ISO/CCITT and Internet Management Coexistence (IIMC):

ISO/CCITT to Internet Management Proxy

(IIMCPROXY)

Draft 3
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Status of this Memo

This document provides information to the network and systems management community. This document is intended as a contribution to ongoing work in the area of multi-protocol management coexistence and interworking. This document is part of a package; see also [IIMCOMIBTRANS] [IIMCIMIBTRANS] [IIMCMIB-II] and [IIMCSEC]. Distribution of this document is unlimited. Comments should be sent to the Network Management Forum IIMC working group (iimc@thumper.bellcore.com).

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Abstract

This document is intended to facilitate the use of the ISO/CCITT Common Management Information Protocol (CMIP) for integrated management of networks via proxy management of TCP/IP networks that are managed using Simple Network Management Protocol (SNMP). This document describes an ISO/CCITT to Internet "proxy" which allows interworking between CMIP-based managers and SNMP-based agents. The proxy emulates CMIS service requests by mapping between corresponding ISO/CCITT GDMO and Internet MIB definitions, and generating SNMP message(s) needed to emulate the service. The proxy also emulates CMIS service responses and notifications by converting incoming SNMP response and trap message(s) in a similar fashion. Thus, the proxy appears as a CMIP-based agent to the manager, and as an SNMP-based manager to the agent. The proxy depends on the availability of corresponding MIB definitions translated as described in [IIMCIMIBTRANS].

Table of Contents

Status of this Memo i
Abstract ii
Table of Contents ii
Revision History iv
1 Introduction 1
1.1 Problem Statement 1
1.2 Overview of IIMC 2
1.3 MIB Translation Procedures 2
1.4 Native Management Model 3
1.5 Proxy Management Model 4
1.6 Scope of this Document 5
1.7 Terms and Conventions 8
2 ISO/Internet Proxy Configuration 11
2.1 ISO/Internet Proxy Containment Tree 11
2.2 System Objects 12
2.3 Translated MIB Schema Information 12
2.4 IIMC Party MIB Objects 14
2.5 IIMC Proxy MIB Objects 14
2.6 OMNIPoint 1 Capability Object 16
2.7 MIB Usage 17
2.8 Retained Information 18
3 Elements of CMIS Service Emulation 18
3.1 Association Service 18
3.2 Object Selection - Scoping and Filtering 19
3.3 Management Operation Services 20
3.4 Synchronization 23
3.5 M-GET Service 24
3.6 M-CANCEL-GET Service 25
3.7 M-SET Service 26
3.8 M-ACTION Service 27
3.9 M-CREATE Service 27
3.10 M-DELETE Service 29

3.11 Management Notification Services 30
4 Common Procedures For CMISE Service Emulation 31
4.1 Verifying Existence Of An Object Instance 32
4.2 Translating Timestamps 32
4.3 Derivation of SNMP Request Parameters 33
4.4 Derivation Of CMIS Parameters 34
5 Error Message Translation 38
5.1 Translating SNMP Error Messages 38
5.2 CMIS Processing Failure 42
6 ISO/CCITT Systems Management Functions 42
6.1 Event Report Management Function 42
6.2 Log Control Function 43
6.3 Scope of the EFD and Log 43
7 ISO/CCITT-Internet Proxy MIB 44
7.1 Proxy MIB GDMO Templates 45
7.2 Proxy MIB ASN.1 Module 55
8 Conformance Requirements 57
8.1 Management Communication Requirements 57
8.2 Management Function Requirements 57
8.3 Management Information Requirements 57
8.4 Service Emulation Requirements 58
9 Acknowledgments 59
References 61
Appendix A (Normative)
Managed Object Conformance Statements (MOCS) 64
Appendix B (Informative)
Example Operation 65

Revision History

Draft 0 - October 9, 1992
Initial draft of this document.

Draft 1 - March 28, 1993
Previous draft of this document (replaced Draft 0).

Draft 2 - May 26, 1993
Previous draft of this document (replaced Draft 1).

Draft 3 - August 5, 1993
Current draft of this document (replaces Draft 2). This draft will undergo QA review and then be published as Issue 1.0. OID values and MOCS proformas will be added prior to publication.

Major Changes Since Last Revision

1. Aligned templates with changes as per [IIMCIMIBTRANS].
   - Added unique naming attributes for all classes.
   - Removed emulation for conceptual table classes.
   - Modified DELETEATT and DELETEVALUE keywords and handling of corresponding "status" attributes.

2. Specified the semantics of the operational and usage state attributes in "remote system" objects. Added retransmission and polling conditional packages to cmipsnmpProxy and cmipsnmpProxyAgent.

3. Added mandatory support for filtering on objectClass.

4. Applied several text changes identified during review of Draft 2.

1 Introduction

This section provides an overview of ISO/CCITT and Internet Management Coexistence (IIMC) activities, insight into the problem being addressed by IIMC, and a brief introduction to the strategy adopted by IIMC: use of translated MIBs in either a proxy or native implementation. The section concludes by describing the scope of this document, and terms and conventions used by this document.

1.1 Problem Statement

The need for enterprise network management has been addressed by development of network management standards within various communities, most notably the ISO/CCITT and Internet communities.

- The ISO/CCITT community developed the Common Management Information Protocol (CMIP) [ISO9596-1], and related SMI documents [ISO10165-1,2,4].

- The Internet community developed the Simple Network Management Protocol (SNMP) [RFC1157], and its successor, SNMPv2 [RFC1448]. The Internet SMI is defined in [RFC1155] and [RFC1442].

These standards share a nearly common management model, but diverge due to differing management philosophies. Although functionally similar, the Internet and ISO/CCITT protocols and SMIs differ in terms of their complexity and specific operations. Business requirements for end-to-end enterprise management include the need to integrate the management of many different devices, potentially owned or administered by many independent organizations. This requires components to be accessed by ISO/CCITT management, Internet management, and proprietary management mechanisms in a manner which presents a unified view of the network, despite protocol and SMI differences.

For example, many telecommunications and computer vendors, represented by organizations such as the Network Management Forum (NMF), and the U.S. government, as specified in the Government Network Management Profile (GNMP), have based their enterprise management model on the ISO/CCITT management model. These organizations are particularly interested in integrated management of devices that use the Internet management. This interest is primarily due to the widespread commercial implementation and use of such devices, especially devices that use the Internet TCP/IP protocol suite.

1.2 Overview of IIMC

This document is part of a package of ISO/CCITT and Internet Management Coexistence (IIMC) drafts. Documents included in this package are:

[IIMCIMIBTRANS]	Translation of Internet MIBs to ISO/CCITT GDMO MIBs
[IIMCOMIBTRANS]	Translation of ISO/CCITT GDMO MIBs to Internet MIBs
[IIMCMIB-II]	Translation of Internet MIB-II (RFC1213) to ISO/CCITT GDMO MIB
[IIMCPROXY]	ISO/CCITT to Internet Management Proxy
[IIMCSEC]	ISO/CCITT to Internet Management Security

These documents together comprise a package aimed at integrating ISO/CCITT-based and Internet-based management systems. These documents represent coexistence and interworking efforts underway within the IIMC working group, chartered under the auspices of the Network Management Forum Architecture Integration ISO/Internet (AIII) technical team.

The IIMC intends to address the problem that end-to-end management requires an integrated, unified view of the managed network, despite differences in management protocol and information structure. Integrated management can be facilitated by the development of "proxy" mechanisms which translate between functionally equivalent service, protocol, and SMI differences to create this unified view. MIB translation procedures can be used to support proxy management, as well as to take advantage of existing MIB definition and avoid duplication of effort. In this way, commercial investment in both ISO/CCITT and Internet-based management technologies can be preserved through deployment of common methods and tools which support integration.

This overall strategy was outlined in a joint publication developed by the NM Forum and X/Open entitled "ISO/CCITT and Internet Management: Coexistence and Interworking Strategy" [NMFTR107]. The documents included in the IIMC package are the next level of detailed specifications which implement several of the methodologies identified in the strategy. Additional specifications may be defined in the future.

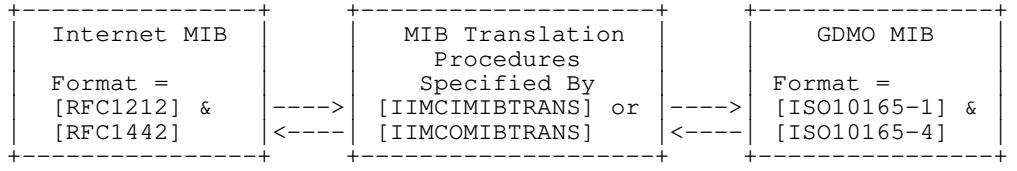
1.3 MIB Translation Procedures

The foundation of IIMC is provided by a pair of Management Information Base (MIB) translation procedures.

- [IIMCIMIBTRANS] specifies translation procedures for converting MIBs from Internet MIB macro format into ISO/CCITT GDMO template format.

- [IIMCOMIBTRANS] specifies translation procedures for converting MIBs from ISO/CCITT GDMO template format into Internet MIB macro format.

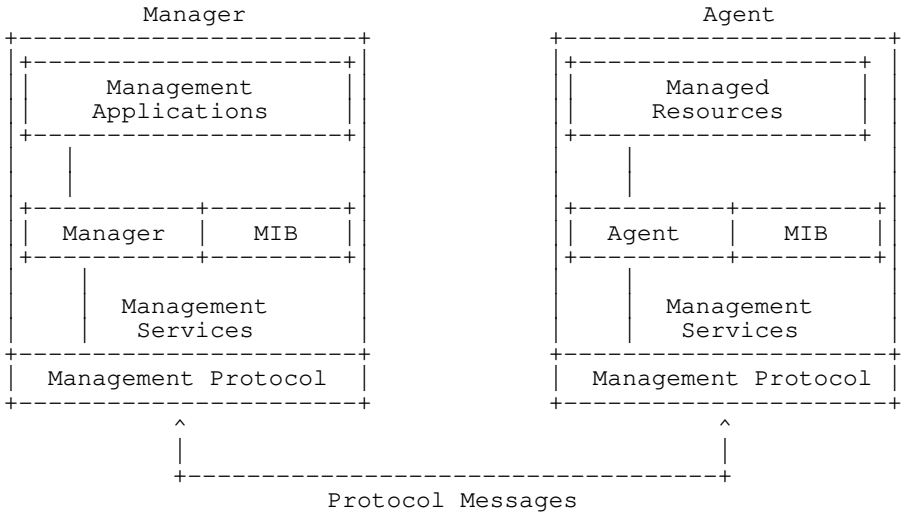
The IIMC approach is to specify direct translation procedures which yield a pair of functionally-equivalent MIBs, as shown in the following figure.



MIBs translated by these procedures may be used to take advantage of existing MIB definitions when business needs require deployment in a different management environment. Translated MIBs may also be used to provide uniformity when multiple management environments are supported by a single system (e.g., dual stack managers). Finally, IIMC MIB translation procedures may be used to support service emulation by a proxy.

1.4 Native Management Model

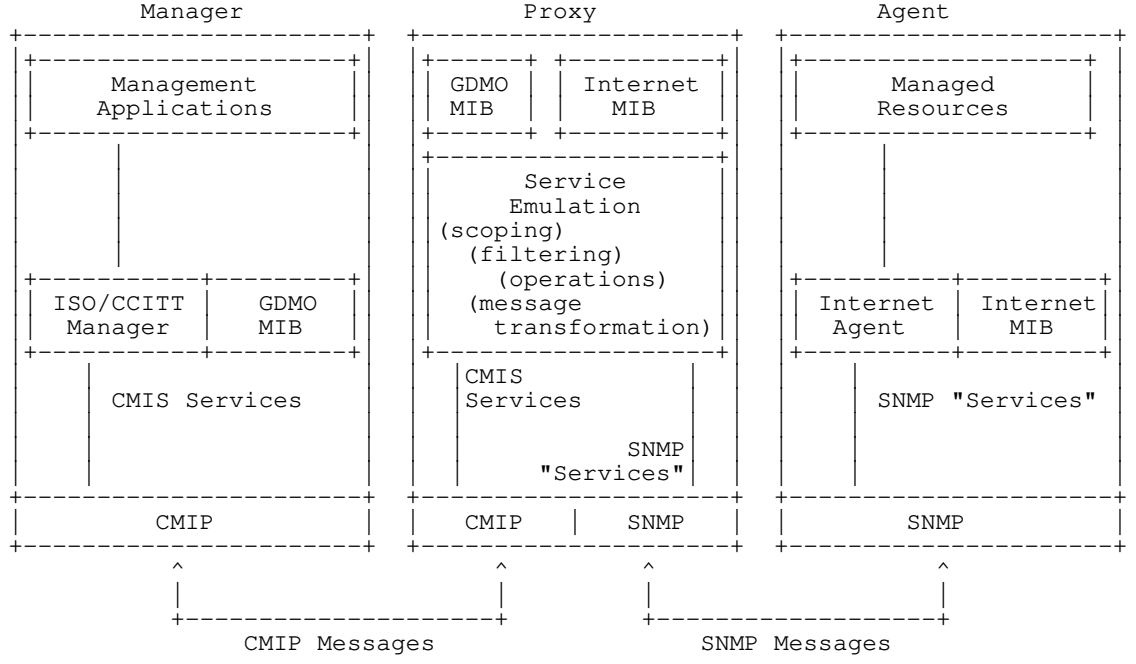
The basic model for ISO/CCITT and Internet management is illustrated in the following diagram.



