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SERIES M: TELECOMMUNICATION MANAGEMENT, INCLUDING TMN AND NETWORK MAINTENANCE

Integrated services digital networks

Common management services – Object management – Protocol neutral requirements and analysis

Recommendation ITU-T M.3700

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Recommendation ITU-T M.3700

Common management services – Object management – Protocol neutral requirements and analysis

Summary

Recommendation ITU-T M.3700 provides the requirements and analysis for one of the common management services – object management. The object management capabilities are intended for re-use by specific information object classes (IOCs).

History

Edition	Recommendation	Approval	Study Group
1.0	ITU-T M.3700	2010-01-13	2

Keywords

Common management service, object management.

FOREWORD

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The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

NOTE

In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

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As of the date of approval of this Recommendation, ITU had not received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementers are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database at http://www.itu.int/ITU-T/ipr/.

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1 Scope

This Recommendation defines the requirements for basic object management, including retrieve object information, create object, delete object, modify object attribute, cancel operation, subscribe notification, receive notification, generate attribute value change notification, generate state change notification, generate object create notification, generate object delete notification.

The operations and notifications specified in this document shall be used, where applicable, in information object class (IOC) definitions of other management interface specifications.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

[ITU-T M.3020] Recommendation ITU-T M.3020 (2009), *Management interface specification methodology*.

[ITU-T M.3060] Recommendation ITU-T M.3060/Y.2401 (2006), *Principles for the Management of the Next Generation Networks*.

[ITU-T M.3701] Recommendation ITU-T M.3701 (2010), *Common management services – State management – Protocol neutral requirements and analysis*.

[ITU-T M.3702] Recommendation ITU-T M.3702 (2010), *Common management services – Notification management – Protocol neutral requirements and analysis*.

[ITU-T X.680] Recommendation ITU-T X.680 (2008) | ISO/IEC 8824-1:2008, *Information technology – Abstract Syntax Notation One (ASN.1): Specification of basic notation*.

3 Definitions

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

This Recommendation uses the following terms from [ITU-T M.3020]:

– agent;
– association;
– data;
– manager;
– information object class (IOC).

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

EM Element Manager

IOC Information Object Class

IRP Integration Reference Point

NE Network Element

NM Network Manager

OS Operations System

UML Unified Modelling Language

5 Conventions

This Recommendation uses the conventions defined in [ITU-T M.3020] for requirements capture and analysis.

6 Requirements

6.1 Business level requirements

6.1.1 Requirements

6.1.1.1 General requirements

This service uses the following services and thus implicitly imports all the requirements defined therein:

- notification management [ITU-T M.3702];
- state management [ITU-T M.3701].

In addition, the following specific requirements apply for object management as specified in this and subsequent clauses.

Identifier	Definition
REQ-OM-FUN-01	The object management functions shall be able to operate on any information object.
REQ-OM-NON-01	The definitions of new object types may specify which object management functions are applicable.
REQ-OM-FUN-02	The object management capabilities shall be independent of any specific definitions of information objects, attributes, etc.

6.1.1.2 Information retrieval

Identifier	Definition
REQ-OM-FUN-03	The agent will provide an operation to retrieve the value of attributes from one or more IOC instances.
REQ-OM-FUN-04	An operation to retrieve the containment relationships between the IOC instances of a containment tree of information objects shall be provided.
REQ-OM-FUN-05	An operation to retrieve the interface versions that are supported by the agent may be provided.

REQ-OM-FUN-06 An operation to cancel a previously initiated operation if it has not completed may be provided. This operation shall, as a minimum, be able to cancel the operation that retrieves attributes. It may be specified to cancel any operation.

6.1.1.3 Life cycle operations

Life cycle operations are not intended to be implemented without implementation of the information retrieval requirements.

Identifier	Definition
REQ-OM-FUN-07	An operation to create an instance of a information object shall be provided.
REQ-OM-FUN-08	An operation to delete one or more instances of information objects shall be provided.
REQ-OM-FUN-09	An operation to modify one or more attributes of one or more instances of information objects shall be provided.
REQ-OM-FUN-10	A manager may subscribe to notifications about a set of object management operations: object creation, object deletion, object modification and when part or the whole configuration information should be synchronized.

6.1.2 Actor roles

The capabilities described in this Recommendation are available and relevant to all agents and managers.

6.1.3 Telecommunication resources

The object management functionality is applicable to all types of telecommunication resources.

6.1.4 High-level use cases

The first overview use-case diagram in Figure 1 shows the overall interaction of the object management function.

