-Difs	MDC_ATTR_CC_ NUM_DIFS	INT-U16	Number of device interfaces; defaults to 1 if not present. Device Interface objects are identified by their index. The index is a 16-bit number between 1 and the Number-Of-Difs attribute value. The list is statically configured at Communication Controller configuration time.	O
This-Connection-Dif-Index	MDC_ATTR_CC_ THIS_DIF_INDEX	INT-U16	Device interface used for the current connection. 0 or not present if this cannot be determined/specified by the implementation.	O
Cc-Ext-Mgmt-Proto-Id	MDC_ATTR_CC_EXT _MNG_PROT	CcExtMgmtProto	Specifies ID for an external management protocol, e.g., Simple Network Management Protocol (SNMP) or Common Management Information Protocol (CMIP).	O

The following data type definitions apply:

```
--
-- Capability attribute specifies the Communication Controller object
--
CcCapability ::= BITS-32 {
     cc-sup-ext-mgmt-protocol(0)          -- Communication Controller object supports an external
                                          -- management protocol (e.g., SNMP); if this bit is set, then
                                          -- the presence of the CC-Ext-Mgmt-Proto-Id attribute is
                                          -- required
}

--
-- CC-OID data type is a regular 16-bit OID from the infrastructure elements nomenclature partition
--
CC-Oid ::= OID-Type

--
-- The following is a list of network management protocols; the value range from 32768 to 65535 is reserved
-- for manufacturer-specific protocols
--
CcExtMgmtProto ::= INT-U16 {
     mgmt-proto-snmp-v1(1),               -- Simple Network Management Protocol Version 1
     mgmt-proto-snmp-v2(2),               -- Simple Network Management Protocol Version 2
     mgmt-proto-snmp-v3(3),               -- Simple Network Management Protocol Version 3
     mgmt-proto-cmip(16)                  -- Common Management Information Protocol
}
```

The Communication Controller object class defines the attribute groups in Table 7.90.

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Table 7.90—Communication Controller object class attribute groups

Attribute group	Attribute group ID	Group elements
Communication Controller Attribute Group (extensible attribute group)	MDC_ATTR_GRP_CC	from Communication Controller: (all)

7.8.1.2 Behavior

The Communication Controller object defines the special method in Table 7.91.

Table 7.91—Communication Controller object methods

Action	Mode	Action ID	Action parameter	Action result
Get-Mib-Data	Confirmed	MDC_ACT_GET_MIB_DATA	GetMibData-Request	GetMibData-Result

The following additional data type definitions are needed:

```
--
-- Data type for the ACTION service
-- One request can retrieve data for one device interface only
--
-- NOTE--If the mib-id-list type is empty, no MibElement data are returned in the response; valid entries in the
-- mib-id-list type are defined in the Mib-Element-List attribute of the Device Interface MibElement object
--

GetMibDataRequest ::= SEQUENCE {
    dif-index                   INT-U16,
    mib-id-list                 MibIdList
}

MibIdList ::= SEQUENCE OF CC-Oid

--
-- Data type for the ACTION service result
--
GetMibDataResult ::= SEQUENCE {
    dif-index                   INT-U16,
    mib-data-list               MibDataList
}

MibDataList ::= SEQUENCE OF MibDataEntry

MibDataEntry ::= SEQUENCE {
    mib-id                      CC-Oid,
    mib-attributes              AttributeList
}
```

7.8.1.3 Notifications

No specific events are defined for the Communication Controller object.

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7.8.2 DCC object

Object:	DCC
Description:	"The DCC object is a Communication Controller object used by medical devices operating as agent systems (i.e., association responders)."
Derived From:	Communication Controller
Name Binding:	Handle
Registered As:	MDC_MOC_DCC (from object-oriented nomenclature partition)

7.8.2.1 Attributes

The DCC object does not define any additional attributes.

7.8.2.2 Behavior

The DCC object does not define any special methods.

7.8.2.3 Notifications

No specific events are defined for the DCC object.

7.8.3 BCC object

Object:	BCC
Description:	"The BCC object is a Communication Controller object used by medical devices operating as manager systems (i.e., association requestors)."
Derived From:	Communication Controller
Name Binding:	Handle
Registered As:	MDC_MOC_BCC (from object-oriented nomenclature partition)

7.8.3.1 Attributes

The BCC object does not define any additional attributes.

7.8.3.2 Behavior

The BCC object does not define any special methods.

7.8.3.3 Notifications

No specific events are defined for the BCC object.

7.8.4 Device Interface object

Object:	Device Interface
Description:	"The Device Interface object represents a BCC or DCC communication port that is an end point of a single association for which (e.g., statistical) data are independently collected by the Communication Controller object. The Device Interface object is not accessible by CMDISE services."
Derived From:	—
Name Binding:	—
Registered As:	MDC_CC_DIF (from infrastructure nomenclature partition)

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7.8.4.1 Attributes

The Device Interface object class does not define any attributes. All its properties are captured in the Device Interface MibElement object. This MibElement object is mandatory for each instance of the Device Interface object that is supported by the Communication Controller object.

7.8.4.2 Behavior

The Device Interface object does not define any special methods.

7.8.4.3 Notifications

No specific events are defined for the Device Interface object.

7.8.5 MibElement object

Object: MibElement
Description: "The MibElement object represents management information about a specific physical or logical port of a Device Interface object. The MibElement object is an abstract base class only."
Derived From: —
Name Binding: —
Registered As: MDC_CC_MIB_ELEM (from infrastructure nomenclature partition)

7.8.5.1 Attributes

The MibElement object class defines the attributes in Table 7.92.

Table 7.92—MibElement object class attributes

Attribute name	Attribute ID	Attribute type	Remark	Qualifier
Mib-Ext-Oid	MDC_CC_MIB_DATA_EXT_OID	OCTET STRING	The OCTET STRING contains a registered ISO OID that is fully encoded by basic encoding rules (BER) if the MibElement is a registered concept. The size of the OCTET STRING shall be even and may require a padding byte. This attribute allows the inclusion of management information base (MIB) definitions from other standards here.	O

The attributes can only be retrieved by the special Communication Controller object method.

No additional data type definitions are needed.

The MibElement object class does not define any attribute group.

7.8.5.2 Behavior

The MibElement object does not define any special methods.

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7.8.5.3 Notifications

No specific events are defined for the MibElement object.

7.8.6 Device Interface MibElement object

Object: Device Interface MibElement
Description: "The Device Interface MibElement object describes the properties of the Device Interface object. This MibElement object is mandatory for each Device Interface object of the Communication Controller object."
Derived From: MibElement
Name Binding: —
Registered As: MDC_CC_MIB_ELEM_DIF (from infrastructure nomenclature partition)

7.8.6.1 Attributes

The Device Interface MibElement object class defines the attributes in Table 7.93.

Table 7.93—Device Interface MibElement object class attributes

Attribute name	Attribute ID	Attribute type	Remark	Qualifier
Dif-Id	MDC_CC_MIB_DATA_DIF_ID	INT-U16	Between 1 and the Number-Of-Difs attribute value in the Communication Controller object.	M
Port-State	MDC_CC_MIB_DATA_DIF_PORT_ST	DifMibPortState	State information about the port.	M
Port-Number	MDC_CC_MIB_DATA_DIF_PORT_NO	INT-U16	Logical port number of this device interface.	O
Dif-Type	MDC_CC_MIB_DATA_DIF_TYPE	CC-Oid	Assumes entries in infrastructure nomenclature partition.	O
Active-Profile	MDC_CC_MIB_DATA_PROFILE_ID	OID-Type	This ID should contain the Profile Support Attribute ID (see ISO/IEEE 11073-20101) as used in the ACSE user information structure that was negotiated in the association phase for the active profile. If no profile is active, the field should be set to 0.	O
Supported-Profiles	MDC_CC_MIB_DATA_SUPP_PROFILES	SupportedProfileList	See below	O
MTU	MDC_CC_MIB_DATA_MTU	INT-U32	Maximum transmit unit, in bytes	O
Link-Speed	MDC_CC_MIB_DATA_LINK_SPEED	INT-U32	In bits per second	O
Mib-Element-List	MDC_CC_MIB_DATA_MIB_ELEM_LIST	MibElementList	A list of MibElements supported by the Device Interface object (in addition to this mandatory MibElement). Assumes that the MibElements are registered in the nomenclature.	M

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The attributes can be retrieved only by the special Communication Controller object method.