Within IIMC documents, this model is referred to as the "native" management model. MIBs translated using IIMC procedures can be used by "native" agent implementations. For example, an ISO/CCITT agent can make visible TCP/IP managed resources using the translated GDMO version of the Internet MIB-II [RFC1213] specified by [IIMCMIB-II]. Dual-stack managers or agents may also be implemented which support both the original MIB and the translated MIB generated using IIMC-specified procedures.

1.5 Proxy Management Model

The basic model for ISO/CCITT to Internet proxy management is illustrated in the following diagram. This proxy is specified by [IIMCPROXY]. A similar approach could also be taken to specify an Internet to ISO/CCITT proxy, although no such IIMC document is currently specified.



This ISO/CCITT to Internet proxy provides emulation of CMIS services by mapping to the corresponding SNMP message(s) necessary to carry out the service request. The service emulation allows management of Internet objects by an ISO/CCITT manager. The left hand side of the proxy behaves like an ISO/CCITT agent, communicating with the ISO/CCITT manager using CMIP protocols. The right hand side of the proxy behaves like an Internet manager, communicating with the Internet agent using SNMP protocols.

The proxy relies on the existence of a pair of directly-related MIB definitions, where the Internet MIB has been translated into ISO/CCITT GDMO using the procedures specified in [IIMCIMIBTRANS]. The proxy uses these MIB definitions and rules

to provide run-time translation of management information carried in service requests and responses.

The proxy is designed with a specified interface between the proxy and the underlying protocol stacks, and so deals primarily in terms of CMIS services and SNMP "services". The proxy emulates services such as CMIS scoping and filtering, processing of CMIS operations, and forwarding/logging of CMIS notifications by performing a mapping process which must be tailored for each protocol (for example, SNMPv1 and SNMPv2 are variants of the same protocol mapping process).

1.6 Scope of this Document

The intent of this document (IIMCPROXY) is to facilitate the use of ISO/CCITT CMIP-based managers to perform integrated management of networks via proxy management of networks that are accessed using Internet SNMP-based agents. There are two major differences between CMISE and SNMP services: the structure of management information, and the management operations supported by the underlying protocols. The ISO/Internet Proxy architecture as shown in section 1.2 provides CMISE service emulation. In another words, the ISO/Internet Proxy acts as a CMIP-based agent with respect to the manager to allow management of Internet objects by the ISO/CCITT manager. CMIS requests are processed by the ISO/Internet proxy and CMIS responses are returned by the ISO/Internet proxy. SNMP traps and Inform requests are converted to CMIS notifications by the ISO/Internet proxy. The implementation of the proxy requires that the Internet MIBs be mapped to ISO/CCITT GDMO definitions.

1.6.1 Approaches to Service Emulation

As described by [NMFTR107], there are different approaches for mapping Internet MIBs and ISO/CCITT MIBs.

- The "direct translation" approach maps each Internet object to a newly defined ISO/CCITT GDMO object that contains: 1) the same information as contained in the Internet object; and 2) the attributes that are inherited from the ISO/CCITT Top object class.

- The "abstract translation" approach maps Internet objects to different ISO/CCITT GDMO objects. For example, the MIB-II system object is similar to, and could be represented by, the ISO/CCITT system object. The abstract translation approach can also be used to map several Internet objects to a single ISO/CCITT GDMO object which provides only a summary view of the original Internet objects.

Either or both approaches could be used by an ISO/CCITT manager to manage Internet agents. This document uses the "direct translation" approach.

To perform the CMISE service emulation, the ISO/Internet proxy can use either of the approaches described by [NMFTR107] to retrieve or modify Internet MIB information.

- In the "stateless" approach, the proxy does not maintain the Internet agent's MIB data. Instead, for each received CMIS request, the ISO/Internet proxy generates one or more SNMP requests to the Internet agent in order to achieve the same intent of the CMIS request.

- The "stateful" approach requires the proxy to replicate an Internet agent's MIB locally, and to send periodic (unsolicited) requests to Internet agents to keep the replicated MIB current. The ISO/Internet proxy then tries to fulfill each incoming CMIS request by using locally-replicated MIB data, instead of sending SNMP requests to the Internet agent.

Stateful and stateless are two extremes; any approach falls somewhere in between.

The "stateful" approach usually provides better response time, but has the drawback that the data retrieved might not be current. In this approach, the poll frequency used to update the locally-replicated MIB has a significant effect on the accuracy of the response.

This document uses the "stateless" approach in which the proxy responds to incoming CMIS requests by generating appropriate SNMP requests. Furthermore, SNMP traps and inform requests are converted to CMIS notifications.

If necessary, the static Internet MIB data retrieved by the ISO/Internet proxy could be cached by the proxy in order to improve the response time of an operation. This document makes no assumption that the proxy caches static information, and so takes no advantage of information which might be cached.

1.6.2 Proxy Inputs and Outputs

This document describes a proxy which emulates CMIS services through generation of appropriate SNMP protocols. The proxy is based on certain inputs and outputs, as shown below in Tables 1 and 2.

CMIS services [ISO9595] are supported by CMIP version 2 protocol [ISO9596-1]. SNMP protocols are as defined for SNMPv1 [RFC1157] and SNMPv2 [RFC1448]. The emulation is slightly different, depending upon whether SNMPv1 or SNMPv2 protocols are being used.

Service	Source
ACSE Associate Indication	CMIP Stack
ACSE Release Indication	CMIP Stack
ACSE Abort Indication	CMIP Stack
CMIS Get Indication	CMIP Stack
CMIS Cancel Get Indication	CMIP Stack
CMIS Set Indication	CMIP Stack
CMIS Create Indication	CMIP Stack
CMIS Delete Indication	CMIP Stack
CMIS Action Indication	CMIP Stack
CMIS Event Report Confirm	CMIP Stack
SNMPv1 Get Response	SNMPv1 Stack
SNMPv1 Trap	SNMPv1 Stack
SNMPv1 Error	SNMPv1 Stack
SNMPv2 Trap	SNMPv2 Stack
SNMPv2 Get Response	SNMPv2 Stack
SNMPv2 Get Bulk Response	SNMPv2 Stack
SNMPv2 Inform Request	SNMPv2 Stack
SNMPv2 Error	SNMPv2 Stack

Table 1 - Proxy Inputs

Service	Target
ACSE Associate Response	CMIP Stack
ACSE Release Response	CMIP Stack
ACSE Abort Request	CMIP Stack
CMIS Get Response	CMIP Stack
CMIS Cancel Get Response	CMIP Stack
CMIS Set Response	CMIP Stack
CMIS Create Response	CMIP Stack
CMIS Delete Response	CMIP Stack
CMIS Action Response	CMIP Stack
CMIS Event Report Indication	CMIP Stack
SNMPv1 Get Request	SNMPv1 Stack
SNMPv1 Set Request	SNMPv1 Stack
SNMPv1 Get Next Request	SNMPv1 Stack
SNMPv2 Get Request	SNMPv2 Stack
SNMPv2 Set Request	SNMPv2 Stack
SNMPv2 Get Next Request	SNMPv2 Stack
SNMPv2 Get Bulk Request	SNMPv2 Stack

Table 2 - Proxy Outputs

This document assumes that CMIP PDUs and SNMP PDUs received by the ISO/Internet proxy are always properly encoded (i.e., the underlying protocol stacks ensure the correctness of the service indications and confirmations that are passed up to the ISO/Internet proxy).

The security architecture, services, protocols, and mechanisms for the ISO/Internet proxy shall be as defined in [IIMCSEC].

1.7 Terms and Conventions

This document assumes that the reader is familiar with ISO/CCITT management and Internet management, and the terminology of each. The term "SNMP" is used throughout this document to indicate either SNMPv1 or SNMPv2, unless a distinction needs to be made.

Other terms and conventions used throughout this document include the following.

1. **ISO/CCITT manager:** An application entity that implements [ISO9596-1] and acts in the manager role.

2. **Internet agent:** An application entity that supports the agent role of one or more of the SNMP protocols, such as [RFC1157] or [RFC1448].

3. **ISO/Internet Proxy:** An application entity that is responsible for emulating CMIS requests by a) generating SNMP requests, b) using SNMP responses to generate CMIS responses, and c) mapping SNMP Traps and InformRequests to CMIS notifications, all between a given (ISO/CCITT manager, Internet agent) pair. A proxy may concurrently support more than one (ISO/CCITT manager and Internet agent) pair.

4. **Known Internet agents:** A set of one or more Internet agents that an ISO/Internet proxy has knowledge of. Each known Internet agent is represented by an instance of the proxy object. This document defines the cmipsnmpProxyAgent object class.

5. **Known SNMP Party Object:** A set of one or more SNMP parties that an ISO/Internet proxy has knowledge of. Each known SNMP party is represented by an instance of the partyEntry object as defined in [IIMCSEC].

6. **Local object (instance):** An object instance that is implemented by the proxy itself (for example, the cmipsnmpProxy and cmipsnmpProxyAgent classes defined in section 7).

7. **Remote object (instance):** An object instance that physically resides within an Internet agent is considered a "remote object" (for example, Internet MIB-II objects like system, tcp, and udp).

8. **Multiple Instance Object:** An object class that may have more than one object instance. For example, Internet MIB table entries.

9. **Delete Information:** The object identifier of the attribute and its attribute value used to indicate that a particular row of a table is deleted. In the case of SNMP V2, rowStatus may be used to represent the delete information.

10. **Proxy System Object:** The [ISO10165-2] DMI system managed object instance that represents the proxy itself.

11. **Remote System Object:** The [ISO10165-2] DMI system managed object instance that represents the remote proxied device on which the Internet agent resides.

Abbreviations

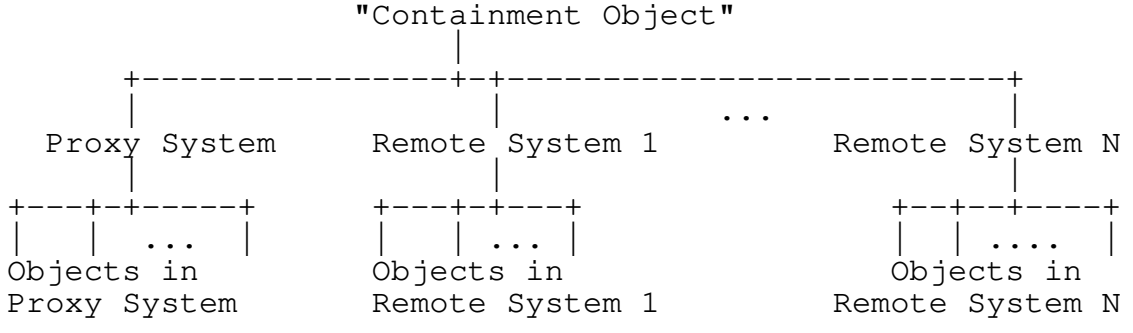
CMIP: Common Management Information Protocol
CMIS: Common Management Information Service
CMISE: Common Management Information Service Element
DN: Distinguished Name
MIB: Management Information Base
MOC: Managed Object Class (CMIP)
MOI: Managed Object Instance (CMIP)
MIT: Management Information Tree (naming tree)
OID: ASN.1 Object Identifier
PDU: Protocol Data Unit
RDN: Relative Distinguished Name
SNMP: Simple Network Management Information Protocol
SNMPv1: Simple Network Management Information Protocol version 1 [RFC1157]
SNMPv2: Simple Network Management Information Protocol version 2 [RFC1448]

2 ISO/Internet Proxy Configuration

In order for the ISO/Internet proxy to interwork with the known Internet agents, the proxy needs to know initialization information such as the transport address, network address, protocol version, and security policy for each of the known Internet agents. Such configuration may be done through an off-line process, or through an on-line management exchange not specified by this document.

2.1 ISO/Internet Proxy Containment Tree

The proxy shall support a forest of object instance trees, each rooted at the ISO/CCITT system managed object defined by [ISO10165-2], with one system object instance for each supported Internet agent, and one system object instance for the proxy itself. Each ISO/CCITT system object is distinguished by the value of its systemId or systemTitle attribute, containing the name associated with the Internet agent or proxy application. This ISO/CCITT to Internet Proxy containment tree is shown below.



The "Proxy System" is the [10165-2] "system" managed object instance that represents the proxy itself. The Proxy System contains all objects representing resources within the proxy itself, including the cmipsnmpProxy and cmipsnmpProxyAgent managed objects.

The "Remote System" is the [10165-2] "system" managed object instance that represents the remote proxied device on which the Internet agent resides. The Remote System contains all objects that are implemented by the remote Internet agent. These would include [IIMCMIB-II] "internetSystem", and any other object supported by the Internet agent.

All objects in the above containment tree can be accessed by scoping from the "Containment Object". This may be an instance of any managed object class. One possible "Containment Object" is the so-called global root (i.e., "CCITT Rec. X.660 | ISO/IEC 9834-1 : 1992":root). In this case, scoped requests including

all Remote Systems can be achieved by using a management operation with the base object class equal to "actualClass" and the base object instance name equal to "{}". The proxy may support other alternative "Containment Objects"; this choice is left to the implementor.

2.2 System Objects

The "Proxy System" object particular to the proxy shall be created automatically by the proxy during its local initialization.