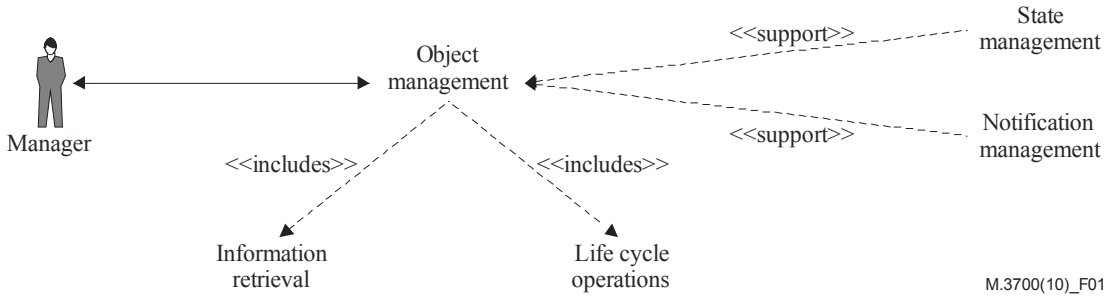

Figure 1 – High level use case for object management

6.1.4.1 Retrieve object information

Use-case stage	Evolution/Specification	<<Uses>> Related use
Goal	The agent returns to the manager attribute values from one or more information object class instances.	
Actor and roles	The manager invokes operations on the agent.	
Telecom resources	The object management functionality is applicable to all types of telecommunication resources.	
Assumptions	The use case is applicable to any information object class. One or several information objects may be retrieved – based on the containment hierarchy. There is an open communication channel between the manager and the agent. This general service is used to get attributes unless a specific service has been defined by one of the common management services.	
Pre conditions	None.	
Begins when	The manager sends a request to retrieve information on one or more IOC instances.	
Step 1	The manager invokes the information retrieval operation on the agent.	
Ends when	Requested information or an exception is returned to the manager, or the operation is cancelled by the manager.	Cancel pending operation
Exceptions	• operationFailed • duplicateInvocation • resourceLimitation • operationCancelled • complexityLimitation	
Post conditions	None.	
Traceability	REQ-OM-FUN-01, REQ-OM-FUN-03, REQ-OM-FUN-04, REQ-OM-FUN-05	

6.1.4.2 Cancel pending operation

Use-case stage	Evolution/Specification	<<Uses>> Related use
Goal	The manager invokes this operation to cancel an on-going operation it issued before.	
Actor and roles	The manager invokes the cancel operation on the agent.	
Telecom resources	The object management functionality is applicable to all types of telecommunication resources.	

Use-case stage	Evolution/Specification	<<Uses>> Related use
Assumptions	The use case is applicable when specified by the relevant information object, Ref. REQ-OM-FUN-01. The previous operation is either already being processed or waiting for processing by the agent. There is an open communication channel between the manager and the agent.	
Pre conditions	The previous operation invoked by this manager has not been completed.	
Begins when	The manager sends a request to cancel a previously issued operation.	
Step 1	The manager invokes the cancel operation on the agent.	
Ends when	The requested operation is cancelled or an exception is returned to the manager.	
Exceptions	• operationFailed	
Post conditions	The operation identified by the operation is cancelled.	
Traceability	REQ-OM-FUN-06	

6.1.4.3 Create object

Use-case stage	Evolution/Specification	<<Uses>> Related use
Goal	This operation is invoked by the manager to request the agent to create a Information object class instance in the MIB maintained by the agent.	
Actor and roles	The manager invokes the operation on the agent.	
Telecom resources	The object management functionality is applicable to all types of telecommunication resources.	
Assumptions	The use case is applicable when specified by the relevant information object, Ref. REQ-OM-FUN-01. This operation will create only one IOC instance. There is an open communication channel between the manager and the agent.	
Pre conditions	A IOC instance with the same distinguished name as the object specified for creation does not exist.	
Begins when	The manager sends a request to create a IOC instance in the MIB maintained by the agent.	
Step 1	The manager invokes the create information object operation on the agent.	
Ends when	The requested IOC instance is created or an exception is returned to the manager.	

Use-case stage	Evolution/Specification	<<Uses>> Related use
Exceptions	• operationFailed • objectClassSpecificationMismatch • invalidObjectInstance • createNotAllowed • noSuchObjectClass • classInstanceConflict • noSuchAttribute • invalidAttributeValue • missingAttributeValue • parentObjectDoesNotExist • objectExists	
Post conditions	a) The IOC instance of the specified object class has been created with the specified distinguished name. b) An object creation notification is emitted for the created object, if notifiable. Notifiable means here that the notification is supported and not suppressed.	
Traceability	REQ-OM-FUN-07	

6.1.4.4 Delete object

Use-case stage	Evolution/Specification	<<Uses>> Related use
Goal	This operation is invoked by the manager to request the deletion of one or more information object class instances from the MIB maintained by the agent.	
Actor and roles	The manager invokes the operation on the agent.	
Telecom resources	The object management functionality is applicable to all types of telecommunication resources.	
Assumptions	The use case is applicable when specified by the relevant information object, Ref. REQ-OM-FUN-01. This operation will delete one or more IOC instances. There is an open communication channel between the manager and the agent.	
Pre conditions	a) The IOC instances specified in the operation exists. b) For any IOC instance specified for deletion, all of its IOC instances must be specified for deletion.	
Begins when	The manager sends a request to delete one or more IOC instances in the MIB maintained by the agent.	
Step 1	The manager invokes the delete information object operation on the agent.	
Ends when	The requested IOC instance(s) are deleted or an exception is returned to the manager.	