The following data type definitions apply:

```
--
-- Supported-Profiles attribute defines which profiles are supported by the Device Interface object; entries
-- in the list are Profile Support Attribute IDs as used in the ACSE user information structure used for
-- negotiating the active profile (see definition of application profiles) (entries in the list are from the
-- infrastructure nomenclature partition)
--
SupportedProfileList ::= SEQUENCE OF CC-Oid

--
-- The Mib-Element-List attribute defines which MibElement objects are supported by the Device Interface
-- object (entries in the list are from the infrastructure nomenclature partition)
--
MibElementList ::= SEQUENCE OF CC-Oid

-- State of the communication port
--
DifMibPortState ::= BITS-16 {
    difmib-port-enabled(0),
    difmib-port-connected(1),          -- port physically connected to line/network
    difmib-port-associated(2),         -- logical connection active on port
    difmib-port-failure(15)            -- port is in a hardware failure state
}
```

The Device Interface MibElement object class does not define any attribute group.

7.8.6.2 Behavior

The Device Interface MibElement object does not define any special methods.

7.8.6.3 Notifications

No specific events are defined for the Device Interface MibElement object.

7.8.7 General Communication Statistics MibElement object

Object: General Communication Statistics MibElement
Description: "The General Communication Statistics MibElement object represents generic communication statistics for one device interface."
Derived From: MibElement
Name Binding: —
Registered As: MDC_CC_MIB_ELEM_GEN_COMM_STATS (from infrastructure elements nomenclature table)

7.8.7.1 Attributes

The General Communication Statistics MibElement object class defines the attributes in Table 7.94.

Table 7.94—General Communication Statistics MibElement object class attributes

Attribute name	Attribute ID	Attribute type	Remark	Qualifier
Packets-In	MDC_CC_MIB_DATA_PACK_IN	MibCcCounter	The number of packets received.	O

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Table 7.94—General Communication Statistics MibElement object class attributes *(continued)*

Attribute name	Attribute ID	Attribute type	Remark	Qualifier
Packets-Out	MDC_CC_MIB_DATA_PACK_OUT	MibCcCounter	The number of packet issued.	O
Octets-In	MDC_CC_MIB_DATA_OCT_IN	MibCcCounter	The number of payload bytes received at transport interface (e.g., without framing).	O
Octets-Out	MDC_CC_MIB_DATA_OCT_OUT	MibCcCounter	The number of payload bytes sent at transport interface (e.g., without framing).	O
Discarded-Packets-In	MDC_CC_MIB_DATA_DISC_PACK_IN	MibCcCounter	Received packets not delivered to upper layers.	O
Discarded-Packets-Out	MDC_CC_MIB_DATA_DISC_PACK_OUT	MibCcCounter	Packets from upper layers not sent to network interface.	O
Unknown-Protocol-Packets-In	MDC_CC_MIB_DATA_UNK_PROT_PACK_IN	MibCcCounter	Received packets with unknown protocol.	O
Queue-Len-In	MDC_CC_MIB_DATA_QUEUE_LEN_IN	MibCcGauge	Size of output packet queue in bytes.	O
Queue-Len-Out	MDC_CC_MIB_DATA_QUEUE_LEN_OUT	MibCcGauge	Size of input packet queue in bytes.	O
Dif-Admin-Status	MDC_CC_MIB_DATA_DIF_STATE	OperationalState	Desired device interface state.	O
Dif-Oper-Status	MDC_CC_MIB_DATA_CUR_DIF_STATE	OperationalState	Current device interface status.	O
Dif-Last-Change	MDC_CC_MIB_DATA_TIME_DIF_LAST_CHANGE	AbsoluteTime	The time when the device interface last changed state.	O
Errors-In	MDC_CC_MIB_DATA_ERRS_IN	MibCcCounter	Corrupt received packets.	O
Errors-Out	MDC_CC_MIB_DATA_ERRS_OUT	MibCcCounter	Corrupt sent packets.	O
Generic-Mode	MDC_CC_MIB_DATA_COMM_MODE	MibCc-CommMode	The mode of the communication.	O
Average-Speed	MDC_CC_MIB_DATA_AVG_SPEED	INT-U32	In bits per second.	O
Maximum-Speed	MDC_CC_MIB_DATA_MAX_SPEED	INT-U32	In bits per second.	O

The attributes can only be retrieved by the special Communication Controller object method.

The following data type definitions apply:

```
--
-- The gauge type (from IETF RFC 1155) represents a non-negative integer that may increase or decrease, but
-- that latches at a maximum value
```

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```
--
MibCcGauge ::= INT-U32

--
-- The counter type (from IETF RFC 1155) represents a non-negative integer that monotonically increases until
-- it reaches a maximum value, at which time it wraps around and starts increasing again from 0
--
MibCcCounter ::= INT-U32

--
-- The communication mode type represents the communication modes that are supported by the device interface.

--
MibCcCommMode ::= BITS-32 {
    comm-mode-simplex(0),
    comm-mode-half-duplex(1),
    comm-mode-full-duplex(2)
}
```

The General Communication Statistics MibElement object class does not define any attribute group.

7.8.7.2 Behavior

The General Communication Statistics MibElement object does not define any special methods.

7.8.7.3 Notifications

No specific events are defined for the General Communication Statistics MibElement object.

7.9 Objects in the Archival Package

The definitions of objects in the Archival Package are given in 7.9.1 through 7.9.6.

7.9.1 Multipatient Archive object

Object: Multipatient Archive
Description: "The Multipatient Archive object groups together one or more Patient Archive objects."
Derived From: Top
Name Binding: Handle
Registered As: MDC_MOC_ARCHIVE_MULTI_PT

7.9.1.1 Attributes

The Multipatient Archive object class defines the attributes in Table 7.95.

Table 7.95—Multipatient Archive object class attributes

Attribute name	Attribute ID	Attribute type	Remark	Qual
Handle	MDC_ATTR_ID_ HANDLE	HANDLE	Name binding attribute.	M
System-Id	MDC_ATTR_SYS_ID	OCTET STRING		M
Location	MDC_ATTR_ LOCATION	OCTET STRING	Example: name of hospital.	M

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Table 7.95—Multipatient Archive object class attributes *(continued)*

Attribute name	Attribute ID	Attribute type	Remark	Qual
Study-Name	MDC_ATTR_STUDY_ NAME	OCTET STRING		M
Version	MDC_ATTR_ ARCHIVE_VERS	OCTET STRING	Example: ADS version 1.0.	M

The Multipatient Archive object class defines in Table 7.96 the attribute groups or extensions to inherited attribute groups.

Table 7.96—Multipatient Archive object class attribute groups

Attribute group	Attribute group ID	Group elements
Archival Attribute Group	MDC_ATTR_GRP_ ARCHIVE	from Multipatient Archive: (all)

7.9.1.2 Behavior

The Multipatient Archive object does not define any special methods.

7.9.1.3 Notifications

The Multipatient Archive object does not generate any special notifications.

7.9.2 Patient Archive object

Object: Patient Archive
Description: "The Patient Archive object groups together vital signs and other information about a single patient."
Derived From: Top
Name Binding: Handle
Registered As: MDC_MOC_ARCHIVE_PT

7.9.2.1 Attributes

The Patient Archive object class defines the attributes in Table 7.97.

Table 7.97—Patient Archive object class attributes

Attribute name	Attribute ID	Attribute type	Remark	Qualifier
Handle	MDC_ATTR_ID_ HANDLE	HANDLE	Name binding attribute.	M
System-Id	MDC_ATTR_SYS_ID	OCTET STRING		M
System-Name	MDC_ATTR_NAME_ SYS	OCTET STRING	Example: filename.	M

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Table 7.97—Patient Archive object class attributes *(continued)*

Attribute name	Attribute ID	Attribute type	Remark	Qualifier
Processing-History	MDC_ATTR_PROC_HIST	OCTET STRING	Example: not processed.	M
Protection	MDC_ATTR_PROTECTION	ArchiveProtection	Example: original recording.	M

The Patient Archive object class defines in Table 7.98 the attribute groups or extensions to inherited attribute groups.

Table 7.98—Patient Archive object class attribute groups

Attribute group	Attribute group ID	Group elements
Archival Attribute Group	MDC_ATTR_GRP_ARCHIVE	from Patient Archive: (all)

The following type definitions apply:

```
--
-- Protection attribute defines the mechanism used for access control; this mechanism is vendor- or
-- implementation-specific
--
ArchiveProtection ::= SEQUENCE {
    protection-type             PrivateOid,
    protection-key              ANY DEFINED BY protection-type
}
```

7.9.2.2 Behavior

The Patient Archive object does not define any special methods.

7.9.2.3 Notifications

The Patient Archive object does not generate any special notifications.

7.9.3 Session Archive object

Object: Session Archive
Description: "The Session Archive object contains information on a single patient that is collected during one stay or visit."
Derived From: Top
Name Binding: Handle
Registered As: MDC_MOC_ARCHIVE_SESSION

7.9.3.1 Attributes

The Patient Archive object class defines the attributes in Table 7.99.

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Table 7.99—Patient Archive object class attributes

Attribute name	Attribute ID	Attribute type	Remark	Qualifier
Handle	MDC_ATTR_ID_ HANDLE	HANDLE	Name binding attribute.	M
S-Archive -Id	MDC_ATTR_ID_ SESS_ARCHIVE	OCTET STRING		M
S-Archive-Name	MDC_ATTR_NAME_ SESS_ARCHIVE	OCTET STRING	Example: study name.	M
S-Archive-Comments	MDC_ATTR_SESS_ ARCHIVE_ COMMENTS	OCTET STRING	Example: part one of MSLT test.	O
Start-Time	MDC_ATTR_TIME_ START	AbsoluteTime		M
Stop-Time	MDC_ATTR_TIME_ STOP	AbsoluteTime		M
Protection	MDC_ATTR_ PROTECTION	ArchiveProtection	Example: original recording.	C

The Patient Archive object class defines in Table 7.100 the attribute groups or extensions to inherited attribute groups.

Table 7.100—Patient Archive object class attribute groups

Attribute group	Attribute group ID	Group elements
Archival Attribute Group	MDC_ATTR_GRP_ ARCHIVE	from Session Archive: (all)

7.9.3.2 Behavior

The Patient Archive object does not define any special methods.

7.9.3.3 Notifications

The Patient Archive object does not define any special notifications.

7.9.4 Physician object

Object: Physician
Description: "The Physician object represents a physician."
Derived From: Top
Name Binding: Handle
Registered As: MDC_MOC_PHYSICIAN

7.9.4.1 Attributes

The Physician object class defines the attributes in Table 7.101.

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Table 7.101—Physician object class attributes

Attribute name	Attribute ID	Attribute type	Remark	Qualifier
Handle	MDC_ATTR_ID_ HANDLE	HANDLE	Name binding attribute.	M
Physician-Id	MDC_ATTR_ID_ PHYSICIAN	OCTET STRING		M
Authorization-Level	MDC_ATTR_AUTH_ LEVEL	Authorization		C
Name	MDC_ATTR_ PHYSICIAN_NAME	OCTET STRING	Unstructured physician name.	O
Given-Name	MDC_ATTR_ PHYSICIAN_NAME_ GIVEN	OCTET STRING		O
Family-Name	MDC_ATTR_ PHYSICIAN_NAME_ FAMILY	OCTET STRING		O
Middle-Name	MDC_ATTR_ PHYSICIAN_NAME_ MIDDLE	OCTET STRING		O
Title-Name	MDC_ATTR_ PHYSICIAN_NAME_ TITLE	OCTET STRING	Example: Professor.	O

The Physician object class defines in Table 7.102 the attribute groups or extensions to inherited attribute groups.

Table 7.102—Physician object class attribute groups

Attribute group	Attribute group ID	Group elements
Physician Attribute Group	MDC_ATTR_GRP_ PHYSICIAN	from Physician: (all)

The following type definitions apply:

```
--
-- Authorization-Level attribute defines the access rights used for access control; this mechanism is vendor-
-- or implementation-specific
--
Authorization ::= SEQUENCE {
    authorization-type          PrivateOid,
    authorization-key           ANY DEFINED BY authorization-type
}
```

7.9.4.2 Behavior

The Physician object does not define any special methods.

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7.9.4.3 Notifications

The Physician object does not define any special notifications.

7.9.5 Session Test object

Object: Session Test
Description: "The Session Test object contains vital signs information of a single patient that is recorded during a single examination or diagnostic treatment. This object contains vital signs metrics in form of PM-Store objects. It also may contain information about equipment that was used for recording (in the form of relations to MDS and Ancillary objects)."
Derived From: Top
Name Binding: Handle
Registered As: MDC_MOC_SESSION_TEST

7.9.5.1 Attributes

The Session Test object class defines the attributes in Table 7.103.

Table 7.103—Session Test object class attributes

Attribute name	Attribute ID	Attribute type	Remark	Qualifier
Handle	MDC_ATTR_ID_ HANDLE	HANDLE	Name binding attribute.	M
St-Archive-Id	MDC_ATTR_ID_ SESS_TEST_ ARCHIVE	OCTET STRING		M
St-Archive-Name	MDC_ATTR_NAME_ SESS_TEST_ ARCHIVE	OCTET STRING	Example: study name.	M
St-Archive-Comments	MDC_ATTR_SESS_ TEST_ARCHIVE_ COMMENTS	OCTET STRING		O
Start-Time	MDC_ATTR_TIME_ START	AbsoluteTime		M
Stop-Time	MDC_ATTR_TIME_ STOP	AbsoluteTime		M
Protection	MDC_ATTR_ PROTECTION	ArchiveProtection		C

The Session Test object class defines in Table 7.104 the attribute groups or extensions to inherited attribute groups.

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Table 7.104—Session Test object class attribute groups

Attribute group	Attribute group ID	Group elements
Archival Attribute Group	MDC_ATTR_GRP_ ARCHIVE	from Session Test: (all)

7.9.5.2 Behavior

The Session Test object does not define any special methods.

7.9.5.3 Notifications

The Session Test object does not generate any special notifications.

7.9.6 Session Notes object

Object: Session Notes
Description: "The Session Notes object contains diagnostic data, patient care details, and treatment-related information in the form of textual data."
Derived From: Top
Name Binding: Handle
Registered As: MDC_MOC_SESSION_NOTES

7.9.6.1 Attributes

The Session Notes object class defines the attributes in Table 7.105.

Table 7.105—Session Notes object class attributes

Attribute name	Attribute ID	Attribute type	Remark	Qualifier
Handle	MDC_ATTR_ID_ HANDLE	HANDLE	Name binding attribute.	M
Sn-Id	MDC_ATTR_ID_ SESS_NOTES_ ARCHIVE	OCTET STRING		M
Sn-Name	MDC_ATTR_NAME_ SESS_NOTES_ ARCHIVE	OCTET STRING		M
Sn-Comments	MDC_ATTR_SESS_ NOTES_ARCHIVE_ COMMENTS	OCTET STRING		O
Start-Time	MDC_ATTR_TIME_ START	AbsoluteTime		M
Stop-Time	MDC_ATTR_TIME_ STOP	AbsoluteTime		M
Findings	MDC_ATTR_ FINDINGS	OCTET STRING		O

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Table 7.105—Session Notes object class attributes *(continued)*

Attribute name	Attribute ID	Attribute type	Remark	Qualifier
Diagnostic-Codes	MDC_ATTR_CODE_ DIAGNOSTIC	SEQUENCE OF ExtNomenRef	Diagnostic codes are specified in a nomenclature scheme not defined in this standard.	M
Diagnosis-Description	MDC_ATTR_DESC_ DIAGNOSTIC	OCTET STRING		O
Procedure-Code	MDC_ATTR_CODE_ PROCEDURE	SEQUENCE OF ExtNomenRef	Procedure codes are specified in a nomenclature scheme not defined in this standard.	M
Procedure-Description	MDC_ATTR_DESC_ PROCEDURE	OCTET STRING		O
Protection	MDC_ATTR_ PROTECTION	ArchiveProtection		C

The Session Notes object class defines in Table 7.106 the attribute groups or extensions to inherited attribute groups.

Table 7.106—Session Notes object class attribute groups

Attribute group	Attribute group ID	Group elements
Archival Attribute Group	MDC_ATTR_GRP_ ARCHIVE	from Session Notes: (all)

7.9.6.2 Behavior

The Session Notes object does not define any special methods.

7.9.6.3 Notifications

The Session Notes object does not generate any special notifications.

7.10 Objects in the Patient Package

7.10.1 Patient Demographics object

Object: Patient Demographics
Description: "The Patient Demographics object contains minimal patient information as required by medical devices."
Derived From: Top
Name Binding: Handle
Registered As: MDC_MOC_PT_DEMOG

7.10.1.1 Attributes

The Patient Demographics object class defines the attributes in Table 7.107.

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Table 7.107—Patient Demographics object class attributes

Attribute name	Attribute ID	Attribute type	Remark	Qualifier
Handle	MDC_ATTR_ID_ HANDLE	HANDLE	Name binding attribute.	M
Pat-Demo-State	MDC_ATTR_PT_ DEMOG_ST	PatDemoState	As a container, this object has a state.	M
Patient-Id	MDC_ATTR_PT_ID	OCTET STRING		O
Name	MDC_ATTR_PT_ NAME	OCTET STRING	Unstructured patient name.	O
Given-Name	MDC_ATTR_PT_ NAME_GIVEN	OCTET STRING		O
Family-Name	MDC_ATTR_PT_ NAME_FAMILY	OCTET STRING		O
Middle-Name	MDC_ATTR_PT_ NAME_MIDDLE	OCTET STRING		O
Birth-Name	MDC_ATTR_PT_ NAME_BIRTH	OCTET STRING	Maiden name.	O
Title-Name	MDC_ATTR_PT_ NAME_TITLE	OCTET STRING	Example: Professor.	O
Sex	MDC_ATTR_PT_SEX	PatientSex		O
Race	MDC_ATTR_PT_ RACE	PatientRace		O
Patient-Type	MDC_ATTR_PT_ TYPE	PatientType		O
Date-Of-Birth	MDC_ATTR_PT_DOB	Date		O
Patient-Gen-Info	MDC_ATTR_PT_GEN _INFO	OCTET STRING	Textual patient-related information.	O
Patient-Age	MDC_ATTR_PT_AGE	PatMeasure	For neonatal, e.g., in hours or in weeks.	O
Gestational-Age	MDC_ATTR_PT_AGE _GEST	PatMeasure	For neonatal.	O
Patient-Height	MDC_ATTR_PT_ HEIGHT	PatMeasure		O
Patient-Weight	MDC_ATTR_PT_ WEIGHT	PatMeasure		O
Patient-Birth-Length	MDC_ATTR_PT_ BIRTH_LENGTH	PatMeasure	For neonatal.	O
Patient-Birth-Weight	MDC_ATTR_PT_ BIRTH_WEIGHT	PatMeasure	For neonatal.	O
Mother-Patient-Id	MDC_ATTR_ID_PT_ MOTHER	OCTET STRING	For neonatal.	O
Mother-Name	MDC_ATTR_PT_ NAME_MOTHER	PatientName	For neonatal.	O

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Table 7.107—Patient Demographics object class attributes *(continued)*

Attribute name	Attribute ID	Attribute type	Remark	Qualifier
Patient-Head-Circumference	MDC_ATTR_CIRCUM_HEAD	PatMeasure		O
Patient-Bsa	MDC_ATTR_PT_BSA	PatMeasure	Body surface area; can be calculated.	O
Patient-Lbm	MDC_ATTR_PT_LBM	Pat Measure	Lean body mass; used for drug dosage calculations.	O
Bed-Id	MDC_ATTR_ID_BED	OCTET STRING		O
Diagnostic-Info	MDC_ATTR_DIAGNOSTIC_INFO	OCTET STRING	Free text for diagnosis.	O
Diagnostic-Codes	MDC_ATTR_CODE_DIAGNOSTIC	SEQUENCE OF ExtNomenRef	Diagnostic codes are specified in a nomenclature scheme not defined in this standard.	O
Admitting-Physician	MDC_ATTR_PHYSICIAN_ADMIT	OCTET STRING	For ICU.	O
Attending-Physician	MDC_ATTR_PHYSICIAN_ATTEND	OCTET STRING	For ICU.	O
Date-Of-Procedure	MDC_ATTR_PROCEDURE_DATE	Date	For operating room (OR).	O
Procedure-Description	MDC_ATTR_DESC_PROCEDURE	OCTET STRING	For OR.	O
Procedure-Codes	MDC_ATTR_CODE_PROCEDURE	SEQUENCE OF ExtNomenRef	For OR; procedure codes are specified in a nomenclature scheme not defined in this standard.	O
Anaesthetist	MDC_ATTR_ANAESTHETIST	OCTET STRING	For OR.	O
Surgeon	MDC_ATTR_SURGEON	OCTET STRING	For OR.	O

NOTE—For practical purposes some patient-related data that could just as well be modeled in the form of Metric objects (e.g., weight, height) are duplicated here in the Patient Demographics object. Implementations need to consider the application needs for proper modeling.

The Patient Demographics object class defines in Table 7.108 the attribute groups or extensions to inherited attribute groups.

Table 7.108—Patient Demographics object class attribute groups

Attribute group	Attribute group ID	Group elements
Patient Demographics Attribute Group	MDC_ATTR_GRP_PT_DEMOG	from Patient Demographics: (all)

The following type definitions apply:

```
--
```

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```
-- State of the Patient Demographics object
--
PatDemoState ::= INT-U16 {
    empty(0),
    pre-admitted(1),
    admitted(2),
    discharged(8)
}

--
-- Patient demographics measured value
--
PatMeasure ::= SEQUENCE {
    value                   FLOAT-Type,
    m-unit                  OID-Type        -- code for units of measure
}

--
-- Patient sex according to ISO/IEC 5218
--
PatientSex ::= INT-U16 {
    sex-unknown(0),
    male(1),
    female(2),
    sex-unspecified(9)
}

--
-- Patient-Type attribute
--
PatientType ::= INT-U16 {
    pt-unspecified(0),
    adult(1),
    pediatric(2),
    neonatal(3)
}

--
-- Patient race according to the Standard Communications Protocol [for computer-assisted] Electrocardiography
(SCP ECG) (see CEN EN 1064)
--
PatientRace ::= INT-U16 {
    race-unspecified(0),
    race-caucasian(1),
    race-black(2),
    race-oriental(3)
}
```

7.10.1.2 Behavior

The Patient Demographics object defines the methods in Table 7.109.