The "Remote System" object particular to an Internet agent system shall be automatically created/deleted by the proxy when an associated cmipsnmpProxyAgent object instance in the Proxy MIB is created/deleted. The Distinguished Name of this system object shall have the same value as the cmipsnmpProxyId attribute in the associated cmipsnmpProxyAgent object instance. Creation/deletion of the system object via management operation is not allowed.

The operationalState and usageState attributes of the "Remote System" object indicate the perceived state of the Internet agent. These two attributes are the same as those defined in [ISO10165-2]. The proxy emulates CMIS M-GET requests on these attributes by issuing SNMP Get or Get-Next requests on an attribute of the corresponding internetSystem object. If no SNMP response is received, a CMIS processingFailure error is returned. Otherwise, if an SNMP response is received, the Internet agent is considered reachable and state attributes value(s) are returned as follows.

- For operationalState attribute, if the Internet agent is reachable, the value "enabled" is returned. This implies that the value "disabled" is never returned.

- For the usageState attribute, if the Internet agent is reachable, the value "active" is returned. This implies that the other values, "idle" and "busy", are never returned. (The proxy has no way of determining actual usage of the Internet system.)

The proxy shall not instantiate any other conditional packages when creating remote system objects.

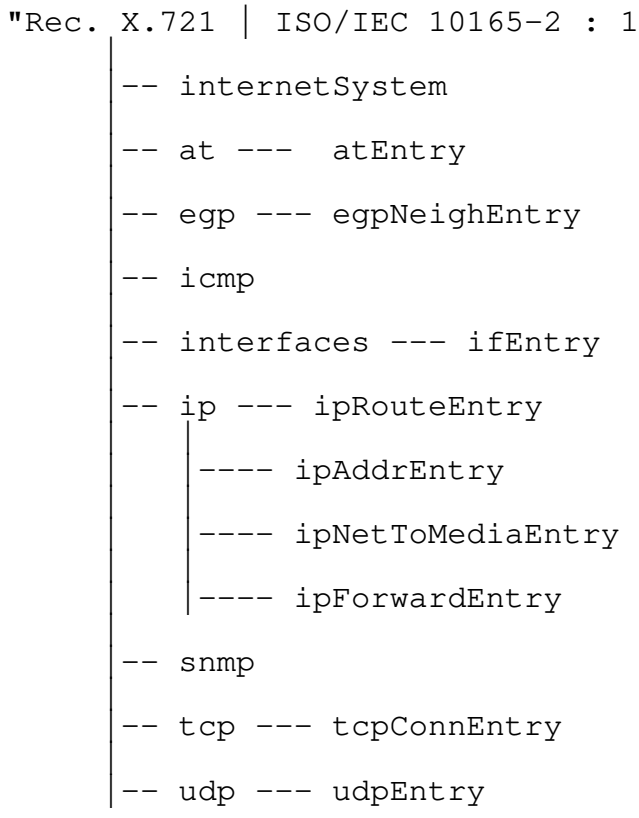
2.3 Translated MIB Schema Information

To perform CMISE service emulation, the ISO/Internet proxy requires the Internet MIB's schema information, described in ISO/CCITT GDMO templates. These templates shall be derived from the original Internet MIB according to the procedures defined by [IIMCIMIBTRANS].

The proxy run-time translation of parameters and protocol translation procedures defined in this document depend on the

MIB translation, naming and registration procedures defined in [IIMCIMIBTRANS]. The translation and registration procedures defined in that document are structured such that the maximum amount of information is preserved to facilitate the translation process.

An example containment tree for an agent supporting the ISO/CCITT GDMO Internet MIB-II [IIMCMIB-II] (derived from the Internet MIB-II [RFC1213]) is illustrated below. A proxy would have multiple instances of such a tree for each Internet agent supported. (The actual structure of the each containment tree depends upon the MIB(s) supported by the proxy.)



As specified in [IIMCIMIBTRANS], NAME BINDINGs for ISO/CCITT GDMO object classes derived from Internet MIB group and table entry types can be automatically inferred from the Internet registration hierarchy. Thus, object classes derived from Internet table entries are bound to the group object classes with which the table entries are associated. Also, object classes derived from Internet groups are bound to the ISO/CCITT system object class.

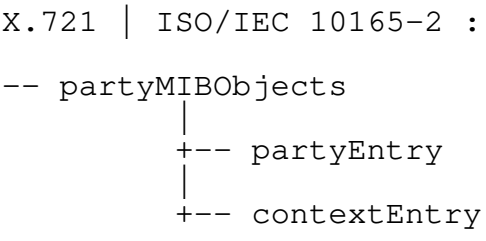
2.4 IIMC Party MIB Objects

Information regarding security policy when accessing agents is contained in Party MIB objects. Binding the Party MIB objects as subordinates of the system object which represents an individual Internet agent allows security policy to be applied on a per Internet agent basis. The Party MIB information can be used by the proxy in a manager role when security services enforcing security policy are implemented in the Internet agent. The services enforced may be authentication, access control, confidentiality and integrity as defined in [RFC1446].

In those situations where the agents may not implement the access control security service on requests from the ISO/CCITT manager (e.g., SNMPv1 agents), the proxy may enforce those services on behalf of the Internet agent. The policy regarding where access control is to be applied is controlled by variables in the cmipsnmpProxy and cmipsnmpProxyAgent managed objects defined in section 7.

The policy regarding security services other than access control, must always be enforced by the Internet agent.

A containment tree diagram for IIMC Party MIB managed object classes which may be instantiated at the proxy is illustrated below. The IIMC Party MIB is subordinate to the ISO/CCITT system managed object that represents the Internet agent.



2.5 IIMC Proxy MIB Objects

The IIMC Proxy MIB defines a set of objects for specifying the information that is needed for both community-based and party-based SNMP management on a per Internet agent basis.

The Proxy MIB consists of a cmipsnmpProxy managed object which contains cmipsnmpProxyAgent object instances, one for each agent being managed by the proxy. The cmipsnmpProxy object class is an immediate subordinate of the "Proxy System" object class. The cmipsnmpProxy object also contains an snmpSecurityParameter object instance which contains default security information.

Each cmipsnmpProxyAgent object has information which identifies an Internet agent and how the agent may be reached. Its naming attribute, which contains the administratively assigned name of the managed device where the Internet agent is located, is used in the naming tree to identify the SNMP managed device.

Creation of a cmipsnmpProxyAgent object instance to represent an Internet agent shall result in the instantiation of a corresponding "Remote System" object representing the Internet agent. The naming attribute value of the "Remote System" shall be the same as the name of the corresponding cmipsnmpProxyAgent object instance. It is recommended that a "OP1 Library Vol. 4":capabilityObject also be created for the proxy.

If the proxy uses an unreliable transport to communicate with the Internet agent, some mechanism may be required to monitor the reachability of the Internet agent and the reliability of the message delivery between the proxy and the Internet agent. Two conditional packages are defined for this purpose.

Retransmission Package

If this package is requested during object creation and the proxy supports the requested retransmission requirements, this package influences SNMP request retransmission by the proxy. SnmpMsgTimeout indicates how long the proxy should wait to receive each SNMP response before "timing out". If the snmpMsgRetryLimit is set to zero, the proxy will only send each SNMP request once. If the snmpMsgRetryLimit is set to one, each SNMP request may be sent twice at most - once for the original request and once for the retry following a timeout. When a timeout occurs and the retry limit has been reached, a CMIS processingFailure error in generated. The timeout and retry limit applies to each individual SNMP request, and not to the CMIS request being emulated.

Polling Package

If this package is requested during object creation and the proxy supports the requested retransmission requirements, this package specifies the interval for polling the Internet agent's reachability. When polling is enabled (has a non-zero value), the proxy issues periodic SNMP Get or Get-Next requests on the Internet system to verify reachability of the Internet agent. If the Internet agent does not respond, a CMIS communicationsAlarm shall be generated indicating loss of signal.

These two packages can optionally be instantiated within the cmipsnmpProxy and/or cmipsnmpProxyAgent objects. If these packages are instantiated in the cmipsnmpProxy object, then these attribute values apply by default to all Internet agents. If these packages are instantiated in an individual cmipsnmpProxyAgent object, then the values

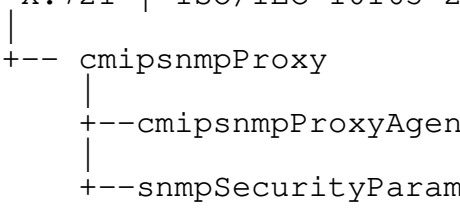
specified there apply to the associated Internet agent, over-riding any default values specified by the superior cmipsnmpProxy object.

The cmipsnmpProxyAgent object may be created by management operation or automatically. For example, the proxy may support discovery of Internet agents, whereby the discovered Internet agents, the associated system object, and capability object shall be created automatically by the proxy itself.

The administrativeState of the cmipsnmpProxyAgent can be locked/unlocked via management operation. If the administrativeState is locked, all incoming CMIS requests for this agent are not carried out. ProcessingFailure with specificErrorInfo set to adminStateLocked (defined in section 7.1.4) shall be returned for all subsequent CMIS requests, and no notifications are generated with this cmipsnmpProxyAgent's internetSystem as the source managed object.

This document refers to instances of IIMC Proxy MIB object classes as "local objects" or as "local object instances".

A containment tree diagram for ISO/CCITT proxy MIB managed object classes is illustrated below.



IIMC Proxy MIB GDMO definitions are described in section 7.

2.6 OMNIPoint 1 Capability Object

If used, the "OP1 Library Vol.4":capability object particular to an Internet agent system shall be automatically created and deleted by the proxy when the associated cmipsnmpProxyAgent object in the Proxy MIB is created and deleted.

The following text describes one possible implementation of gathering information defined in the Capability object's supportedObjectClassList. When the cmipsnmpProxyAgent is created, or when the supportedObjectClassList attribute changes, the proxy shall find out all the object classes defined in all the GDMO documents described in the supportedMIBs attribute. The proxy then forms an SNMP Get Next Request with all the object classes (translated to the OID used by the Internet agent) in a variable binding list to find out whether a particular object class is supported by the Internet

agent. The proxy then fills the supportedNameBindingList by finding out all the NAME BINDINGs used by the object classes in the supportedObjectClassList.

2.7 MIB Usage

The information described in sections 2.1 through 2.6 is maintained by the proxy and used to perform run-time translation between corresponding CMIS and SNMP parameters.

The following definitions are extracted from [IIMCIMIBTRANS] clause 2.3.1, where (c) and (a) refer to class and attribute, respectively.

From [IIMCIMIBTRANS] clause 2.1:

```
{classOID}     ::= {iimcAutoTrans
                    <internetEntityId>(c)}

and

{attributeOID}  ::= {iimcAutoTrans
                    <internetEntityId>(a)}
```

From [IIMCIMIBTRANS] clause 2.2, the ISO/CCITT naming attribute value contains either an ASN.1 NULL value, or a list of index variables in an ASN.1 SEQUENCE with their values represented in their appropriate syntax. (the "( )" indicates "contents of"):"

```
(naming attribute)  ::=  <internet instanceId>
```

where the <internet instanceId> is an ASN.1 NULL, or a SEQUENCE identifying the INDEX attributes used to name the object class, and their syntax. Managed objects for which only a single instance resides in the managed system, e.g., tcp, ip, shall use the ASN.1 NULL for their value. Managed object classes that may have multiple instances, e.g., table entries, shall use as their value an ASN.1 SEQUENCE that contains values of the attributes derived from internet objects identified in the INDEX (or AUGMENTS) clause of the Internet Macro from which the object class is derived, as defined in [RFC1155] or [RFC1442].

For example, the ISO/CCITT naming attribute value for the instance of ipRouteEntry specific to IP address "129.83.2.17" contains the ipDestination index variable as an IP address represented in an ASN.1 OCTET STRING of size 4 as specified in [RFC1242].

The Internet uses the following convention to uniquely identify an Internet object instance:

```
{internet object name}::= {<internetEntityId>(a)
                           <internet instanceId>}
```

Refer to [IIMCIMIBTRANS] for additional detail.

2.8 Retained Information

The proxy must retain information obtained from the ISO/CCITT manager during association establishment, and for individual CMIS requests on the association.

For each outstanding CMIS request, the proxy needs to maintain the ISO/CCITT invoke id, object class and object instance. When SNMP responses are received, the proxy shall use the retained information to form the associated parameters in CMIS responses.

For scoped CMIS requests, the proxy shall maintain some state information to keep track of the portion of the Internet MIB that is being traversed.

3 Elements of CMIS Service Emulation

The following sections describe the conceptual process for performing CMIS service emulation. In an actual implementation, it should be possible to combine some of the processing. It is highly recommended that the implementors of the ISO/Internet proxy combine the processes where possible to optimize the implementation.

3.1 Association Service

The proxy should provide the association service as defined in section 8.1 of [ISO9596-1]. This service includes association establishment and association release.

In ISO/CCITT systems management, management entities may exchange initialization information during the association establishment phase. Such information is used only by the proxy for its own configuration and is not conveyed to the communicating Internet agents.

This document does not define any application context; however, a proxy may be required to support the following application contexts as defined in the ISO standards and CCITT recommendations:

> ISO Systems Management application context; or
> CCITT TMN application context one.

CMIP and SMASE functional units may be negotiated between the ISO/CCITT manager and the ISO/Internet proxy. Once a set of functional units is agreed, the proxy will ensure only the agreed services are accepted over the association.

The CMIP protocol used between the ISO/CCITT manager and the ISO/Internet proxy is a connection-oriented protocol which requires an association be maintained throughout the management exchange(s). The protocol between the proxy and the Internet agent, however, may be a connection-less protocol which does not require the existence of an association.