Use-case stage	Evolution/Specification	<<Uses>> Related use
Exceptions	• operationFailed • invalidObjectInstance • deleteNotAllowed • resourceLimitation • complexityLimitation	
Post conditions	• All of the IOC instances selected for deletion are deleted. • Some but not all of the selected instances were deleted and for any of the instances deleted all of the child instances of that instance is deleted. • An object deletion notification is emitted for each notifiable deleted object. Notifiable means here that the notification is supported and not suppressed. An object deletion notification of a information object containing a sub-tree implies deletion of all information objects in the sub-tree. The agent should make the best effort to reduce the number of object deletion notifications, for example by sending only one notification for the sub-tree root object in the event of a successful deletion of an entire sub-tree.	
Traceability	REQ-OM-FUN-08	

6.1.4.5 Modify object

Use-case stage	Evolution/Specification	<<Uses>> Related use
Goal	This operation is invoked by the manager to request the modification of management information (information object attribute values) in the MIB maintained by the agent.	
Actor and roles	The manager invokes the operation on the agent.	
Telecom resources	The object management functionality is applicable to all types of telecommunication resources.	
Assumptions	The use case is applicable when specified by the relevant information object, Ref. REQ-OM-FUN-01. Attributes of one or several information objects may be modified – based on the containment hierarchy. There is an open communication channel between the manager and the agent.	
Pre conditions	The IOC instance specified in the operation exists.	
Begins when	The manager sends a request to modify one or more IOC instance in the MIB maintained by the agent.	
Step 1	The manager invokes the modify information object operation on the agent.	
Ends when	The requested IOC instance(s) are modified or an exception is returned to the manager.	

Use-case stage	Evolution/Specification	<<Uses>> Related use
Exceptions	• operationFailed • modifyNotAllowed • noSuchAttribute • invalidAttributeValue • missingAttributeValue • resourceLimitation • complexityLimitation	
Post conditions	• All of the attributes of all of the IOC instances selected for modification are modified as specified. • Some attributes of some of the selected IOC instances were modified but not all attributes of all selected IOC instances. • An Attribute Value Change notification is emitted for the notifiable attributes of each modified object instance. Notifiable means here that the notification is supported and not suppressed.	
Traceability	REQ-OM-FUN-09	

6.1.4.6 Subscribe for object management notification

Notification subscription use cases are defined in [ITU-T M.3702].

7 Analysis

7.1 System context

The object management service makes use of the following common management services, as shown in Figures 2 and 3.