Table 7.109—Patient Demographics object methods

Action	Mode	Action ID	Action parameter	Action result
Discharge-Patient	Confirmed	MDC_ACT_DISCH_PT	—	PatDemoState
Admit-Patient	Confirmed	MDC_ACT_ADMIT_PT	AdmitPatInfo	PatDemoState
Pre-Admit-Patient	Confirmed	MDC_ACT_PRE_ ADMIT_PT	AdmitPatInfo	PatDemoState

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The following type definitions apply:

```
--
-- Admit-Patient method
--
AdmitPatInfo ::= AttributeList
```

7.10.1.3 Notifications

The Patient Demographics object defines the events in Table 7.110.

Table 7.110—Patient Demographics object events

Event	Mode	Event ID	Event parameter	Event result
Patient-Demographics-Modified	Confirmed/ Unconfirmed	MDC_NOTI_PT_ DEMOG_MOD	AttributeList	—
Patient-Demographics-State-Change	Confirmed/ Unconfirmed	MDC_NOTI_PT_ DEMOG_ST_MOD	AttributeList	—

No additional type definitions are needed.

8. Service model for communicating systems

8.1 General

This clause defines the basic application layer services provided by communicating systems that comply with this standard. The services are used by application processes to exchange vital signs information and commands for device and measurement control.

8.2 Communicating systems

The communication architecture that is assumed here is based on the agent-manager concept found in ISO systems management. It is possible to distinguish three types of systems that communicate and process vital signs information:

a) Vital signs information agent (i.e., an agent system that provides vital signs information in the form of managed medical objects)

b) Vital signs information manager (i.e., a manager system that consumes and acts upon vital signs information in the form of managed medical objects)

c) Vital signs information hybrid system (i.e., a system that both provides and consumes vital signs information)

NOTE—The term *vital signs* refers to the scope of this standard, not to the type or timeliness of information. Archived vital sign information can, for example, be provided on a vital signs information agent to supply manager applications with the requested data using remote database access.

A single communication application may consist of two or more of the above-mentioned systems.

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Example: A central arrhythmia review system may consist of an ECG monitor (i.e., a vital signs information agent), an arrhythmia computer (i.e., a vital signs information hybrid system), and a central display and storage device (i.e., a vital signs information manager).

8.3 General service model overview

The range of devices, system configurations, and applications in the scope of this standard (i.e., vital signs) is very wide. From a simple device providing a single numerical measurement to a system that consists of a number of dynamically reconfigurable measurement and processing devices, there is a large variation in complexity. Over time, it is likely that new information objects or objects providing specific functionality will have to be added to the DIM to cope with ongoing developments in the field of medical devices and measurements.

Therefore, specialized messages for all possible vital signs and each possible application cannot be defined without causing penalties for small-scale devices and difficulties in the future maintenance of this standard and any implementations that are based on it. These obstacles necessitate the definition of a generalized service model that is largely independent of the DIM and does not require modification if new information objects are needed.

The DIM is strictly based on object-oriented methodology. It defines vital signs information in the form of objects and object hierarchies (i.e., managed medical objects). The information objects each have identifiers, attributes, and methods.

The service model for communicating systems provides access to these managed medical objects by means of basic object management services that are independent of specific information object definitions. Such object management services make it possible to extend the information model by adding additional objects in subsequent standards without affecting the service model.

General object management services as defined in this standard are conceptually based on OSI system management in general (i.e., ISO/IEC 10040, the ISO/IEC 10164 family of standards) and specifically on the ISO/IEC common management information service element (CMISE) (i.e., ISO/IEC 9595).

NOTE—Objects that provide extended management services as defined in ISO/IEC 10164 family of standards are defined in the DIM, in particular in the Extended Services Package. Extended services defined by objects are invoked by the general object management services defined in this clause. Unless otherwise noted, in this clause the term *services* refers to the application layer services defined here.

The services enable the exchange of information about managed medical objects defined in the DIM between two peer entities. In a communicating system, the services are provided by the CMDISE. This name is chosen to make the functional similarity to CMISE obvious, but at the same time leave the definition of a cost-/performance-improved service model implementation to the interoperability work item instead of requiring a ISO/IEC CMIP-conformant implementation.

Service calls shall be mapped to a protocol, the Common Medical Device Information Protocol (CMDIP), the definition of which is outside the scope of this standard. The CMDIP is defined in ISO/IEEE 11073-20101.

ISO/IEC CMIP (i.e., ISO/IEC 9596-1) is considered a valid protocol implementation of the generalized object management services provided by the CMDISE defined in this standard. Additional (e.g., cost and/or performance optimized) implementations are explicitly not excluded and may be found in dependent standard(s).

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8.3.1 Conceptual architecture of communicating systems

The conceptual architecture of communicating devices for which this standard provides information object definitions is expressed in Figure 8.1. This figure shows how the services provided by CMDISE relate to object definitions defined in this standard and to applications using these object definitions.

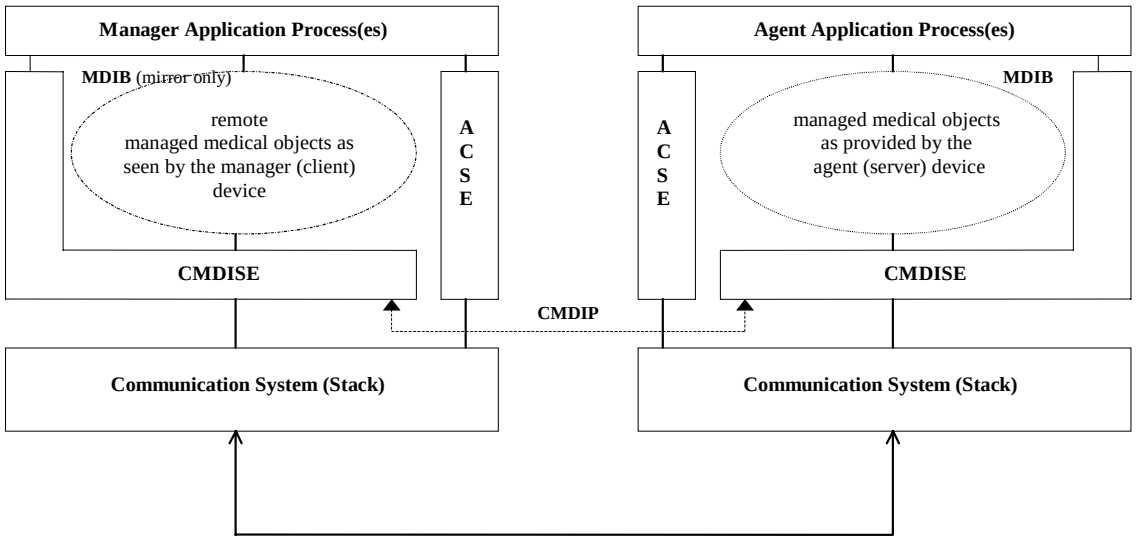

Figure 8.1—Conceptual communicating systems architecture

The application processes shown in Figure 8.1 are service users; the CMDISE and the ACSE are service providers.

This architectural model shows the following components that are used or referenced in this standard:

- A CMDISE, which provides the services defined in Clause 8 to application processes. The services are mapped to messages defined by the CMDIP.
- ACSE, which provides services to establish logical connections between MDSs. ACSE and the corresponding protocol are defined in ISO/IEC 8649 and ISO/IEC 8650-1. It provides service primitives for the following:
  - Requesting and accepting an association
  - Releasing an association and accepting the release
  - Association abort in case of a failure
- A standardized MDIB that contains managed medical object instances as defined in this standard (i.e., in the DIM).
- A standardized communication system (i.e., communication stack or profile, defining Layer 1 to Layer 6 of the OSI reference model). In addition to basic communication, this system may also provide services for synchronization between multiple devices, fragmentation of large messages, flow control, etc.

NOTE—The definition of association control and lower layer communication profiles is outside the scope of this standard. They are shown in Figure 8.1 for completeness only.