3.2 Object Selection - Scoping and Filtering

Managed object selection is used to identify a set of managed object instances in the management information tree (MIT) to which a CMIS request applies. Managed object selection is performed in two phases: scoping; and then, filtering. Scoping is used to select candidate object instances in the MIT to which operations may apply. A filter is then applied to attributes of the previously scoped object instances in order to identify the subset of object instances on which the CMIS operation is to be performed.

If no filter is specified, the CMIS request will be performed for all object instances identified by the scope parameter. If no scope parameter is specified, the default is the base managed object instance only.

There are different ways of performing the scoping operation, depending on the implementation. This document specifies one possible way of providing the managed object selection service.

The proxy has no direct knowledge of current object instances that exist in the Internet agent. Therefore, it must first determine the existence of an object instance before it knows whether it is within the scope. Obviously, all objects in the scope must be instances of object classes that are within the scope. Thus, the proxy should first determine the set of object classes within the scope, and then discover what instances of those object classes actually exist in the Internet agent. This set of object classes that are within the scope are called the "object class group" (OCG).

The following pseudo code algorithm specifies a generic method of determining the members of an "object class group".

Define the set of object classes at the current level in the naming tree that are being processed as the "class level group" (CLG).

Define the set of object classes at the next level in the naming tree that are to be processed after the CLG as the "next level group" (NLG).

Define the managed object class named by the incoming request as the "base managed object" (BMO).

Minimum Level and Maximum Level are derived from the CMIS scope parameter, as follows.

CMIS Scope	Min Level	Max level
baseObjectAlone	0	0
firstLevelOnly	1	1
individualLevels	N	N
baseToNthLevel	0	N
wholeSubtree	0	Depth of the tree

```
CLG = {BMO};
OCG = {}; /* empty set */
currentScope  = 0;
WHILE ( currentScope <= Maximum Level )
     NLG = {children of objects in CLG};
     IF (currentScope >= Minimum Level)
          THEN OCG = {union of OCG and CLG};
     CLG = NLG;
     currentScope = currentScope + 1;
ENDWHILE;
```

The determination of the set NLG as {children of objects in CLG} may be done using implementation-dependent internal data structures of the proxy.

An alternative method to determine NLG is to use the NAME BINDING templates directly. The following algorithm could then be used to determine the NLG.

```
WHILE (CLG not equal to {})
     Remove an object from CLG;
     FOR (all name bindings in this proxy's associated
     Capability object)
          IF object == SUPERIOR
               THEN NLG = {union of the
               SUBORDINATE object and NLG};
     ENDFOR;
ENDWHILE;
```

3.3 Management Operation Services

If the specified instances (i.e., those selected by scoping process) are "local objects", the proxy performs the services using local means.

If the specified instances are "remote objects", then the following steps apply. Any objects that physically reside in the Internet agents are considered "remote objects". For example, Internet MIB II objects like system, tcp, and udp are considered "remote objects".

1) Determine if the attributes specified by the filter expression (if any) belong to the object class. If not, remove the object class from the object class group.

2) Determine if an instance of the object exists by attempting to retrieve, for the first instance, all of the attributes specified in the CMIS filter and the attributeId list or attribute list.

   i) For single instance objects (i.e., Internet group objects), if the object contains at least one attribute that is implemented by the remote Internet agent, use an SNMP Get Request or Get-Next Request with the parameters translated according to section 4.

      If the object does not contain any attribute that is implemented in the remote Internet agent (e.g., the Internet MIB-II at group), then the object exists if and only if there exists a subordinate object (table entries). The proxy shall attempt to determine if there exists a subordinate object by issuing an SNMP Get-Next Request using as an argument the Internet object name for the object, <internetEntityId>(c). If the SNMP response contains an Internet object that translates to an attribute of a subordinate of the object, then the object exists. If the object does not exist, remove it from the object class group.

   ii) For multiple instance objects (i.e., Internet table entry objects), use an SNMP Get-Next Request with the parameters translated as shown in section 4. This will result in the retrieval of the first instance of the translated Internet objects (i.e., a table entry). If the resulting table entry has been deleted, or is otherwise unavailable for retrieval, then go to step 5.

3) If the filter exists and it evaluates to FALSE, then perform no further processing on the object. However, for multiple instance objects, save the results of step 2 part (ii).

4) If no filter is specified or the filter evaluates to TRUE, attempt to perform the operation on the object, as follows.

   - If the CMIS operation is M-GET, the M-GET is completed from the Internet agent. Formulate the appropriate CMIS M-GET response and send it to the manager.

- If the CMIS operation is M-SET, perform the corresponding SNMP Set Request on the Internet objects. When the SNMP Response returns, formulate the appropriate CMIS M-SET response and send it to the manager.

  If the proxy gets the variable(s) to be modified during emulation of CMIS M-SET and any variable already has the requested value, the proxy shall still generate the SNMP Set request to guarantee that all behavior associated with the operation is executed.

- If the CMIS operation is M-CREATE, perform the create on the Internet objects (conceptual row elements) using the algorithm appropriate to the object. The proxy shall verify that none of the attribute values violate the object definition before it performs the SNMP operation. When the create process finishes, formulate the appropriate CMIS M-CREATE response and send it to the manager.

- If the CMIS operation is M-DELETE, perform the delete on the Internet objects. When the SNMP Response returns, formulate the appropriate CMIS M-DELETE response and send it to the manager.

5) For multiple instance objects, use an SNMP Get-Next Request, with the parameters translated according to section 4, and with the <internet instanceId> set to the values retrieved for the previous instances for all Internet object names. This will result in the retrieval of the next instance of the translated Internet objects. If the Internet object instances are not of the same type as those requested, then all instances of the multiple instance object class have been processed; go to step 6. If the Internet object instances are of the same type as those requested then retain the results of the Get-Next Request for the next iteration and repeat steps 3-5.

   In order to reduce the amount of traffic generated by multiple Get-Next requests, the proxy can use the SNMPv2 Get-Bulk request with the non-repeaters parameter set to zero and the max-repetitions set to some arbitrary value (either by guessing or based on previous knowledge). Setting non-repeaters to zero makes the Get-Bulk operation behave like Get-Next.

6) Attempt to select another object class from the object class group. If one exists, go to step 1; otherwise, return an appropriate final CMIP PDU (e.g., empty M-GET or M-SET response) and terminate processing the request.

3.4 Synchronization

If the ISO/Internet proxy receives a CMIS "atomic" request, but cannot perform the operation atomically, the "synchronization not supported" CMIS error response should be returned to the ISO/CCITT manager.

If SNMPv1 is used, the types of atomic requests that the ISO/Internet proxy can perform are as follows.

1) If all the instances selected by a scoped CMIS request are "local object instances", then the ISO/Internet proxy can perform the CMIS request locally (and atomically); and

2) If the CMIS request can be performed by the ISO/Internet proxy using a single SNMP request, then the operation can also be performed atomically.

In SNMPv1, either a Get or Set operation would fail if the operation on any selected variable(s) failed. This remains true for SNMPv2 Set operations, but not for SNMPv2 Get operations. Using SNMPv2, if you request 4 variables in a Get request, and there is an error in one of the variables, you get a response with 3 valid values and one error. The proxy shall fail a CMIS "atomic" request if the corresponding SNMPv2 Get operation is only partially successful.

For a "best effort" request, the ISO/Internet proxy should try to perform the request on all the instances specified by the request. Since the SNMP protocol supports only "atomic" operations, an operation (especially an SNMP Set Request operation) on multiple variables may be rejected if the operation on any one of the selected variables failed. Upon receiving such an error, the proxy should retry the request by sending multiple requests with each request containing only a single variable. In the time window in which these SNMP requests are being processed, another SNMP Set Request could be issued which could modify the value of a selected variable. For this reason, the complete integrity of a CMIS scoped request cannot be guaranteed. A proxy which complies with this document is not required to detect or avoid this situation, and will not usually report any error if this situation occurs.

3.5 M-GET Service

The following sub-sections describe how the M-GET service may be emulated. Upon receiving a CMIS M-GET request, the proxy first verifies the existence of the base managed object. The procedures for verifying the existence of a managed object is described in section 4.1.

3.5.1 Form The Request

If the CMIS request's attributeIdList parameter is empty (selects all attributes), the proxy shall query the schema information to find out what attributes are specified for the requested object class.

If the CMIS request's attribute specifies a non-null attributeIdList, the proxy shall verify that the identified attribute(s) are specified for the object class. If the identified attribute is not specified in the object class, the proxy shall return a noSuchAttribute CMIS error without sending SNMP requests to the Internet agent.

For all attributes that are specified in the object, an SNMP Get or SNMP Get-Next Request shall be formed, based on the mapping specified in section 4.

Use of SNMP Get or Get-Next is an implementation issue; however, SNMP Get-Next is recommended for performance reasons. Since some non-conforming agents may not implement all the object types in an object group, SNMPv1 Get would return a noSuchName error in this case, and the proxy will need to remove the non-implemented variable binding and resend the SNMP Request. If SNMP Get-Next is used instead, the proxy would either discard the non-implemented attribute or translate the SNMP Response to appropriate CMIS getListError.

If the NAME BINDING used by the object instance defines the object as deletable, the proxy shall include the DELETEATT (specified in the NAME BINDING template scannable behavior) in the requested variable binding list.

If the response for this variable binding is either the same as the DELETEVALUE specified in the NAME BINDING template scannable behavior, or SNMPV2ROWSTATUS "notReady", this object instance shall be treated as if the object instance does not exist.

3.5.2 Form The Response(s)

The proxy shall form the CMIS response according to the mappings specified in section 4.

If the CMIS request's attributeIdList is omitted (selects all attributes), the proxy shall supply all the attributes that are inherited from the ISO/CCITT Top object in the CMIS response. The proxy shall also retrieve all attributes that are implemented by the Internet agent. If the Internet agent does not implement all the variables in an object (which violates conformance to the SNMP specification), the proxy shall form the CMIS GetListError response.

3.6 M-CANCEL-GET Service

The M-CANCEL-GET operation shall be performed as described in [ISO9596-1]. The ISO/Internet proxy does not need to generate any SNMP Requests in order to emulate the CMIS M-CANCEL-GET request. However, upon receiving an M-CANCEL-GET request, the ISO/Internet proxy shall stop sending further CMIS M-GET responses to the ISO/CCITT manager for the canceled M-GET request. Furthermore, the proxy shall not initiate further SNMP Requests to the Internet agent for the canceled M-GET request. If the Internet agent continues to return SNMP Get responses corresponding to the canceled M-GET request, they shall be discarded by the proxy.

Depending on when an M-CANCEL-GET request is received, the proxy may send out different responses for the canceled M-GET request and for the M-CANCEL-GET request.

If the Invoke Id of the M-GET request to be canceled is not recognized by the proxy, the proxy shall return a "no such invoke identifier" CMIS error to the ISO/CCITT manager. This can happen when the proxy has not received such an M-GET request, or when the proxy has completed the identified M-GET request.

An M-GET operation is considered completed if the corresponding M-GET response has been sent. For the single object M-GET case, this means the sending of a single M-GET response. For the scoped multiple object case, this means the sending of the final empty M-GET response for the linked replies.

If the identified M-GET request was received, but has not been completed, the proxy generates an "operation canceled error" to the ISO/CCITT manager as a response to the canceled M-GET request. In this case, the proxy will also acknowledge the successful completion of the M-CANCEL-GET request to the ISO/CCITT manager.

3.7 M-SET Service

The following sections describe how M-SET service may be emulated. Upon receiving a CMIS M-SET request, the proxy verifies the existence of the based managed object, according to the procedures defined in section 4.1.

3.7.1 Perform The Set Operation

For each selected ISO/CCITT object instance, the proxy would generate one or more SNMP Set Requests to modify the attributes identified by the CMIS modificationList parameter, according to the specified modify operator. Only the "replace" modify operator is supported by the ISO/Internet proxy. The modify operator is optional and if it is not specified in a CMIS request, the "replace" operator should be assumed.

The proxy shall check its MIB schema to verify that the attributes to be modified during emulation of CMIS M-SET include the REPLACE property.

The CMIS "add value" and "remove value" modify operators are not supported by SNMP protocol, and are not supported by the ISO/Internet proxy. Since SNMP uses default values only for initialization (i.e. at creation time), the "set to default" modify operator is not supported by the ISO/Internet proxy either. If the modify operator value included in an M-SET request is not supported, "invalid operator" should be reported in the CMIS setListError response.

If the CMIS M-SET request sets the DELETEATT to the DELETEVALUE (specified in the NAME BINDING template scannable behavior associated with the object instance), the proxy shall return a CMIS "invalidOperation" error.

If emulation of the CMIS M-SET request requires generation of a SNMP Get/Get-Next request and the NAME BINDING associated with the object instance indicates that the object is deletable, then the proxy shall include the DELETEATT in the variable binding list of the SNMP Get/Get-Next request. If DELETEVALUE or SNMPV2ROWSTATUS "notReady" is returned, the proxy behaves as though the object instance does not exist.

If the proxy does not need to issue an SNMP Get/Get-Next request to emulate the CMIS M-SET service, the proxy shall attempt to perform the request. This is the only case where an agent which is behaving badly may make an invalid table entry appear to be instantiated.

3.7.2 Form The Response(s)

If the M-SET request is an "unconfirmed" request, SNMP Get responses are ignored and no CMIS response shall be returned.