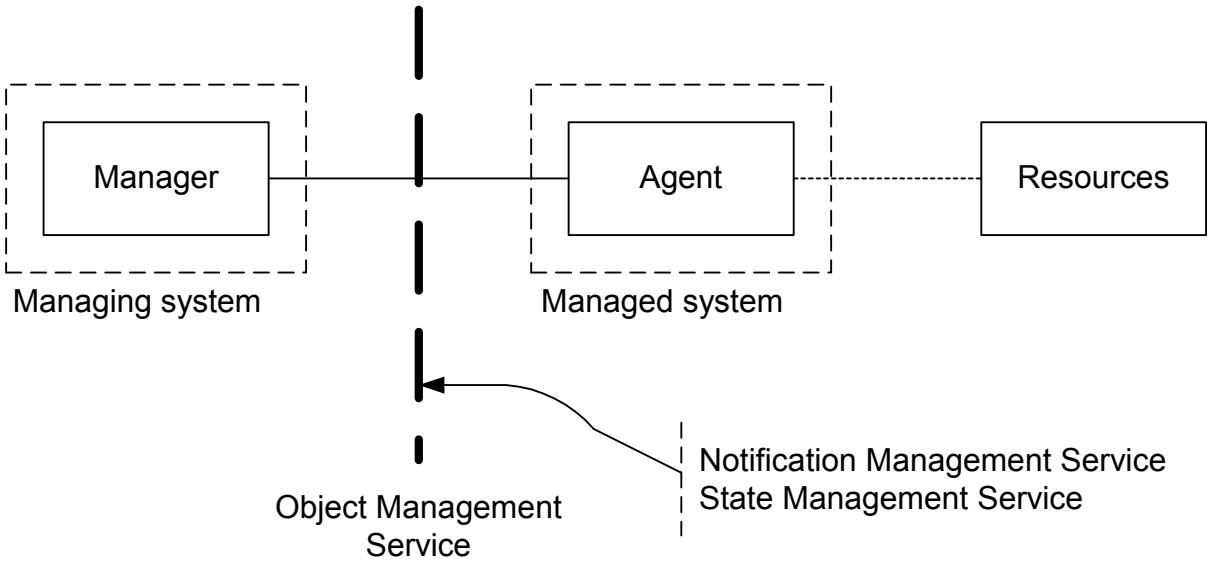

Figure 2 – System context A

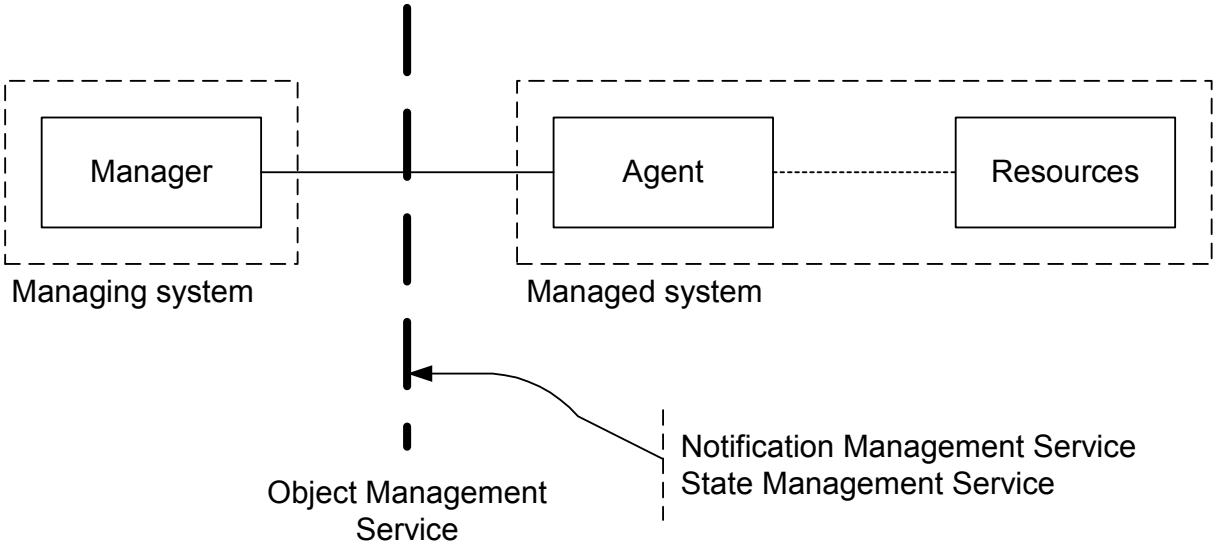

Figure 3 – System context B

7.2 Information object classes

This Recommendation defines the common management function for object management. There is no information object class defined in this Recommendation.

7.3 Interface definition

7.3.1 Class diagram representing interfaces

Figure 4 – Class diagram

7.3.2 Generic rules

The following rules are relevant for all specifications. They shall simply be copied as part of the specification.

Rule 1: *Each operation with at least one input parameter supports a pre-condition valid_input_parameter which indicates that all input parameters shall be valid with regards to their information type. Additionally, each such operation supports an exception operation_failed_invalid_input_parameter which is raised when pre-condition valid_input_parameter is false. The exception has the same entry and exit state.*

Rule 2: *Each operation with at least one optional input parameter supports a set of pre-conditions supported_optional_input_parameter_xxx where "xxx" is the name of the optional input parameter and the pre-condition indicates that the operation supports the named optional input parameter. Additionally, each such operation supports an exception operation_failed_unsupported_optional_input_parameter_xxx which is raised when (a) the pre-condition supported_optional_input_parameter_xxx is false and (b) the named optional input parameter is carrying information. The exception has the same entry and exit state.*

Rule 3: *Each operation shall support a generic exception operation_failed_internal_problem which is raised when an internal problem occurs and that the operation cannot be completed. The exception has the same entry and exit state.*

NOTE – Security considerations and resulting generic rules are for further study.

7.3.3 Interface object management (M)

Each interface is defined by its name and by a sequence of operations or notifications, as defined below.

Operation name	Qualifier	Requirement IDs
getMoAttributes	M	REQ-OM-FUN-01, REQ-OM-FUN-03, REQ-OM-FUN-04, REQ-OM-FUN-05
cancelOperation	O	REQ-OM-FUN-01, REQ-OM-FUN-06
createObject	O	REQ-OM-FUN-01, REQ-OM-FUN-07
deleteObject	O	REQ-OM-FUN-01, REQ-OM-FUN-08
setMoAttributes	O	REQ-OM-FUN-01, REQ-OM-FUN-09

In the following operation definitions, there is a 'status' parameter in the output parameter definitions. In total, there are 6 values enumerated, but a specific operation may support only part of them, as listed in the operation output parameters definition table.

```
Status ::= ENUMERATED{
     operationSucceeded,
     operationFailed,
     operationPartiallySucceeded,
     cancelSucceeded,
     operationAlreadyCompleted,
     cannotCancel
}
```

7.3.3.1 Operation getAttributes (M)

7.3.3.1.1 Definition

This operation is invoked by manager to request the retrieval of management information (information object attribute names and values) from the MIB maintained by the agent. One or several information objects may be retrieved – based on the containment hierarchy. A design may choose to split this operation in several operations (e.g., operations to get "handlers" or "iterators" to information objects fulfilling the scope/filter criteria and other operations to retrieve attribute names/values from these "handlers").

7.3.3.1.2 Input parameters

Parameter name	Support qualifier	Information type/Legal values	Comment
invokeIdentifierIn	CM	`INTEGER` *A unique identifier that is Solution Set dependent.*	This parameter identifies the current invocation. This parameter is used in the 'cancelOperation' operation to cancel an on-going 'getMOAttributes' operation.
baseObjectInstance	M	*`Name`*	The MO instance that is to be used as the starting point for the selection of information objects to which the filter (when supplied) is to be applied.

scope	O	`SEQUENCE {`
		`scopeType ENUMERATED {`
		`base-object-only,`
		`nTH-Level-subordinates,`
		`base-nTH-level,`
		`base-all`
		`},`
		`theLevel INTEGER`
		`}`
		
		NOTE – The level contains valid information if *`nTH-Level-subordinates`* or *`base-nTH-level`* is used.
			This parameter defines how many levels of the containment hierarchy to select for the filter defined below. The selection starts from the MO given by the baseObjectInstance parameter. The levels of selection that may be performed are:
			`base-object-only`: the base object alone (default);
			`nTH-Level-subordinates`: the nth level subordinates of the base object;
			`base-nTH-level`: the base object and all of its subordinates down to and including the nth level;
			`base-all`: the base object and all of its subordinates.

filter	O	*See comment*	This parameter defines a filter test to be applied to the scoped Information object(s). If the filter is empty, all of the information objects included by the scope are selected. The actual syntax and capabilities of the filter is solution set specific. However, each solution set should support a filter consisting of one or several assertions that may be grouped using the logical operators AND, OR and NOT. Each assertion is a logical expression of attribute existence, attribute value comparison ("equal to X, less than Y", etc.) and MO Class.