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The manager system may use CMDISE services to build and to maintain a local copy of the agent's MDIB. As a conceptual illustration, Figure 8.1 shows a mirror of the agent's MDIB in the manager system. Note that object manipulation is always carried out by agent application processes.

An agent application populates and updates objects and attribute values in the agent MDIB. Applications running in the manager system may access the local copy of the MDIB in the manager for efficient data access (but services always act upon object instances in the agent's MDIB).

Objects in the MDIB can be remotely accessed only by using CMDISE services.

NOTE—Application access to the MDIB inside a specific system is a local implementation issue and is outside the scope of this standard. The actual implementation of the MDIB is also a local implementation issue and, therefore, outside the scope of this standard.

The following groups of services for the management of medical information are defined in this standard:

a) *Operational services:* This standard defines the following operational services on managed medical objects:

   1) Retrieve object attribute value

   2) Modify object attribute value

   3) Invoke object-defined functions

   4) Create and delete object instances

b) *Notification services:* This standard defines the following service that makes it possible to convey event notifications between communicating systems:

   1) Report asynchronous events that occurred within an object

c) *Services used by a manager system:* The manager system (i.e., client) invokes operational services to determine the agent (i.e., server) configuration, to retrieve medical object attribute values (e.g., measurements), and to control the agent. The manager system responds to notification services, if required, by providing an acknowledgment.

d) *Services used by an agent system:* The agent system invokes notification services to report the occurrence of defined events. The agent system responds to operational services by providing a result.

e) *Services used by a hybrid system:* A hybrid system invokes both operational and notification services as appropriate for a particular application. A hybrid system responds to both operational and notification services.

8.4 General object management services definition

Communicating systems that comply with the definitions in this standard provide or make use of the object management services defined in this subclause. The extent to which these services are used by any particular communicating system depends on its role and its scope. Objects defined in the DIM specify the extent to which they use these services and the extent to which they can be accessed (i.e., controlled) by these services.

Service parameters defined in this subclause represent minimum requirements for communicating systems. In other words, an implementation of the service model may add extended functionality (e.g., authentication, access control, extended object selection) that requires additional parameters on top of the definitions in this standard. A protocol definition shall define the actual parameter data types and their usage in protocol messages.

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8.4.1 EVENT REPORT service

The EVENT REPORT service is used to report an event about a managed object instance. The service may be used in confirmed mode or in unconfirmed mode. In confirmed mode, an EVENT REPORT service call requires a response.

Example: An SpO2 monitor (i.e., an agent in a data logger application) may detect a transducer failure. The application process uses the EVENT REPORT service provided by the CMDISE to notify an associated manager of this technical alarm condition.

Unlike all other management services, the EVENT REPORT service, as a notification service, is initiated by an agent application process; the manager application process is the receiver and responder.

The EVENT REPORT service has the parameters in Table 8.1.

Table 8.1—EVENT REPORT service parameters

Parameter	Description
Invoke Identifier	Unique ID (e.g., a sequence number) assigned to a specific instance of the service so that it can be distinguished from other service invocations that a service provider may have in progress.
Mode	Confirmed or unconfirmed; confirmed mode requires a response.
Object Class	Identifies class of the object that generates the event (with the values defined in nomenclature/dictionary).
Object Instance	Identifies instance of the object that generates the event.
Event Time	Time the event was generated.
Event Type	Identifies the type of event (with the values defined in nomenclature/dictionary).
Event Information	(Optional) Additional information about the event, as defined by the Event Type parameter. The Event Information parameter is defined by the object that generates the event.

The confirmed EVENT REPORT service returns a response that has the parameters in Table 8.2.

Table 8.2—EVENT REPORT service result parameters

Parameter	Description
Invoke Identifier	Returns the unique Invoke Identifier parameter of the EVENT REPORT service so that the response can be related to the request.
Object Class	Same value as in EVENT REPORT service (optional).
Object Instance	Same value as in EVENT REPORT service (optional).
Current Time	(Optional).
Event Type	Same value as in EVENT REPORT service (optional).
Event Reply Information	(Optional) Additional information, as defined by the Event Type parameter.

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If the EVENT REPORT service call cannot be processed, an error is returned indicating the type of failure.

8.4.2 GET service

The GET service allows the retrieval of attribute data from managed object instances. The GET service is always used in confirmed mode. The GET service response contains the requested data (or an error notification).

Example: A data storage manager application may use the GET service to retrieve the serial number and revision information from a connected measurement device.

A manager process invokes the GET service (i.e., sends a GET service request message) to retrieve one, several, or all attributes of a selected managed object instance in an agent. The GET service result returns a list containing the requested attribute values.

The GET service has the parameters in Table 8.3.

Table 8.3—GET service parameters

Parameter	Description
Invoke Identifier	Unique ID (e.g., a sequence number) assigned to a specific instance of the service.
Object Class	Identifies class of the object that contains the requested attributes (i.e., values defined in nomenclature/dictionary).
Object Instance	Identifies instance of the object that contains the requested attributes.
Attribute Identifier List	List of attribute IDs (i.e., values defined in nomenclature/dictionary) for which values are to be retrieved.

The GET service returns a response that has the parameters in Table 8.4.

Table 8.4—GET service result parameters

Parameter	Description
Invoke Identifier	Returns the unique Invoke Identifer parameter of the GET service.
Object Class	Same value as in GET service.
Object Instance	Same value as in GET service.
Attribute List	A list of attribute ID–attribute value pairs.

If the GET service call cannot be processed, an error is returned indicating the type of failure.

8.4.3 SET service

The SET service allows the modification of attribute data contained in managed object instances. The SET service may be used in confirmed mode or in unconfirmed mode. In confirmed mode, a SET service call requires a response.

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Example: A central computer may use the SET service to set the current date and time in a device that has been newly connected to a network.

The manager process invokes the SET service (i.e., sends a SET service request message) to modify one or several attributes of a selected object instance in an agent. For each attribute that is to be modified, the request contains the attribute ID, a modify operator (to select whether the attribute value should be replaced, added to a list, deleted from a list, or set to a default value), and (optionally) the attribute value.

The SET service has the parameters in Table 8.5.

Table 8.5—SET service parameters

Parameter	Description
Invoke Identifier	Unique ID (e.g., a sequence number) assigned to a specific instance of the service.
Mode	Confirmed or unconfirmed.
Object Class	Identifies class of the object that contains the attributes to be modified (i.e., values defined in nomenclature/dictionary).
Object Instance	Identifies instance of the object that contains the attributes to be modified.
Modification List	List of (modify operator - attribute ID - attribute value) records. The modify operator may be replace, addValues, removeValues, setToDefault.

The confirmed SET service returns a response that has the parameters in Table 8.6.

Table 8.6—SET service result parameters

Parameter	Description
Invoke Identifier	Returns the unique Invoke Identifier parameter of the SET service.
Object Class	Same value as in SET service.
Object Instance	Same value as in SET service.
Attribute List	A list of attribute ID–attribute value pairs (optional).

If the SET service call cannot be processed, an error is returned indicating the type of failure.

8.4.4 ACTION service

The ACTION service makes it possible to invoke a predefined method (i.e., procedure) of a managed medical object. The ACTION service may be used in confirmed mode or in unconfirmed mode. In confirmed mode, an ACTION service call requires a response.

Example: A monitoring system may use the ACTION service to start a calibration procedure on a measurement device.

The definition of object methods and the consequent object behavior are dependent on the specification of the managed object, not on the ACTION service. The object specification in the DIM defines all available

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object methods that can be invoked by the ACTION service, along with their specific parameter and result data types.

The ACTION service has the parameters in Table 8.7.

Table 8.7—ACTION service parameters

Parameter	Description
Invoke Identifier	Unique ID (e.g., a sequence number) assigned to a specific instance of the service.
Mode	Confirmed or unconfirmed.
Object Class	Identifies class of the object that should execute the action (with the values defined in nomenclature/dictionary).
Object Instance	Identifies instance of the object that should execute the action.
Action Type	Identifies the type of the action (with the values defined in nomenclature/dictionary).
Action Information	Additional parameters for the action, as defined by the action type.