If the M-SET request is a "confirmed" request, the proxy shall construct an M-SET response. The CMIS M-SET response should contain the attribute values list or the appropriate setListError. Once the CMIS M-SET response has been constructed, it is passed to the CMIP service provider, which send the corresponding CMIP PDU to the ISO/CCITT manager.

If the CMIS M-SET request is a scoped request, attribute values of each ISO/CCITT object are reported as a linked reply.

3.8 M-ACTION Service

Since Internet MIBs do not have any actions defined, the translation of CMIS M-ACTION to corresponding SNMP operations is not needed. Any CMIS M-ACTION request which is received pertaining to a translated Internet MIB object will be rejected

by the proxy with an "noSuchAction" error response. However, CMIS M-ACTION may be used by the proxy for other purposes.

3.9 M-CREATE Service

3.9.1 Request Validation

The ISO/Internet proxy is responsible for validating that incoming CMIS M-CREATE requests do not violate NAME BINDING and object class definitions.

3.9.2 Name Binding

The ISO/Internet proxy must determine if an instance may be created according to the CREATE clause of the NAME BINDING template specified for the object class. If the instance cannot be created, the CMIS error response "classInstanceConflict" is returned.

The ISO/Internet proxy must also determine from the NAME BINDING template if the instance specified in the request may be created under the superior object instance identified in the M-CREATE request. If the NAME BINDING does not specify the identified containment relationship, an "invalidObjectInstance" CMIS error response should be returned.

3.9.3 Check For Duplication

The proxy must determine if the instance already exists. If it does, a "duplicate managed object instance" CMIS error response should be returned.

3.9.4 With Reference Object

If a CMIS M-CREATE request includes a reference object, the ISO/Internet proxy should retrieve the referenced object instance from the Internet agent.

The proxy uses an SNMP Get-Next Request for retrieval, with the parameters translated according to section 4, and with the <internet instanceId> set to the translated <internet instanceId> of the reference object for all Internet object names.

The proxy checks if the attribute used for SNMP row creation indicates that the row is not available for use (e.g., has been deleted or is in some other not ready condition). This attribute is the DELETEATT attribute indicated in the scannable portion of table entries translated according to [IIMCIMIBTRANS].

If the reference object instance does not exist, the proxy must send a "No such reference object" CMIS error response to the ISO/CCITT manager.

3.9.5 With Automatic Instance Naming

A CMIS M-CREATE request can use automatic instance naming to form a name for the object instance to be created. Automatic instance naming is used if: a) a CMIS M-CREATE request does not specify a distinguished name for the object instance to be created; and b) the request specifies an object class that has a NAME BINDING allowing automatic instance naming.

It is the responsibility of the ISO/Internet proxy to select an instance name based on the behavior of the object class and name binding. In some cases, the relative distinguished name (RDN) is formed using attributes provided in the CMIS M-CREATE request. For example, the RDN for the Internet MIB-II "atEntry" could be formed from the "atNetIfIndex" attribute and the "atNetAddress" attribute. In other cases, the RDN can be assigned by the ISO/Internet proxy.

If the superior object instance is not specified, the ISO/Internet proxy cannot create the object instance and a "processing failure" CMIS error should be returned.

3.9.6 Perform The Create Operation

The CMIS M-CREATE is realized by setting the status column of the corresponding Internet MIB table entry to a valid value with all other columns of the table entry properly initialized. If the combination of the attributes specified in the CMIS M-CREATE request and the attributes obtained from the reference object do not provide a complete set of attribute values for all of the mandatory attributes for the entry specified by the object class being instantiated, then the ISO/Internet proxy should still try to create the object with all the available attributes.

If SNMPV2ROWSTATUS appears in the NAME BINDING template scannable behavior for this object, the following procedures shall be followed:

- if "active" is specified is the CMIS M-CREATE request, then the proxy shall set the SNMP rowStatus object to "createAndGo";

- if "notInService" is specified in the CMIS M-CREATE request, then the proxy shall set the SNMP rowStatus object to "createAndWait"; or

- in all other cases, the proxy shall set the SNMP rowStatus object to "createAndGo".

If the actual creation process with the incomplete attribute list succeeds, the ISO/Internet proxy should retrieve all the attributes of the newly-created entry, including the attributes

which have values supplied by the Internet agent using default values. This complete list of attribute values is returned in the CMIS M-CREATE response.

If the actual creation process with this partial attribute list fails, the ISO/Internet proxy sends a "missing attribute value" CMIS error back to the ISO/CCITT manager.

3.9.7 Form The Response

The results from the Internet agent are used by the proxy to construct a CMIS M-CREATE response, which is then returned to the ISO/CCITT manager, using the mappings defined by section 4.

3.10 M-DELETE Service

3.10.1 Perform the Delete Operation

For all the selected ISO/CCITT object instances, the following procedures should be taken.

3.10.2 Name Binding

Determine from the NAME BINDING template if the instance specified in the request may be deleted. If the NAME BINDING does not allow the deletion of the identified object, a CMIS error response is returned.

3.10.3 Perform The Delete Operation

If the object instance identified in the CMIS M-DELETE request exists, the delete operation is performed.

Object deletion is achievable only if there is a columnar object representing the status of each conceptual row. Deleting an object instance is realized by setting the status columnar object to an invalid value. The value representing "invalid" is implementation-specific. The proxy therefore needs to be aware of the "invalid" value and the status columnar object in order to perform the deletion. The NAME BINDING scannable behavior associated with the object instance provides this information.

Object deletion is achieved by sending an SNMP Set Request to the Internet agent to change the DELETEATT value to the DELETEVALUE (for SNMPv1), or to change the rowStatus value to "destroy" (for SNMPv2).

3.10.4 Form The Response(s)

This process includes formatting the CMIP M-DELETE response. Once the CMIS M-DELETE response has been constructed, it is returned to the ISO/CCITT manager.

3.11 Management Notification Services

Although SNMPv1 and SNMPv2 use different PDU structures to convey Traps, all SNMP Traps are mapped to the IIMC-defined internetAlarm notification and sent as CMIS M-EVENT-REPORTs. Since SNMP Traps are not confirmed, the translated CMIS M-EVENT-REPORTs are sent as "unconfirmed" event reports.

If the SNMPv2 manager-to-manager communication is supported between an Internet manager and an ISO/CCITT manager, it is possible for the proxy to receive an InformRequest from the Internet system. Like Traps, InformRequests are also mapped to CMIS M-EVENT-REPORTs. Unlike Traps, the internetAlarm notifications resulting from InformRequests are sent as "confirmed" event reports.

If the translation of Traps to notifications fails, no CMIS M-EVENT-REPORT will be generated and the SNMP Traps are simply discarded.

The proxy shall expect a CMIS M-EVENT-REPORT response for all internetAlarm notifications sent in confirmed mode. The CMIS M-EVENT-REPORT response shall contain an empty event report argument. Upon receipt of the CMIS M-EVENT-REPORT response, the proxy shall return an SNMP Response PDU to the Internet agent that is in accordance with SNMPv2 protocol rules and contains an error code of "noError".

If the translation of an SNMPv2 InformRequest to a CMIS M-EVENT-REPORT fails, the proxy shall send an SNMP Response to the originator of the SNMP InformRequest with the error code of "genErr".

If the proxy cannot determine the Internet agent that initiated the SNMP Trap, then the CMIS M-EVENT-REPORT shall be sent as if it originated from the cmipsnmpProxy managed object class. This can occur when there are multiple agents associated with the same network address or when the proxy is unable to recognize the network address. Otherwise, the proxy should always be able to determine the originator from the network address in the Trap message and the event will be sent as if it originated from the MIB-II internetSystem under the remote system.

The proxy shall determine the originator of the SNMP Trap using the following rules in sequence:

- Compare the Trap sender's network address against all the known proxy agent's network addresses. If a unique SNMP agent matches this address, the originator of the Trap is identified.

- If more than one known proxy agent's network address matches the Trap sender's network address, then the transport address of all the matched proxy agents shall be

compared against the Trap sender's transport address. If a unique SNMP agent matches this transport address, the originator of the SNMP Trap is identified.

- If more than one known proxy agent's network and transport address matches the Trap sender's addresses, then the known security parameters associated with the proxy agents are compared with the values supplied in the SNMP Trap PDU. For SNMPv1, community strings shall be compared. For SNMPv2, party ids shall be compared. If a unique match is found, the originator of the SNMP Trap is identified.

- If the above rules can not produce a unique match, then the originator of the SNMP Trap cannot be identified.

Refer to section 6 for additional information regarding discrimination of notifications.

4 Common Procedures For CMISE Service Emulation

The procedures described in this section are used during CMISE service emulation defined in section 3. These procedures are collected together here for ease of specification, and to facilitate common implementation.

4.1 Verifying Existence Of An Object Instance

Since the proxy does not maintain a replicate copy of the MIB data maintained by the Internet agents, the existence of a managed object, such as a base managed object specified in an incoming CMIS request, may need to be verified before further processing, such as scoping and filtering.

If the base object specified in the request does not exist in the Internet agent, then the proxy must send a "NoSuchObjectInstance" CMIS error response back to the ISO/CCITT manager.

If the base managed object is a pseudo object, the ISO/Internet proxy tries to determine if there exists a non-pseudo subordinate object. The base object exists if and only if there exists a non-pseudo subordinate object.

4.2 Translating Timestamps

This document does not specify a standard translation for the timestamp value in CMIS responses. However, the following paragraphs describe two potential implementations for this translation: ISO/Internet proxy's local time, and Internet agent's local time with fixed unknown delta.

4.2.1 ISO/Internet Proxy's Local Time

The timestamp value in the CMIS response can be set to the time provided by the ISO/Internet proxy's internal clock when the final SNMP Response is received to complete processing of a given CMIS request.

4.2.2 Internet Agent's Local Time

The ISO/Internet proxy can query the Internet agent for "sysUpTime", in addition to the original SNMP variable binding list in the first SNMP Request. Using this method, this value is recorded as the "agent's initial sysUpTime" and the ISO/Internet proxy's local time is recorded as "initial contact time".

Each CMIS request is then translated to one or more SNMP Requests by the ISO/Internet proxy to fulfill the CMIS request. If the last SNMP Request for the same CMIS request is an SNMP Get Request, the "sysUpTime" is added into the SNMP variable binding list. Otherwise, an extra SNMP Get Request is issued with "sysUpTime" as the only element in the variable binding list. This new "sysUpTime" is called "agent's current sysUpTime".

The timestamp in the last CMIS response is then calculated as follows: initial contact time + (agent's current sysUpTime - agent's initial sysUpTime).

This approach eliminates the inaccuracy caused by network delay between the ISO/Internet proxy and Internet agent, and gives the ISO/CCITT manager a more accurate indication of when the operation was actually performed by the Internet agent (rather than the time that the response was processed by the ISO/Internet proxy).

However, in order to convert the sysUpTime, which is the time ticks since the system was last re-initialized, to the CMIS event time, the proxy must be made aware of every reinitialization of the Internet agents. Although each Internet agent generates a Trap when it first comes up, there is no guarantee that the proxy will receive this Trap. Therefore, this method may also be inaccurate.

4.3 Derivation of SNMP Request Parameters

4.3.1 SNMPv2 Party and Context Parameters

The SNMPv2 source/destination party and context parameters shall be derived from the values in the privileged attribute certificate (PAC) passed in the access control parameter of the incoming ACSE or CMIS request.

If no incoming access control parameter is received, the proxy shall use the default context and parties in the snmpSecurityParameter object instance contained by the cmipsnmpProxyAgent. If no default applies, the operation shall be rejected by the proxy with an access denied error.

4.3.2 SNMPv1 Community String Parameter

The SNMPv1 community string parameter shall be derived from the value in the privileged attribute certificate(PAC) passed in the access control parameter of the ACSE or CMIS request.

If no incoming access control parameter is received, the proxy shall use the default community string in the snmpSecurityParameter object instance contained by the cmipsnmpProxyAgent. If no default applies, the operation shall be rejected by the proxy with an access denied error.

4.3.3 Internet Agent Transport Address

For SNMPv2, the proxy uses the value of the destination party identifier, derived according to the procedures in 4.3.1, to look up the transport address in a partyEntry object instance.

For SNMPv1, the Internet agent transport address shall be derived from the associated transport address in the table of cmipsnmpProxyAgent entries. The cmipsnmpProxyAgent is the one which has the same systemId as the attribute value within the RDN of the system object provided in the AETitle (if local name is used), or the CMIS managed object instance parameter.

4.3.4 SNMP Variable-Bindings Parameter

The SNMP variable-bindings list parameter contains a sequence of varBinds, each of which is an (Internet object name, value) pair.

For CMIS M-CREATE, M-SET, M-DELETE requests, the Internet object name shall be derived from the DN contained in the CMIP managed object instance parameter, and the attribute identifier provided in the CMIS request attributeIdList or attributeList parameter, using the algorithm defined in [IIMCIMIBTRANS] clause 2.3.1.

For M-CREATE and M-SET requests, the Internet object value shall be assigned the attribute value associated with the attributeId from which the Internet object name was derived.

For M-GET requests, it is recommended the Internet object value is NULL.

For M-DELETE requests, the proxy shall use the delete information as described in the NAME BINDING template behavior defined for the object class. Within the BEHAVIOUR text, the

DELETEATT specifies the Internet object name and DELETEVALUE specifies the Internet object value which signifies row deletion.