Parameter name	Support qualifier	Information type/Legal values	Comment
attributeListIn	M	SET OF *<Name>*	This parameter identifies the attributes to be returned by this operation An empty list means "Return all attributes". For future releases the possibility to specify a list of attributes is expected.

7.3.3.1.3 Output parameters

This information is provided in a table.

Parameter name	Support qualifier	Matching information/ Information type/Legal values	Comment
invokeIdentifierOut	CM (Note)	INTEGER *invokeIdentifierIn from the input parameters of this operation*	This parameter identifies the current invocation in both IRPManager and IRPAgent. This parameter can be used together with the 'cancelOperation' operation to cancel an on-going 'getMOAttributes' operation.
managedObject Class	M	*Name*	For each returned MO: The class of the MO instance.
managedObject Instance	M	*Name*	For each returned MO: The name of the MO instance.
attributeListOut	M	SET OF SEQUENCE{ *<Name of attribute>*, *<Value of attribute>* *}*	For each returned MO: A list of name/value pairs for MO.
status	M	ENUMERATED { operationSucceeded, operationFailed }	An operation may fail because of a specified or unspecified reason.
NOTE – This parameter is meaningful only if the agent supports the cancelOperation.			

7.3.3.1.4 Pre-condition

baseObjectExists

Assertion Name	Definition
baseObjectExists	The IOC instance specified by the baseObjectInstance parameter exists.

7.3.3.1.5 Post-condition

None specific.

7.3.3.1.6 Exceptions

Name	Definition
operationFailed	Condition: Pre-condition is false or post-condition is false. Returned information: The output parameter status. Exit state: Entry state.
duplicateInvocation	Condition: The invoke identifier specified was allocated to another operation Returned information: The output parameter status. Exit state: Entry state. NOTE – This exception is conditional and applies only to designs where it is meaningful.
resourceLimitation	Condition: Operation not performed due to resource limitation. Returned information: The output parameter status. Exit state: Entry state.
operationCancelled	Condition: Operation cancelled by cancelOperation operation. Returned information: The output parameter status. Exit state: Entry state.
complexityLimitation	Condition: Operation not performed because a parameter was too complex. Returned information: The output parameter status. Exit state: Entry state.
baseObjectDoesNotExist	Condition: Operation not performed because the specified base object does not exist. Returned information: The output parameter status. Exit state: Entry state.

7.3.3.2 Operation cancelOperation (O)

7.3.3.2.1 Definition

The manager invokes this operation to cancel an on-going operation it issued before. The set of operations that can be cancelled is specified for IOC as appropriate.

7.3.3.2.2 Input parameters

Parameter name	Support qualifier	Information type/Legal values	Comment
invokeIdentifierIn	M	`INTEGER` A unique identifier that is solution set dependent.	This parameter identifies an on-going operation to be cancelled.

7.3.3.2.3 Output Parameters

Parameter name	Support qualifier	Information type/Legal values	Comment

status	M	`ENUMERATED {`
		`cancelSucceeded,`
		`operationAlreadyCompleted,`
		`cannotCancel`
		`}`
			An operation may fail because of a specified or unspecified reason.

7.3.3.2.4 Pre-condition

operationExits

Assertion name	Definition
operationExits	The operation identified by the invokeIdentifierIn is ongoing.

7.3.3.2.5 Post-condition

operationCancelled

Assertion name	Definition
operationCancelled	The operation identified by the invokeIdentifierIn is cancelled.

7.3.3.2.6 Exceptions

Name	Definition
operationFailed	Condition: Pre-condition is false or post-condition is false. Returned information: The output parameter status. Exit state: Entry state.

7.3.3.3 Operation createObject (O)

7.3.3.3.1 Definition

This operation is invoked by the manager to request the agent to create a IOC instance in the MIB maintained by the agent. This operation will create only one IOC instance.

7.3.3.3.2 Input parameters

Parameter name	Support qualifier	Information type/Legal values	Comment
managedObjectClass	M	*Name*	This parameter specifies the class of the new IOC instance.
managedObjectInstance	M	*Name*	This parameter specifies the instance of the information object that is to be created and registered.
referenceObjectInstance	O	*Name*	This parameter may have a null value. When this parameter is supplied, it must specify an existing instance of a information object, called the reference object, of the same class as the new object to be created. Attribute values associated with the reference object instance become the default values for those not specified by the attributeListIn parameter.