The confirmed ACTION service returns a response that has the parameters in Table 8.8.

Table 8.8—ACTION service result parameters

Parameter	Description
Invoke Identifier	Returns the unique Invoke Identifier parameter of the ACTION service.
Object Class	Same value as in ACTION service.
Object Instance	Same value as in ACTION service.
Action Type	Identifies the type of the action; same value as in ACTION service.
Action Reply	(Optional) Result of the action, as defined by the action type.

If the ACTION service call cannot be processed, an error is returned indicating the type of failure.

8.4.5 CREATE service

The CREATE service is used to create a new instance of a managed medical object. Attributes of the new object can be specified when using this service. The CREATE service is always used in confirmed mode and requires a response.

> **Example:** A data logger application may use the CREATE service to create an extended service object (e.g., a Scanner object) in a monitoring measurement agent (i.e., the agent system). This scanner processes all numerical measurement data and sends a report (i.e., event report) to the charting application every minute.

The CREATE service does not permit the creation of instances of arbitrary objects in the MDIB of the agent system. A system that complies with the definitions in this standard has to specify which object classes can be dynamically created.

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The CREATE service has the parameters in Table 8.9.

Table 8.9—CREATE service parameters

Parameter	Description
Invoke Identifier	Unique ID (e.g., a sequence number) assigned to a specific instance of the service.
Object Class	Identifies class of the object that should be created (with the values defined in nomenclature/dictionary).
Superior Object Class	Identifies class of the superior (with respect to containment hierarchy) object instance.
Superior Object Instance	Identifies instance of the superior (with respect to containment hierarchy) object.
Attribute List	A list of attribute ID–attribute value pairs (optional) to set the initial values of attributes.

The CREATE service returns a response that has the parameters in Table 8.10.

Table 8.10—CREATE service result parameters

Parameter	Description
Invoke Identifier	Returns the unique Invoke Identifier parameter of the CREATE service.
Object Class	Same value as in CREATE service.
Object Instance	Assigned by CMDISE according to object name binding.

If the CREATE service call cannot be processed, an error is returned indicating the type of failure.

8.4.6 DELETE service

The DELETE service is used to delete instances of managed objects. The delete service is always used in confirmed mode and requires a response.

> **Example:** When the data logger application from the previous example no longer needs the measurement data provided by the agent system, it uses the DELETE service to delete the extended services object (i.e., the Scanner object instance).

The DELETE service does not permit the deletion of instances of arbitrary objects in the MDIB of the agent system. A system that complies with the definitions in this standard has to specify which object classes can be dynamically deleted.

The DELETE service has the parameters in Table 8.11.

The DELETE service returns a response that has the parameters in Table 8.12.

If the DELETE service call cannot be processed, an error is returned indicating the type of failure.

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Table 8.11—DELETE service parameters

Parameter	Description
Invoke Identifier	Unique ID (e.g., a sequence number) assigned to a specific instance of the service.
Object Class	Identifies class of the object that should be deleted (with the values defined in nomenclature/dictionary).
Object Instance	Identifies instance of the object that should be deleted.

Table 8.12—DELETE service result parameters

Parameter	Description
Invoke Identifier	Returns the unique Invoke Identifier parameter of the DELETE service.
Object Class	Same value as in DELETE service.
Object Instance	Same value as in DELETE service.

9. MDIB nomenclature

The set of objects and object instantiations occurring in any device of the communicating system as described in the DIM forms the MDIB. Each instantiation of the objects of this model needs a unique identification. The total set of terms forms the MDIB nomenclature or the data dictionary. Because a large number of instantiations exist, a structured identification scheme, i.e., a nomenclature**,** is necessary. The nomenclature for the MDIB comprises several thousand terms concerning the object-oriented modeling elements, demographic patient data, device descriptions, measurement values, measurement methods, measurement locations, alarm information, etc. It is open for extensions due to progress in medicine and technology without the need to change structures and terms within an established set of terms.

The nomenclature also supports the development of a dictionary that is language independent with a coding scheme for easy and fast computer access.

The MDIB (i.e., data dictionary) is presented in ISO/IEEE 11073-10101. It contains the terms (i.e., systematic names), descriptions, and codes for the following target categories:

— Object-oriented modeling elements resulting from the DIM

— Medical devices and device systems

— Units of measurements

— Metrics (measurements and enumerations)

— Body sites (i.e., specifications for measurement locations)

— Alerts

— External nomenclatures

Each of the respective clauses starts with a detailed description on how to build the systematic name for the target category concerned.

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10. Conformance model

10.1 Applicability

It is expected that this standard will be used together with other base standards or referenced by other standards in the ISO/IEEE 11073 family of standards to define applications (e.g., for the exchange of vital signs measurement databases) or to define functional communication profiles (e.g., medical device interoperability profiles).

Such additional specifications or standards are necessary to fully enable an implementation or a system using this standard.

It is possible for an implementation or a system to conform to the following element of this standard, which contains concrete definitions:

— DIM class hierarchy and object definitions (i.e., object attributes, notifications, methods, and data type definitions).

However, conformance to this element alone does not provide interoperability of applications or medical devices.

Standards for specific applications or functional communication profiles are expected to define an appropriate conformance model that includes specific conformance requirements for this standard on vital signs representation. They also need to define additional conformance criteria for semantic and dynamic behavior of the implementation, which are out of the scope of this standard.

Conformance to definitions of this standard is specified at the appropriate application interface or system interface only. Only the behavior at this interface is considered for conformance. Implementation details that cannot be perceived externally are not subject to conformance specification.

> **Example:** A communicating medical device uses the object classes and type definitions as defined in this standard to distribute data to other devices. It may be compliant to this standard, even if it does not use any object-oriented implementation internally.

10.2 Conformance specification

This standard on vital signs representation offers a high degree of flexibility in how the model is applied for a certain medical device, particularly in the following areas:

— Information model of a specific device

— Use of attributes, value ranges, and access

— Use of extended communication services (i.e., scanners), scan periods, and scanner configurability

To support interoperability of applications and systems, an implementation based on this standard shall provide specific details about the way that the definitions of this standard are applied.

These specifications have to be provided in form of a set of implementation conformance statements (ICSs). An ICS is a form of data sheet that discloses details of a specific implementation and specifies which features are provided. Specific applications or functional communication profiles that are based on this standard shall define more specific conformance requirements in addition to or as a replacement of the ICS defined here.

NOTE—The ICSs defined in 10.3 provide understanding of the details of an implementation. However, they are not sufficient to provide interoperability of devices or applications. For such interoperability, additional specifications (e.g.,

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timing, latencies, system loading assumptions) shall be taken into account. These specifications are not within the scope of this standard.

10.3 ICSs

10.3.1 General format

The ICSs have to be supplied in the form of tables. Templates for these ICS tables are given in 10.3.2 through 10.3.7. The tables have to be filled out and provided as an overall conformance statement document.

Generally the column headers of an ICS table contain the following information:

— Index, which is an identifier (e.g., a number) of a specific feature.

— Feature, which briefly describes the characteristic for which a conformance statement must be made.

— Reference, which is a reference to the definition of the feature (may be empty).

— Status, which specifies the conformance requirement (i.e., the requirements for a conforming implementation regarding the feature). In some cases, this standard does not specify conformance requirements, but still wants a definition of the status of a particular feature.

— Support, which is filled out by the implementer and specifies the characteristics of the feature in the implementation.

— Comment, which contains additional information provided by the implementer.

The value of the Status and Support columns are permitted to range from simple to complex entries. Examples of simple values are as follows:

m mandatory
o optional
x prohibited
c conditional
n/a not applicable

More complex expressions or specific lists of items are defined in the specific ICS table.