4.4 Derivation Of CMIS Parameters

Given the rules specified in this section, and knowledge of the IIMC containment hierarchy (name bindings), the ISO/CCITT {classOID}, {attributeOID}, and distinguished name can be derived from Internet names and the agent identifier.

The iimcAutoTrans OID is known to the proxy. It is defined in [IIMCIMIBTRANS].

4.4.1 Attribute Id Parameter

Using knowledge of the Internet name structure, and knowledge of valid <internetEntityId>(a) values known to the proxy, the <internetEntityId>(a) and <internet instanceId> may be extracted from the Internet object name.

The extraction process is not possible if the valid <internetEntityId>(a) value is not known to the proxy. In that case ,the translation process cannot be performed.

The ISO/CCITT attribute identifier is formed as:

{iimcAutoTrans <internetEntityId>(a)}

4.4.2 Managed Object Class Parameter

In CMIS response, the managed object class parameter can be derived from the proxy's retained information.

If actual class is used in the incoming CMIS request, the proxy must derive the object class parameter from the DN in the original CMIS request. The proxy shall derive the managed object class OID from the attribute type OID of the last RDN by removing the common prefix. If the CMIS request is a scoped request, the object class shall be derived from the retained information. If the Distinguished name is an empty set of RDN, "CCITT Rec. X.660 | ISO/IEC 9834-1 : 1992": root is assumed as the object class.

4.4.3 Managed Object Instance Parameter

The managed object instance value (the base managed object's DN) is retained by the proxy during processing of the CMIS request. However, for DNs other than the base managed object instance, the following steps shall be taken to derive the subordinate RDNs.

1) The final RDN shall be formed by the proxy using the instance index portion of the variable binding in the SNMP

response and the NAME BINDING information associated with the object class definition. Assume that the object class was able to be determined using the procedures of 4.4.2. The naming attribute type OID can be obtained directly form the NAME BINDING definition. If the DN represents a single instance object, the naming attribute is NULL. Otherwise, the naming attribute can be formed according to the naming attribute's syntax definition.

2) The sequence of other RDNs for the DN may be determined as follows.

Use knowledge of the containment hierarchy defined by name bindings, and the Internet agent's identifier. The name binding of the object class may be identified as the one that contains the object class OID as its final component, in accordance with the name binding registration procedures defined in [IIMCIMIBTRANS] clause 2.1.3. Use the superior/subordinate relationships in the name bindings to build the DN in reverse, beginning with the final RDN and ending with the RDN for the ISO/CCITT system object. For superior classes that can have only a single instance, the naming attribute OID can be obtained from the name binding definition and the naming attribute value is NULL. The agent's identifier is used as that of the value for the RDN of the ISO/CCITT system object.

One case exists for MIBs derived according to [IIMCIMIBTRANS] where it is possible for the superior object class to have multiple instances. This may occur when the subordinate object class is translated as the result of an SNMPv2 AUGMENTS clause and the superior object class is a table entry. In that case, the instance of the superior object class is identified by the same instanceId that identifies the subordinate object. The naming attribute value of this RDN is the same as the final RDN.

If the Internet agent's address cannot be determined, then it may not be possible to associate a notification with a specific agent. This may be a problem if multiple Internet agents are associated with the same network address. In such cases, the DN for the cmipsnmpProxy object instance shall be used as the DN for the object instance.

4.4.4 EventId Parameter

The eventId parameter shall be the OID assigned the internetAlarm as defined in [IIMCIMIBTRANS].

4.4.5 InternetAlarm ProbableCause Parameter

The internetAlarm notification probableCause parameter shall be derived as defined in [IIMCIMIBTRANS] clause 3.2.5.

Internet traps/notifications are registered using the OID corresponding to the value of the Internet snmpTrapOID object defined in [RFC1450].

For SNMPv1 Trap PDUs, the snmpTrapOID is derived as stated in the SNMPv1/SNMPv2 Coexistence document [RFC1452] clause 4.1.2 (2). That definition is repeated below:

"... if the value of the generic-trap field is 'enterpriseSpecific' then the value used is the concatenation of the enterprise field from the trap PDU with additional sub-identifiers, '0', and the value of the specific-trap field."

For notifications defined according to the SNMPv2 SMI, the probableCause is determined by either the snmpTrapOID.0 or snmpEventID.i, which is contained in the second variable binding of the Trap or InformRequest, respectively.

Only the "globalValue" (i.e., OID form) of the probableCause syntax shall be used.

4.4.6 InternetAlarm AttributeIdentifier List

The following process shall be followed for each variable in the variable-bindings, excluding the first two variable-bindings.

The name portion of the variable binding shall be converted to an ISO/CCITT attributeId using the procedure specified in section 4.4.1. The converted ISO/CCITT attributeId shall be placed in the attributeIdList.

4.4.7 InternetAlarm ObjectInstanceList

The following process shall be followed for each variable in the variable-bindings, excluding the first two variable-bindings.

The name portion of the variable binding shall be converted to an ISO/CCITT object instance name using the procedures specified in section 4.4.3. The converted ISO/CCITT object instance name shall be placed in the object instance list.

If the proxy cannot determine the object instance name (e.g., because the Internet agent's identifier cannot be determined), then the objectInstanceList parameter shall not be included in the internetAlarm.

4.4.8 InternetAlarm InternetTrapInfo Parameter

The following process shall be followed for each variable in the variable-bindings.

The name portion of the variable binding shall be converted to an ISO/CCITT object instance name using the procedures specified in section 4.4.3. The converted ISO/CCITT object instance name shall be placed in the objectInstance field of the internetTrapInfo parameter.

If the Internet agent's identifier cannot be determined, or the <internetEntityId>(a) is unknown to the proxy, then the object instance name cannot be determined and the objectInstance field shall not be included in the internetTrapInfo parameter, but shall be included in the unknownVarBindList parameter.

4.4.9 InternetAlarm UnknownVarBindList Parameter

If the proxy cannot determine the attributeId for a variable binding (i.e., because the <internetEntityId>(a)portion of the Internet object name is not known to the proxy), then that variable binding shall be included in the unknownVarBindList parameter.

4.4.10 InternetAlarm PerceivedSeverity Parameter

The proxy cannot determine the perceivedSeverity for the translated SNMP Trap without specific knowledge of the Trap. Therefore, the proxy always assumes "indeterminate" for all the CMIS M-EVENT-REPORTs generated as a result of SNMP Traps.

However, a proxy can build in some local knowledge of the SNMP Traps and assign different perceivedSeverity values based on its local knowledge. Such local knowledge is not within the scope of this document.

4.4.11 InternetAlarm TransportDomain Parameter

For SNMPv2 Traps, the transportDomain parameter may be determined by using the one of the party identifier parameters associated with the Trap. The partyEntry object identified by the party identifier contains the partyDomain attribute.

For either SNMPv1, or SNMPv2 Traps, knowledge of the transport protocol used may be provided to the proxy. Alternatively, if the transport address can be determined, the proxy can determine the transport protocol from the format of the address. The proxy may then be able to determine the appropriate transportDomain value from local knowledge of the OIDs registered for different transport domains.

4.4.12 InternetAlarm TransportAddress Parameter

See section 4.3.3 for possible ways to determine the transport address.

4.4.13 InternetAlarm AccessControl Parameter

The access control parameter shall be assigned the community string or party identifiers associated with the SNMP Trap.

5 Error Message Translation

5.1 Translating SNMP Error Messages

SNMP error responses received by the ISO/Internet proxy are translated to CMIS error responses and sent back to the ISO/CCITT manager. The following sections provides a mapping for SNMP error messages to CMIS error responses.

5.1.1 tooBig

If the SNMP error "tooBig" is received, the ISO/Internet proxy should try to break the SNMP Request into smaller requests and resend the requests. If it is not feasible to break the request to any smaller request, and this error occurs, the CMIS error response "Complexity limitation" should be returned to the ISO/CCITT manager.

5.1.2 noSuchName

If the SNMP error "noSuchName" occurs when an attribute is queried as part of a CMIS Filter evaluation, then the filterItem will be evaluated as FALSE.

In order to check if an object exists, all the object class's attributes should be queried until at least one attribute's existence is verified. If none of the attributes exist, and the object is the base managed object, then a "NoSuchObjectInstance" CMIS error response should be returned.

If the object exists and the SNMP "noSuchName" error occurs when attempting to read or modify an attribute, a CMIS "No Such Attribute" error response should be returned to the ISO/CCITT manager.

If the ISO/Internet proxy maintains correct schema information and the Internet agent is a conforming agent, an Internet object's attributes should either all exist or none exist. In order to make the ISO/Internet proxy a practical solution, the preceding error situation is included in order to deal with a non-conforming Internet agent.

5.1.3 badValue

If the SNMP error "badValue" is returned for an SNMP Get Request, then a "processing failure" CMIS error response should

be returned to the ISO/CCITT manager. In the ProcessingFailure parameter of the CMIS error response, the errorId should be "snmpBadValue", and the errorInfo should be the variable binding identified by the error-index.

If the badValue error occurs during an SNMP Set Request to fulfill a CMIS M-DELETE request, a "processing failure" CMIS error response should be returned. In the ProcessingFailure parameter, the errorId should be " cannotDelete" and the errorInfo should be the variable binding that is identified by the error-index.

5.1.4 readOnly

The proxy should never receive an SNMP readOnly error from an SNMPv1 agent. If this error is received, a "processing failure" CMIS error response should be returned to the ISO/CCITT manager. In the processingFailure parameter, the errorId should be "snmpReadOnly" and the errorInfo should be the variable binding that is identified by the error-index.

For SNMPv2, if the SNMP error "readOnly" occurs when checking for the existence of a base object, a "processingfailure" CMIS error response should be returned to the ISO/CCITT manager. In the ProcessingFailure parameter of the CMIS error response, the errorId should be "snmpReadOnly", and the errorInfo should be the variable binding identified by the error-index. If the error occurs when deleting the object, then the deleteErrorInfo field in the response shall be set to "accessDenied".

5.1.5 genErr

If the SNMP error "genErr" occurs, the "ProcessingFailure" CMIS error response should be returned to ISO/CCITT manager. If the entry exists, scoping continues; otherwise, scoping terminates. In the ProcessingFailure parameter of the CMIS error response, the errorId should be "snmpGenErr".

There are additional error messages in SNMPv2. Most of the errors are defined for the Set Request. Since a Set Request may be originated when processing a CMIP M-SET request, an M-CREATE request or an M-DELETE request, the proxy must ensure each error code is translated to the one which is most compatible with the original CMIS request. In addition, the proxy must ensure the selected error value is compatible with the use of other parameters such as scoping, filtering, synchronization and multiple linked reply.

5.1.6 noAccess

This error indicates the variable binding's name specifies a variable which is not accessible by an SNMP Get or Set Request. This error should be mapped to the CMIS "invalidOperation" error.

5.1.7 wrongType

This error indicates the variable binding's value field of an SNMP Set Request specified a type which is inconsistent with that required for the variable. This error may be mapped to the CMIS "invalidAttributeValue" error.

5.1.8 wrongLength

This error indicates the variable binding's value field of an SNMP Set Request specifies, according to the ASN.1 language, a length which is inconsistent with that required for the variable. If the original CMIS request is M-CREATE or M-SET, the CMIS error "InvalidAttributeValue" shall be returned. If the original CMIS request is M-DELETE, the CMIS "processing failure" error shall be returned.

5.1.9 wrongEncoding

This error is used to indicate the variable binding's value field of an SNMP Set Request contains an ASN.1 encoding which is inconsistent with that field's ASN.1 tag. This error should be mapped to the CMIS "processingFailure" error.

5.1.10 wrongValue

This error indicates the variable binding's value field in an SNMP Set Request specifies a value which could under no circumstances be assigned to the variable. This error should be mapped to the CMIS "invalidAttributeValue" error.

5.1.11 noCreation

This error is generated when an SNMP Set Request variable binding name specified a variable which does not exist and could not ever be created. This error should be mapped to the CMIS "invalidObjectInstance" error.

5.1.12 inconsistentValue

This error indicates that an SNMP Set Request variable binding value field specified a value that could under other circumstances be assigned to the variable, but is presently inconsistent. If the SNMP Set Request was generated as a result of a CMIS M-CREATE or M-SET operation, the error should be mapped to the CMIS "invalidAttributeValue" error.

If the SNMP Set Request was generated as a result of CMIS M-DELETE operation, the error may be mapped to the CMIS "processingfailure" error.

5.1.13 resourceUnavailable

This error indicates that the assignment of a value by an SNMP Set Request requires the allocation of a resource which is presently unavailable. This error may be mapped to the CMIS "resourceLimitation" error.

5.1.14 commitFailed

When performing an SNMP Set Request, the Internet agent must ensure all variable assignments occur atomically. If any of the assignments fail, an SNMP "commitFailed" error is returned. If the original CMIS request is a "best effort" request, the proxy should either retry the failed variable assignments by sending multiple SNMP Set Requests, or return a CMIS setListError with a "processingfailure" error.

5.1.15 undoFailed

When performing an SNMP Set Request, the Internet agent must ensure all variable assignments occur atomically. If any of the assignments fail, the agent should undo all the assignments. An SNMP "undoFailed" error is returned when the agent cannot undo all the assignments. CMIS does not have any error value equivalent to this. The CMIS "processing failure" error must be returned.