Parameter name	Support qualifier	Information type/Legal values	Comment

attributeListIn	M	SET OF SEQUENCE{
		<*Name of attribute*>,
		<*Value of attribute*>
		}
			This parameter may have a null value. When this parameter is supplied, it contains a list of name/value pairs specifying attribute identifiers and their values to be assigned to the new information object. These values override the values for the corresponding attributes derived from either the reference object (if the referenceObjectInstance parameter is supplied) or the default value set specified in the definition of the information object's class.

7.3.3.3.3 Output parameters

Parameter name	Support qualifier	Information type/Legal values	Comment

attributeListOut	M	SET OF SEQUENCE{
		<*Name of attribute*>,
		<*Value of attribute*>
		}
			This list of name/value pairs contains the attributes of the new information object and the actual value assigned to each.

status	M	ENUMERATED {
		operationSucceeded,
		operationFailed
		}
			An operation may fail because of a specified or unspecified reason.

7.3.3.3.4 Pre-condition

IOCIDoesNotExist

Assertion name	Definition
IOCIDoesNotExist	A IOC instance with the same distinguished name as the object specified for creation does not exist.

7.3.3.3.5 Post-condition

IOCICreated AND objectCreationNotificationEmitted

Assertion name	Definition
IOCICreated	The IOC instance of the specified object class has been created with the specified Distinguished Name.
objectCreation NotificationEmitted	An object creation notification is emitted for the created object, if notifiable. Notifiable here means that the notification is supported and not suppressed. "Emitted" here corresponds to the association stereotyped as <<emits>> in [ITU-T M.3020].

7.3.3.3.6 Exceptions

Name	Definition
operationFailed	Condition: Pre-condition is false or post-condition is false. Returned information: The output parameter status. Exit state: Entry state.
objectClassSpecificationMismatch	Condition: The object class named by ObjectClassIdentifier input parameter does not match the object class of the information object specified by a non-null referenceObjectInstance input parameter. Returned information: The output parameter status. Exit state: Entry state.
invalidObjectInstance	Condition: The object instance name specified implied a violation of the naming rules; Returned information: The output parameter status. Exit state: Entry state.
createNotAllowed	Condition: The object to be created may not be created over the interface. Returned information: The output parameter status. Exit state: Entry state.
noSuchObjectClass	Condition: The class of the specified information object is not recognized. Returned information: The output parameter status. Exit state: Entry state.
classInstanceConflict	Condition: The specified IOC instance may not be created as member of the specified class. Returned information: The output parameter status. Exit state: Entry state.
noSuchAttribute	Condition: A specified attribute is not recognized or is not valid for specified object class. Returned information: The output parameter status. Exit state: Entry state.
invalidAttributeValue	Condition: Value specified for an attribute is not valid for that attribute. Returned information: The output parameter status. Exit state: Entry state.
missingAttributeValue	Condition: One or more required attribute values were not supplied and default values are not available. Returned information: The output parameter status. Exit state: Entry state.
parentObjectDoesNotExist	Condition: The parent MO instance of the IOC specified to be created does not exist. Returned information: The output parameter status. Exit state: Entry state.

7.3.3.4 Operation deleteObject (O)

7.3.3.4.1 Definition

This operation is invoked by the manager to request the deletion of one or more IOC instances from the MIB maintained by the agent.

7.3.3.4.2 Input parameters

Parameter name	Support qualifier	Information type/Legal values	Comment
baseObjectInstance	M	*Name*	The MO instance that is to be used as the starting point for the selection of information objects to which the filter (when supplied) is to be applied.
scope	O	*See corresponding parameter in getMOAttributes.*	See corresponding parameter in *getMOAttributes*.
filter	O	*See comment*	See corresponding parameter in *getMOAttributes*.

7.3.3.4.3 Output parameters

Parameter name	Support qualifier	Information type/Legal values	Comment

deletionList	M	SET OF SEQUENCE{
		<Name of Instance>,
		<Name of object class>
		}
			If the base object alone is specified, then this parameter is optional; otherwise it contains a list of Name of Instance and Name of object class pairs identifying the information objects deleted.

status	M	ENUMERATED {
		operationSucceeded,
		operationFailed,
		operationPartiallySucceeded
		}
			An operation may fail because of a specified or unspecified reason. The operation is partially successful if some, but not all, objects selected to be deleted are actually deleted.

In lieu of a synchronization parameter, best effort synchronization will apply; that is, all information objects selected for this operation will perform the operation if possible regardless of whether some information objects fail to perform it.

7.3.3.4.4 Pre-condition

baseObjectExists AND allChildrenOfObjectsToBeDeletedSpecifiedForDeletion

Assertion name	Definition
baseObjectExists	The IOC instance specified by the baseObjectInstance parameter exists.
allChildrenOfObjectsToBeDeletedSpecifiedFor Deletion	For any IOC instance specified for deletion, all of its dependant IOC instances must be specified for deletion.

7.3.3.4.5 Post-condition

(selectedObjectsDeleted OR someSelectedObjectsDeleted) AND objectDeletionNotificationEmitted

Assertion name	Definition
selectedObjectsDeleted	All of the IOC instances selected for deletion are deleted.
someSelectedObjects Deleted	Some but not all of the selected IOC instances were deleted and for any of the IOC instances deleted all of the child IOC instances of that IOC instance is deleted.
objectDeletion NotificationEmitted	An object deletion notification is emitted for each notifiable deleted object. Notifiable here means that the notification is supported and not suppressed. "Emitted" here corresponds to the association stereotyped as <<emits>> in Recommendation [ITU-T M.3020]. An object deletion notification of a information object containing a sub-tree implies deletion of all information objects in the sub-tree. The agent should make the best effort to reduce the number of object deletion notifications, for example by sending only one notification for the sub-tree root object in the event of a successful deletion of an entire sub-tree.