10.3.2 General ICS

In a top-level General ICS, the implementer specifies the versions/revisions that are supported by the implementation as well as some high-level system behavior definitions.

Table 10.1 shows the General ICS.

Table 10.1—General ICS

Index	Feature	Reference	Status	Support	Comment
GEN-1	Implementation Description	—	Identification of the device/application. Description of functionality.		
GEN-2	Standard Document Revision	(Standard documents)	(Set of existing revisions)	(Set of supported revision)	

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Table 10.1—General ICS *(continued)*

Index	Feature	Reference	Status	Support	Comment
GEN-3	Conformance Deviation	—	Provides information about possible deviations from the DIM (e.g., nonstandard attributes, objects)	(Set of deviations)	
GEN-4	Object Containment Tree	6.2	Provides object containment diagram showing relations between object instances used by the application. A conforming implementation uses object relations only as defined in the DIM.		
GEN-5	Nomenclature Revision	(Standard documents)	(Set of existing revisions)	(Set of supported revision)	
GEN-6	Use of other Nomenclature Schemes	—	Are nomenclature codes from other standard coding schemes used in the implementation?	Yes/No (If yes: list of other nomenclatures)	Note that the use of other nomenclatures severely impacts interoperability.
GEN-7	Data Structure Encoding	—	—	Description of encoding method for ASN.1 data structures	
GEN-8	Dynamic Object Instances	—	Is the set of object instances at run-time static or dynamic?	Static/Dynamic	
GEN-9	Use of Private Objects	—	Does the implementation use objects that are not defined in the DIM?	Yes/No [If yes: explain in DIM MOC ICS (see 10.3.4)]	
GEN-10	Use of Private Nomenclature Extensions	—	Does the implementation use private extensions to the nomenclature? Private nomenclature extensions are allowed only if the standard nomenclature does not include the specific terms required by the application.	Yes/No (If yes: explain in the appropriate ICS)	
GEN-11	Communication Profile and Hardware	—	Description of communication profile and hardware requirements for interfacing (only applicable for communicating devices).		

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Table 10.1—General ICS *(continued)*

Index	Feature	Reference	Status	Support	Comment
GEN-12	File Format and Storage Media	—	Description of file formats used for archiving vital signs data; definition of supported storage media (only applicable for archival applications).		
GEN-13	ACSE	ISO/IEC 8649 ISO/IEC 8650-1	Use of ACSE protocol (only applicable for communicating systems).	Specify use of optional fields in ACSE protocol data units (PDUs).	

For each implementation, one General ICS shall be provided.

10.3.3 Service Support ICS

The Service Support ICS defines which services that are defined in the service model are implemented. This ICS needs only be supplied for communicating devices.

Table 10.2 shows the Service Support ICS.

Table 10.2—Service Support ICS

Index	Feature	Reference	Status	Support	Comment
SRV-1	GET Service	8.4.2	o		
SRV-2	SET Service	8.4.3	o		
SRV-3	Confirmed SET Service	8.4.3	o		
SRV-4	EVENT REPORT Service	8.4.1	m		
SRV-5	Confirmed EVENT REPORT Service	8.4.1	o		
SRV-6	ACTION Service	8.4.4	o		
SRV-7	Confirmed ACTION Service	8.4.4	o		
SRV-8	CREATE Service	8.4.5	o		
SRV-9	DELETE Service	8.4.6	o		

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The Support column of the completed table should define if the implementation invokes the service (e.g., sends a GET PDU), provides the service (e.g., processes a received GET PDU), or does not implement the service at all.

In addition, specific restrictions should be listed (e.g., if a specific service is restricted to only one object class).

10.3.4 DIM managed object class (MOC) ICS

The DIM MOC ICS defines which managed medical objects (not base classes) are used by the implementation. Table 10.3 is a template only. For each object supported by the implementation, one row shall be filled out.

Table 10.3—Template for DIM MOC ICS

Index	Feature	Reference	Status	Support	Comment
MOC-[1–*n*]	Object Name and OID	Reference to the clause in this standard where the object is defined	Implemented	Specify restrictions, e.g., maximum number of supported instances CREATE/DELETE services are supported.	

If the implementation uses private objects, these objects should also be specified in the DIM MOC ICS. A separate definition should be appended to the conformance statement that can be referenced in the Reference column.

The Support column should indicate specific restrictions about the object implementation. In particular, it shall indicate whether object instances can be dynamically created/deleted using the CREATE/DELETE service.

In addition to the DIM MOC ICS, an object containment diagram (i.e., class instance diagram) should be provided that allows reviewing the class hierarchy used by the implementation.

10.3.5 MOC Attribute ICS

For each supported object as defined in the DIM MOC ICS, a MOC Attribute ICS has to be provided that defines which attributes are used/supported by the implementation, including any inherited attributes. Table 10.4 is a template only.

Table 10.4—Template for MOC Attribute ICS

Index	Feature	Reference	Status	Support	Comment
ATTR-*x*–*n*	Attribute Name and Attribute ID	Reference to the clause in this standard where the object is defined	m/o/c (see 7.1.1 for an explanation of these abbreviations)	Access (i.e., GET, GET-GRP, SET, SCAN, SCAN-GRP, ER, CR-ER; see third paragraph after this table) Value ranges Additional restrictions Static/dynamic value	

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The *x* in the Index column is the ID of the managed object for which the table is supplied (i.e., the index of the managed object as specified in the DIM MOC ICS). There is one separate table for each supported managed object.

The *n* in the Index column is just a serial number (1..*m*).

The attribute access specification fields in the Support column have to be specified if the implementation provides access services for attributes. (In other words, the fields are not needed for a plain storage format.) The fields have the following meanings:

GET	Attribute can be individually accessed by the GET service.
GET-GRP	Attribute can be accessed by the GET service as part of an attribute group.
SET	Attribute can be individually modified by the SET service.
SCAN	Attribute can be individually accessed by a Scanner object (individual scan list entry).
SCAN-GRP	Attribute can be accessed by a Scanner object (attribute group scan list entry).
ER	Attribute changes are communicated by event reports from the container object itself.
CR-ER	Attribute value is provided within the notification that announces the availability of the container object (object create notification).

The Support column should also contain attribute value ranges (if applicable), hints about specific restrictions for attribute access or attribute availability and information, and an indication if the attribute value is static or dynamic in the implementation.

NOTE—The attribute definition tables in this standard define a minimum mandatory set of attributes for each object.

10.3.6 MOC Behavior ICS

The MOC Behavior ICS specifies all implemented object methods that can be invoked by the ACTION service. Table 10.5 is a template only. One table has to be provided for each object that supports special methods.

Table 10.5—Template for MOC Behavior ICS

Index	Feature	Reference	Status	Support	Comment
ACT-*x–n*	Method Name and Method ID	Reference to the clause in this standard where the object method is defined		Specific restrictions	

The *x* in the Index column is the ID of the managed object for which the table is supplied (i.e., the index of the managed object as specified in the DIM MOC ICS). There is one separate table for each managed object that supports specific object methods (i.e., actions).

The *n* in the Index column is just a serial number (1..*m*).

The Support column should specify any restrictions for the method.

10.3.7 MOC Notification ICS

The MOC Notification ICS specifies all implemented notifications (typically in form of the EVENT REPORT service) that are emitted by supported objects. Table 10.6 is a template only. One table has to be provided for each object that supports special object notifications.

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Table 10.6—Template for MOC Notification ICS

Index	Feature	Reference	Status	Support	Comment
NOTI-*x–n*	Notification Name and Notification ID	Reference to the clause in this standard where the event is defined		Specific restrictions	

The *x* in the Index column is the ID of the managed object for which the table is supplied (i.e., the index of the managed object as specified in the DIM MOC ICS). There is one separate table for each managed object that supports specific object notifications (i.e., events).

The *n* in the Index column is just a serial number (1..*m*).

The Support column should specify any restrictions for the notification.

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