5.1.16 authorizationError

This error indicates that an SNMP Request has been discarded because the authorization context used in the request does not allow the PDU type. This error is mapped to the CMIS "accessDenied" error.

5.1.17 notWritable

The "notWritable" error is used to indicate that an SNMP Set Request is trying to modify the value of a variable which is not modifiable, no matter what new value is specified. This error shall be mapped to the CMIS "invalidOperation" error.

5.2 CMIS Processing Failure

There are many error scenarios in which the error cannot be mapped to a specific CMIS error. In these cases, the "processing failure" CMIS error response should be reported back to the ISO/CCITT manager. This includes scenarios in which the Internet agent becomes unreachable during emulation of a CMIS request.

In order to provide the ISO/CCITT manager with a better description of the error, the specificErrorInfo field of the CMIS ProcessingFailure is used to convey the cause of the

problem. Refer to the IIMC specific error PARAMETER templates defined in section 7.1.4.

6 ISO/CCITT Systems Management Functions

ISO/CCITT systems management standards include a set of Systems Management Function specifications. An ISO/Internet proxy may choose to support some or all of these systems management functions. This section provides some of the modeling approaches which may be used in supporting ISO/CCITT systems management functions.

6.1 Event Report Management Function

The ISO/CCITT Event Report Management Function [ISO10164-5] defines an Event Forwarding Discriminator (EFD) managed object which allows an ISO/CCITT manager to control the forwarding and processing of potential event reports by an ISO/CCITT agent. The Event Report Management Function maybe supported by an ISO/Internet proxy to allow the ISO/CCITT manager to control where and how Internet Traps and Inform Requests may be forwarded.

Since all Internet Traps and Inform Requests are translated by the proxy and are forwarded to their destinations by the proxy, EFD managed objects are best supported by the proxy as local objects. Upon receiving a CMIS M-CREATE request for an EFD, the proxy creates the EFD object instance according to the specified name binding. Once created, the EFD is used by the proxy to determine which CMIS M-EVENT-REPORTs are to be forwarded to a particular destination during a specified time period.

6.2 Log Control Function

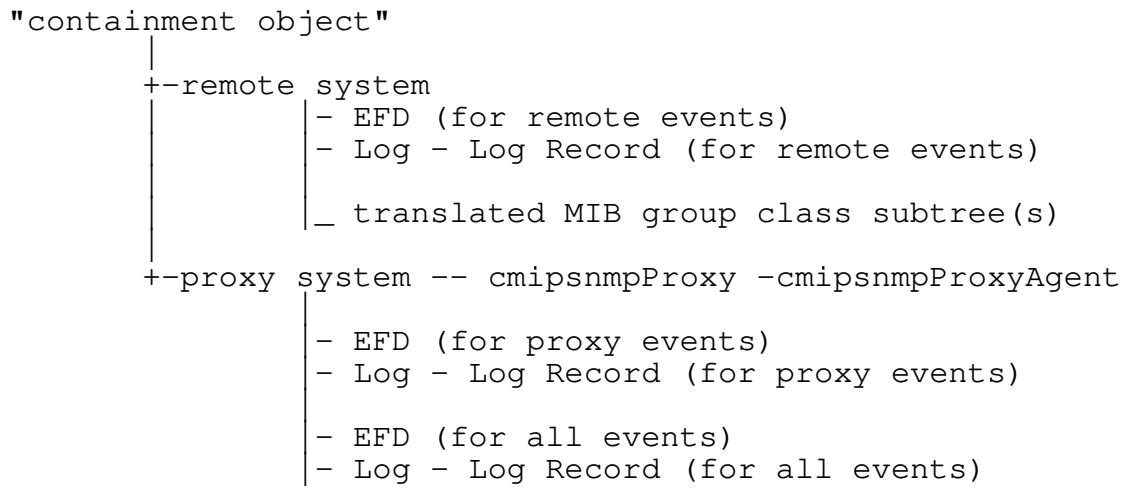
The ISO/CCITT Log Control Function [ISO10164-6] defines a Log managed object which allows control and monitoring of a log and the retrieval of its log records. If the Log managed object is supported, Internet Traps and Inform Requests may be logged according to a predefined criteria.

Since only notifications are logged and these are constructed by the proxy, the Log managed object can be defined as a local object of a proxy. Upon receiving a CMIS M-CREATE request for a Log object, the proxy creates the Log instance according to the specified name binding. Once created, the Log is used by the proxy to process the received Traps and Inform Requests (and local notifications) for logging.

An InternetAlarmRecord managed object class is defined in [IIMCIMIBTRANS].

6.3 Scope of the EFD and Log

EFD and Log objects can be created under either the remote system or the proxy system objects. EFD and Log object instance behavior is different depending on its position in the containment tree.



EFD and Log objects contained by the remote system object shall process only those events generated by the objects known to each Internet agent (i.e., objects contained by the same remote system object).

EFD and Log objects contained by a proxy system object with the instance name "ProxyOnly" shall process only those events emitted from the object instances contained by the proxy system. Any other EFD or Log object contained by the proxy system shall apply to any event (including all events generated by any object). If an EFD or Log is created under the proxy system using automatic instance naming, the proxy shall choose a name other than the name "ProxyOnly".

7 ISO/CCITT-Internet Proxy MIB

The ISO/CCITT-Internet Proxy MIB defines a set of objects for specifying the information that is needed for both community-based and party-based SNMP management on a per Internet agent basis. The containment hierarchy and other introductory information regarding this Proxy MIB can be found in section 2.3.

The GDMO templates and ASN.1 modules are included here in one section to facilitate automated processing. Comments and subsection headers are included in the form of ASN.1 comments, i.e., preceded by "--".

This document (IIMCPROXY) is allocated the following registration identifier for purposes of referencing material contained herein.

```
iimcIIMCProxy OBJECT IDENTIFIER ::= {iimcManagementDocMan 3}
```

7.1 Proxy MIB GDMO Templates

-- 7.1.1 Proxy MIB Managed Object Classes

```
cmipsnmpProxyAgent MANAGED OBJECT CLASS
   DERIVED FROM
            "Rec. X.721 | ISO/IEC 10165-2 : 1992":top;
   CHARACTERIZED BY
             cmipsnmpProxyAgentPkg PACKAGE
                  BEHAVIOUR cmipsnmpProxyAgentPkgBehaviour
               BEHAVIOUR
                 DEFINED AS
                 !This managed object class is used to
                 represent an Internet agent in the
                 proxy MIB. Each agent that the proxy
                 manages is represented by an instance
                 of this object class.

                 The cmipsnmpProxyAgentId attribute
                 contains the administratively-
                 assigned name of the managed system
                 that contains the Internet agent.
                 Usually this is an Internet Domain
                 Name. This attribute value shall be
                 determined by the manager when the
                 object is created.

                 The transportAddress and
                 transportDomain attributes provide
                 information used to send SNMP
                 requests to the Internet agent. The
                 semantics of these attributes are
                 defined by [IIMCIMIBTRANS].

                 The managementProtocol attribute
                 specifies the Internet management
                 protocol used by the proxy to manage
                 devices.  It shall be the OID
                 indicating SNMPv1, SNMPv2, or some
                 other protocol. This attribute is
                 assigned a value (an OID) by the
                 manager that is appropriate for the
                 Internet agent.

                 The supportedMIBs attribute
                 identifies the set of GDMO documents
                 that describe the MIBs that the
                 Internet agent supports. The
```

```
                ISO/CCITT manager may add elements to
                or remove elements from this
                attribute.

                The remote system object instance that
                represents the Internet agent shall be
                created by the proxy automatically when
                an instance of the cmipsnmpProxyAgent
                class is created.  The "OP1 Library Vol.
                4":capabilityObject defined by [NMF006]
                shall be created if the proxy supports
                the capability object.

                The accessControlMechanism attribute
                indicates whether no access control,
                Internet access control as specified in
                [RFC1446], or ISO/CCITT access control
                as specified in [ISO10164-9] is to be
                used. The default is no access control.

                The administrativeState of the
                cmipsnmpProxyAgent can be locked/unlocked
                via management operation. When
                administrativeState is locked, any
                incoming CMIS requests for this agent
                result in a CMIS processingFailure
                response (adminStateLocked), and no
                notifications are generated with this
                cmipsnmpProxyAgent's internetSystem as
                the source managed object class.

                The communicationAlarm with probableCause
                equal to lossOfSignal shall be generated by
                the proxy when it fails in communicating with
                the agent (for example, when exceeding max
                retries for an SNMP message). Optional
                notification fields such as additionalText and
                additionalInfo can be used to supply useful
                details to the manager (an implementation
                option).!;;

        ATTRIBUTES
           cmipsnmpProxyAgentId GET,
           {iimcIIMCIMIBTRANS}:transportAddress GET-REPLACE,
           {iimcIIMCIMIBTRANS}:transportDomain GET-REPLACE,
           managementProtocol  REPLACE-WITH-DEFAULT GET,
           supportedMIBs       GET-REPLACE ADD-REMOVE,
           accessControlMechanism
                 DEFAULT VALUE
                    IimcProxyASN1.agentOnlyAccessControl
                 GET-REPLACE,
           "Rec. X.721 | ISO/IEC 10165-2 : 1992":
           administrativeState GET-REPLACE;
```

```
        NOTIFICATIONS
          "Rec. X.721 | ISO/IEC 10165-2 : 1992":
          communicationsAlarm;;;

      CONDITIONAL PACKAGES
      retransmissionPackage
           PRESENT IF
           !supported by the proxy and requested during creation!,
      pollingPackage
           PRESENT IF
           !supported by the proxy and requested during creation!;

   REGISTERED AS  { iimcProxyObjectClass 1 };


cmipsnmpProxy MANAGED OBJECT CLASS
   DERIVED FROM
     "Rec. X.721 | ISO/IEC 10165-2 : 1992":top;
   CHARACTERIZED BY
     cmipsnmpProxyPkg PACKAGE
     BEHAVIOUR
     cmipsnmpProxyPkgBehaviour BEHAVIOUR
     DEFINED AS
     !This managed object class is used to contain
     objects that represent an Internet agent in the
     proxy MIB.

     The internetAlarm shall be emitted by this object
     class when the application level source of the SNMP
     Trap or Inform Request cannot be determined. The
     address field of the internetAlarm shall be set to
     the network address associated with the SNMP Trap
     or Inform Request.!;;
   ATTRIBUTES
     cmipsnmpProxyId GET;
   NOTIFICATIONS
     {iimcIIMCIMIBTRANS}:internetAlarm;;;

   CONDITIONAL PACKAGES
      retransmissionPackage
           PRESENT IF
           !supported by the proxy and requested during creation!,
      pollingPackage
           PRESENT IF
           !supported by the proxy and requested during creation!;

REGISTERED AS  {iimcProxyObjectClass 2};
```

```
snmpSecurityParameter MANAGED OBJECT CLASS
   DERIVED FROM
     "Rec. X.721 | ISO/IEC 10165-2 : 1992" : top;
   CHARACTERIZED BY
     defaultSecurityParameterPkg PACKAGE
     BEHAVIOUR
     defaultSecurityParameterPkgBehaviour BEHAVIOUR
     DEFINED AS
     ! This object instance contains the default security
     parameter that is used only when such AccessControl
     field is not received during association
     establishment.!;;
   ATTRIBUTES
     snmpSecurityParameterId  GET,
     snmpSecurity             GET-REPLACE
                              ADD-REMOVE ;;;
   REGISTERED AS  {iimcProxyObjectClass 3};
```

-- 7.1.2 Proxy MIB Packages

```
retransmissionPackage PACKAGE
   BEHAVIOUR retransmissionPackageBehaviour BEHAVIOUR
   DEFINED AS

   !This optional package is used to influence proxy
   service emulation, as described in section 2.5. Note
that
   the timeout is a requested value.  The actual timeout
   depends on the proxy.  Also note that the timeout is NOT
   a timeout on CMIS request processing.

   This package can optionally be instantiated within the
   cmipsnmpProxy and/or cmipsnmpProxyAgent objects.  If this
   package is instantiated in the cmipsnmpProxy object, then
   these attribute values apply by default to all Internet
   agents. If this package is instantiated in an individual
   cmipsnmpProxyAgent object, then the values specified
   there apply to the associated Internet agent, over-riding
   any default values specified by the superior
   cmipsnmpProxy object.!;;

   ATTRIBUTES
              snmpMsgRetryLimit GET-REPLACE,
              snmpMsgTimeout    GET-REPLACE;
   REGISTERED AS  { iimcProxyPackage 1 };


pollingPackage PACKAGE
   BEHAVIOUR pollingPackageBehaviour BEHAVIOUR
   DEFINED AS
   ! This optional package specifies the interval
   to be used by the proxy for polling the Internet
```

```
   agent, as described in section 2.5.

   This package can optionally be instantiated within the
   cmipsnmpProxy and/or cmipsnmpProxyAgent objects.  If this
   package is instantiated in the cmipsnmpProxy object, then
   these attribute values apply by default to all Internet
   agents. If this package is instantiated in an individual
   cmipsnmpProxyAgent object, then the values specified
   there apply to the associated Internet agent, over-riding
   any default values specified by the superior
   cmipsnmpProxy object.!;;

   ATTRIBUTES
           pollPeriod   GET-REPLACE;
   REGISTERED AS  { iimcProxyPackage 2 };
```