7.3.3.4.6 Exceptions

Name	Definition
operationFailed	Condition: Pre-condition is false or post-condition is false. Returned information: The output parameter status. Exit state: Entry state.
invalidObjectInstance	Condition: The object instance name specified implied a violation of the naming rules. Returned information: The output parameter status. Exit state: Entry state.
deleteNotAllowed	Condition: Some of the object instances to be deleted may not be deleted over the interface. Returned information: The output parameter status. Exit state: Entry state.
resourceLimitation	Condition: Operation not performed due to resource limitation. Returned information: The output parameter status. Exit state: Entry state.
complexityLimitation	Condition: Operation not performed because a parameter was too complex. Returned information: The output parameter status. Exit state: Entry state.

7.3.3.5 Operation setAttributes (O)

7.3.3.5.1 Definition

This operation is invoked by the manager to request the modification of management information (information object attribute values) in the MIB maintained by the agent. Attributes of one or several information objects may be modified – based on the containment hierarchy.

7.3.3.5.2 Input Parameters

Parameter name	Support qualifier	Information type/Legal values	Comment
baseObjectInstance	M	*Name*	The MO instance that is to be used as the starting point for the selection of information objects to which the filter (when supplied) is to be applied.
scope	O	See comment	See corresponding parameter in *getMOAttributes*.
filter	O	See comment	See corresponding parameter in *getMOAttributes*.

modificationList	M	SET OF SEQUENCE{
		<*Name of attribute*>,
		<*Value of attribute*>
		OPTIONAL,
		opType ENUMERATED{
		replace,
		add-values,
		remove-values,
		set-to-default
		}
		}
		
		See comment for when attribute values are required and when they are optional.
			This parameter contains a set of attribute modification specifications, each of which contains:
			1. Name of attribute(s) to be modified.
			2. the value(s) to be used in the modification of the attribute. The use of this parameter is defined by the modify operator. This parameter is optional when the set to default modify operator is specified and if supplied, shall be ignored.
			3. modify operator: the way in which the attribute values(s) (if supplied) is(are) to be applied to the attribute. The possible operators are:
			replace: the attribute value(s) specified shall be used to replace the current values(s) of the attribute;
			add values: the attribute values(s) specified shall be added to the current value(s) of the of the attribute. This operator shall only be applied to a set-valued attribute and shall perform a set union (in the mathematical sense) between the current values(s) of the attribute and the attribute value(s) specified. Value(s) specified in the attribute value parameter which is(are) already in the current values of the attribute shall not cause an error to be returned.

Parameter name	Support qualifier	Information type/Legal values	Comment
			remove values: the attribute value(s) specified shall be removed from the current values(s) of the attribute. This operator shall only be applied to a set-valued attribute and shall perform a set difference (in the mathematical sense) between the current value(s) of the attribute and the attribute values(s) specified. Value(s) specified in the attribute value parameter which is(are) not in the current value(s) of the attribute shall not cause an error to be returned; set to default: when this operator is applied to a single-valued attribute, the value of the attribute shall be set to its default value. When this operator is applied to a set-valued attribute, the value(s) of the attribute shall be set to their default value(s) and only as many values as defined by the default shall be assigned. If there is no default value defined, an error shall be returned. NOTE – Set is used here in the mathematical sense so that a set-valued attribute is an unordered set of unique values. The modify operator is optional, and if it is not specified, the replace operator shall be assumed. The modificationList parameter contains a single set of attribute modification specifications and this same set is applied to each IOC instance to be modified.

7.3.3.5.3 Output Parameters

Parameter name	Support qualifier	Information type/Legal values	Comment

modificationList Out	M	SET OF SEQUENCE{
		<*Name of instance*>,
		<*Name of object class*>,
		modifiedAttrs SET OF SEQUENCE{
		<*Name of attribute*>,
		<*Value of attribute*>
		}
		}
			This parameter will provide for each IOC instance the name of the IOC instance, the name of object class, and a list of name/value pairs of the modified attributes of the modified IOC instance after modification. The form of this information is solution set dependant and may be provided in one or many data structures.

status	M	ENUMERATED {
		operationSucceeded,
		operationFailed,
		operationPartiallySucceeded
		}
			An operation may fail because of a specified or unspecified reason and no attributes have been updated. The operation is only successful if all specified attributes of all selected objects are actually modified. Otherwise, the operation is partially successful.

In lieu of a synchronization parameter, best effort synchronization will apply; that is, all information objects selected for this operation will perform the operation if possible regardless of whether some information objects fail to perform it.

7.3.3.5.4 Pre-condition

baseObjectExists

Assertion name	Definition
baseObjectExists	The IOC instance specified by the baseObjectInstance parameter exists.

7.3.3.5.5 Post-condition

(selectedObjectsModified OR someSelectedObjectsModified) AND attributeValueChangeNotificationEmitted

Assertion name	Definition
selectedObjectsModified	All of the attributes of all of the IOC instances selected for modification are modified as specified.
someSelectedObjects Modified	Some attributes of some of the selected IOC instances were modified but not all attributes of all selected IOC instances.
attributeValueChange NotificationEmitted	A notifyAttributeValueChange notification is emitted for the notifiable attributes of each modified object instance. Notifiable here means that the notification is supported and not suppressed. "Emitted" here corresponds to the association stereotyped as <<emits>> in Recommendation [ITU-T M.3020].

7.3.3.5.6 Exceptions

Name	Definition
operationFailed	Condition: Pre-condition is false or post-condition is false. Returned information: The output parameter status. Exit state: Entry state.
modifyNotAllowed	Condition: The object to be modified may not be modified over the interface. Returned information: The output parameter status. Exit state: Entry state.
noSuchAttribute	Condition: A specified attribute is not recognized or is not valid for specified object class. Returned information: The output parameter status. Exit state: Entry state.
invalidAttributeValue	Condition: Value specified for an attribute is not valid for that attribute. Returned information: The output parameter status. Exit state: Entry state.
missingAttributeValue	Condition: One or more required attribute values were not supplied and default values are not available. Returned information: The output parameter status. Exit state: Entry state.
resourceLimitation	Condition: Operation not performed due to resource limitation. Returned information: The output parameter status. Exit state: Entry state.
complexityLimitation	Condition: Operation not performed because a parameter was too complex. Returned information: The output parameter status. Exit state: Entry state.
noDefaultSpecified	Condition: Operation not performed because default values is not specified for one or more affected information objects. Returned information: The output parameter status. Exit state: Entry state.

7.3.3.6 Notification attributeValueChanged (O)

7.3.3.6.1 Definition

Attribute Value Change Notification is a notification generated in case the value of attribute in an object instance is changed. Some object class may not support attribute value change notification, so it is optional.

7.3.3.6.2 Input parameters

The notification header defined in [ITU-T M.3702] already includes general parameters needed in a notification. The following table only defines specific parameters.

Parameter name	Qualifiers	Matching information/ Information type/Legal values	Comment

attributeListOld	O	SET OF SEQUENCE{
		<*Name of attribute*>,
		<*Value of attribute*>
		}
			This parameter may have a null value. When this parameter is supplied, it contains a list of name/value pairs specifying attribute identifiers and their values before change.

attributeListNew	M	SET OF SEQUENCE{
		<*Name of attribute*>,
		<*Value of attribute*>
		}
			It contains a list of name/value pairs specifying attribute identifiers and their values newly set.

7.3.3.6.3 Triggering event

When Object class supports this notification and object instance's attribute value is changed.

7.3.3.7 Notification stateChanged (O)

7.3.3.7.1 Definition

State Change Notification is a notification generated in case the value of state attribute in an object instance is changed. Some object class may not support state change notification, so it is optional.

7.3.3.7.2 Input parameters

The notification header defined in [ITU-T M.3702] already includes general parameters needed in a notification. The following table only defines specific parameters.

Parameter name	Qualifiers	Matching information/ Information type/Legal values	Comment

attributeListOld	O	SET OF SEQUENCE{
		<*Name of attribute*>,
		<*Value of attribute*>
		}
			This parameter may have a null value. When this parameter is supplied, it contains a list of name/value pairs specifying attribute identifiers and their values before change.

attributeListNew	M	SET OF SEQUENCE{
		<*Name of attribute*>,
		<*Value of attribute*>
		}
			It contains a list of name/value pairs specifying attribute identifiers and their values newly set.

7.3.3.7.3 Triggering event

When Object class supports this notification and object instance's state attribute value is changed.

7.3.3.8 Notification objectCreated (M)

7.3.3.8.1 Definition

Object Create Notification is a notification generated in case an object instance is created.

7.3.3.8.2 Input parameters

The notification header defined in [ITU-T M.3702] already include general parameters needed in a notification. The following table only defines specific parameters.

Parameter name	Qualifiers	Matching information/ Information type/Legal values	Comment

attributeListNew	M	SET OF SEQUENCE{
		<*Name of attribute*>,
		<*Value of attribute*>
		}
			It contains a list of name/value pairs specifying attribute identifiers and their values newly set.

7.3.3.8.3 Triggering event

When Object class supports this notification and object instance is newly created.

7.3.3.9 Notification objectDeleted (M)

7.3.3.9.1 Definition

Object Deleted Notification is a notification generated in case an object instance is deleted.

7.3.3.9.2 Input parameters

The notification header defined in [ITU-T M.3702] already includes general parameters needed in a notification. The following table only defines specific parameters.

Parameter name	Qualifiers	Matching information/ Information type/Legal values	Comment

attributeListOld	O	SET OF SEQUENCE{
		<*Name of attribute*>,
		<*Value of attribute*>
		}
			This parameter may have a null value. When this parameter is supplied, it contains a list of name/value pairs specifying attribute identifiers and their values before change.

7.3.3.9.3 Triggering event

When Object class supports this notification and object instance's attribute value is changed.

Bibliography

The protocol-neutral object management capabilities defined in this specification are based on multiple sources identified in this bibliography.

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