-- 7.1.3 Proxy MIB Attributes

```
accessControlMechanism ATTRIBUTE
   WITH ATTRIBUTE SYNTAX
     IimcProxyASN1.AccessControlEnforcement;
   MATCHES FOR EQUALITY, ORDERING;
   BEHAVIOUR accessControlMechanismBehaviour BEHAVIOUR
     DEFINED AS
     !The accessControlMechanism attribute indicates
     which access control is to be applied at the proxy
     device.  The mechanism may be no access control,
     the internet access control as defined in
     [RFC1446] or one of the ISO access control
     mechanisms as defined in [ISO10164-9].!;;
REGISTERED AS {iimcProxyAttributeID 1 };


cmipsnmpProxyAgentId ATTRIBUTE
   WITH ATTRIBUTE SYNTAX
     IimcProxyASN1.CmipsnmpProxyAgentId;
   MATCHES FOR EQUALITY;
   BEHAVIOUR cmipsnmpProxyAgentIdBehaviour BEHAVIOUR
     DEFINED AS
     !This is the naming attribute for the cmipsnmpProxyAgent
     object class.  This attribute contains the RDN of the
     remote system which represents the proxied device.!;;
REGISTERED AS {iimcProxyAttributeID 2 };
```

```
cmipsnmpProxyId ATTRIBUTE
   WITH ATTRIBUTE SYNTAX
     IimcProxyASN1.CmipsnmpProxyId;
   MATCHES FOR EQUALITY;
   BEHAVIOUR cmipsnmpProxyIdBehaviour BEHAVIOUR
     DEFINED AS
     !This is the naming attribute for the
     cmipsnmpProxy object class.!;;
REGISTERED AS { iimcProxyAttributeID 3 };


managementProtocol ATTRIBUTE
   WITH ATTRIBUTE SYNTAX
           IimcProxyASN1.ObjectIdentifier;
           MATCHES FOR EQUALITY;
    BEHAVIOUR managementProtocolBehaviour BEHAVIOUR
           DEFINED AS
           !This attributes specifies the Internet
           management protocol used for proxy to
           managed devices.  It shall have a value of
           either SNMPv1 or SNMPv2.!;;
REGISTERED AS {iimcProxyAttributeID 4 };


pollPeriod ATTRIBUTE
   WITH ATTRIBUTE SYNTAX IimcProxyASN1.PollPeriod;
   MATCHES FOR EQUALITY, ORDERING;
   BEHAVIOUR pollPeriodBehaviour
   BEHAVIOUR
           DEFINED AS
          !When polling  is enabled (has a non-zero value), the
          proxy issues periodic SNMP Get or Get-Next requests
          on the Internet system to verify reachability of the
          Internet agent. A value of zero means no polling
          shall be used.!;;
REGISTERED AS { iimcProxyAttributeID 5 };


supportedMIBs ATTRIBUTE
   WITH ATTRIBUTE SYNTAX
           IimcProxyASN1.SupportedMIBs;
   MATCHES FOR
           EQUALITY, SET-COMPARISON, SET-INTERSECTION;
   BEHAVIOUR supportedMIBsBehaviour BEHAVIOUR
   DEFINED AS
   !This attribute specifies the OIDs of the GDMO
   documents that are translated from the Internet MIBs
   that the Internet agent supports.  This attribute
   reflects what the OSI manager requests and the proxy
   is capable of supporting.  If the OSI manager requests
   to add values which are not supported by the proxy,
   the M-CREATE or M-SET fails!;;
REGISTERED AS {iimcProxyAttributeID 6};
```

```
snmpMsgRetryLimit ATTRIBUTE
   WITH ATTRIBUTE SYNTAX IimcProxyASN1.RetryLimit;
        MATCHES FOR EQUALITY, ORDERING;
   BEHAVIOUR snmpMsgRetryLimitBehaviour BEHAVIOUR
   DEFINED AS
   !If the snmpMsgRetryLimit is set to zero, the
   proxy will only send each SNMP request once. If
   the snmpMsgRetryLimit is set to one, each SNMP
   request may be sent twice at most - once for the
   original request and once for the retry
   following a timeout. The range of this attribute
   is between 0 and 100, where 0 indicates no retry
   shall be attempted.!;;
REGISTERED AS { iimcProxyAttributeID 7 };


snmpMsgTimeout ATTRIBUTE
    WITH ATTRIBUTE SYNTAX
        IimcProxyASN1.TimeoutInterval;
    MATCHES FOR EQUALITY, ORDERING;
    BEHAVIOUR snmpMsgTimeoutBehaviour BEHAVIOUR
    DEFINED AS
    !This attribute indicates how many milliseconds the proxy
    should wait to receive each SNMP response before "timing
    out".!;;
REGISTERED AS { iimcProxyAttributeID 8 };


snmpSecurity ATTRIBUTE
   WITH ATTRIBUTE SYNTAX
     IimcProxyASN1.SnmpSecurity;
   MATCHES FOR EQUALITY, SET-COMPARISON, SET-INTERSECTION;
   BEHAVIOUR snmpSecurityBehaviour BEHAVIOUR
     DEFINED AS
     !This attribute specifies the default values to be used
     when other AccessControl values are not available (i.e.,
     when no AccessControl fields are received during
     association establishment or on a given CMIS
     operation).!;;
   REGISTERED AS {iimcProxyAttributeID 9 };


snmpSecurityParameterId ATTRIBUTE
   WITH ATTRIBUTE SYNTAX
     IimcProxyASN1.SnmpSecurityParameterId;
   MATCHES FOR EQUALITY;
   BEHAVIOUR snmpSecurityParameterIdBehaviour
     BEHAVIOUR DEFINED AS
     !This is the naming attribute for the
     snmpSecurityParameter object class.!;;
   REGISTERED AS { iimcProxyAttributeID 10 };
```

-- 7.1.4 Proxy MIB Name Bindings

```
cmipsnmpProxy-systemNB  NAME BINDING
   SUBORDINATE OBJECT CLASS cmipsnmpProxy;
   NAMED BY SUPERIOR OBJECT CLASS
     "Rec. X.721 | ISO/IEC 10165-2 : 1992":system;
   WITH ATTRIBUTE cmipsnmpProxyId;
   BEHAVIOUR cmipsnmpProxy-systemNBBehaviour BEHAVIOUR
     DEFINED AS
     !There is only one object instance of this object class in
     the proxy and this managed object instance should be
     created by the proxy process.  It is not creatable and
     deletable via CMIP management operation.!;;
   REGISTERED AS {iimcProxyNameBinding 1};


cmipsnmpProxyAgent-cmipsnmpProxyNB  NAME BINDING
   SUBORDINATE OBJECT CLASS cmipsnmpProxyAgent;
   NAMED BY SUPERIOR OBJECT CLASS cmipsnmpProxy;
   WITH ATTRIBUTE cmipsnmpProxyAgentId;
   BEHAVIOUR cmipsnmpProxyAgent-cmipsnmpProxyNBBehaviour
   BEHAVIOUR
     DEFINED AS
     !This managed object may be created and deleted
     either by management action, or by local action, of
     the proxy.

     A side effect of the creation/deletion of this object
     shall be the creation/deletion of the ISO system
     managed object associated with the Internet agent.

     The cmipsnmpProxyAgentId contains the RDN of
     the proxied device.!;;

   CREATE WITH-REFERENCE-OBJECT;
   DELETE;
   REGISTERED AS {iimcProxyNameBinding 2};


snmpSecurityParameter-cmipsnmpProxyNB  NAME BINDING
   SUBORDINATE OBJECT CLASS snmpSecurityParameter;
   NAMED BY SUPERIOR OBJECT CLASS cmipsnmpProxy;
   WITH ATTRIBUTE snmpSecurityParameterId;
   BEHAVIOUR snmpSecurityParameter-cmipsnmpProxyNBBehaviour
   BEHAVIOUR
     DEFINED AS
     !This managed object is created automatically when the
     containing cmipsnmpProxy object is created. There is
     only one instance of this class per cmipsnmpProxy.!;;
   REGISTERED AS {iimcProxyNameBinding 3};
```

-- 7.1.4 Proxy MIB Parameters

```
adminStateLocked PARAMETER
        CONTEXT SPECIFIC-ERROR;
        WITH SYNTAX
        IimcProxyASN1.MiscellaneousError;    BEHAVIOUR
        adminStateLockedBehaviour  BEHAVIOUR DEFINED AS
        !This error is used by the proxy to indicate the
        administrativeState of the proxied device is
        locked and no more proxy service is provided to
        the proxied device.!;;
REGISTERED AS { iimcProxyParameter 1 };


noResponse      PARAMETER
        CONTEXT SPECIFIC-ERROR;
        WITH SYNTAX     IimcProxyASN1.VarBindList;
        BEHAVIOUR       noResponseBehaviour BEHAVIOUR
        DEFINED AS
        !This error is used by the proxy to indicate it
        has not received any SNMP response for an SNMP
        request required to emulate a CMIS service.!;;
REGISTERED AS { iimcProxyParameter 2 };


cannotDelete    PARAMETER
        CONTEXT SPECIFIC-ERROR;
        WITH SYNTAX     IimcProxyASN1.VarBind;
        BEHAVIOUR       cannotDeleteBehaviour BEHAVIOUR
        DEFINED AS
        !The proxy emulates the CMIS M-DELETE service by
        issuing an SNMP Set Request on the DELETEATT that is
        specified in the NAME BINDING template scannable
        behavior for this object. However, if the agent
        returns an SNMP badValue error, it means the Internet
        agent does not allow deletion of the specified table
        entry and this CMIS error shall be returned in
        response to the CMIS M-DELETE.!; ;
REGISTERED AS { iimcProxyParameter 3 };


protocolNotImplemented  PARAMETER
        CONTEXT SPECIFIC-ERROR;
        WITH SYNTAX     IimcProxyASN1.ProtoNotImplErrorInfo;
        BEHAVIOUR       protocolNotImplementedBehaviour
        BEHAVIOUR DEFINED AS
        !If the transport, authentication, or privacy
        protocol required is not supported by the
        proxy,  this CMIS error shall be returned.!;;
REGISTERED AS { iimcProxyParameter 4 };
```

```
snmpTooBig      PARAMETER
        CONTEXT SPECIFIC-ERROR;
        WITH SYNTAX     IimcProxyASN1.VarBindList;
        BEHAVIOUR       snmpTooBigBehaviour
        BEHAVIOUR DEFINED AS
        !This error is used by the proxy to indicate that
        SNMP variable bindings generated during CMIS
        emulation caused the Internet agent to return an SNMP
        tooBig error.!;;
REGISTERED AS { iimcProxyParameter 5 };


snmpBadValue    PARAMETER
        CONTEXT SPECIFIC-ERROR;
        WITH SYNTAX     IimcProxyASN1.VarBind;
        BEHAVIOUR       snmpBadValueBehaviour BEHAVIOUR
        DEFINED AS
        !This error is used by the proxy to indicate that
        SNMP variable bindings generated during CMIS
        emulation caused the Internet agent to return an SNMP
        badValue error.!;;
REGISTERED AS { iimcProxyParameter 6 };


snmpGenErr      PARAMETER
        CONTEXT SPECIFIC-ERROR;
        WITH SYNTAX  IimcProxyASN1.MiscellaneousError;
        BEHAVIOUR       snmpGenErrBehaviour BEHAVIOUR
        DEFINED AS
        !This error is used by the proxy to indicate that
        SNMP variable bindings generated during CMIS
        emulation caused the Internet agent to return an SNMP
        genError error.!;;
REGISTERED AS { iimcProxyParameter 7 };


wrongLength     PARAMETER
        CONTEXT SPECIFIC-ERROR;
        WITH SYNTAX     IimcProxyASN1.VarBind;
        BEHAVIOUR       wrongLengthBehaviour BEHAVIOUR
        DEFINED AS
        !This error is used by the proxy to indicate that
        SNMP variable bindings generated during CMIS
        emulation caused the Internet agent to return an SNMP
        wrongLength error.!;;
REGISTERED AS { iimcProxyParameter 8 };
```

```
wrongEncoding   PARAMETER
        CONTEXT SPECIFIC-ERROR;
        WITH SYNTAX     IimcProxyASN1.VarBind;
        BEHAVIOUR       wrongEncodingBehaviour
        BEHAVIOUR DEFINED AS
        !This error is used by the proxy to indicate that
        SNMP variable bindings generated during CMIS
        emulation caused the Internet agent to return an SNMP
        wrongEncoding error.!;;
REGISTERED AS { iimcProxyParameter 9 };
```

7.2 Proxy MIB ASN.1 Module

```
IimcProxyASN1 {iimcManagementModMan 3}
DEFINITIONS IMPLICIT TAGS ::= BEGIN
IMPORTS
     iimcManagementProxy, iimcIIMCProxy,
     iimcManagementModMan, iimcManagementDocMan,
     iimcIIMCIMIBTRANS
          FROM IimcAssignedOIDs {iimcManagementModMan 1}

     ObjectIdentifier, AccessControlInfo
          FROM IimcCommonDef {iimcManagementModMan 2}

     MiscellaneousError
          FROM Parameter-ASN1Module { joint-iso-ccitt ms(9)
          smi(3) part2(2) asn1Module(2) 3 }

     VarBind, VarBindList
          FROM SNMPv2-PDU

     DistinguishedName
          FROM InformationFramework { joint-iso-ccitt ds(5)
          modules (1) informationFramework (1) };

-- for ISO/CCITT-Internet proxy specific extension
iimcProxySpecificExtension OBJECT IDENTIFIER
             ::={iimcManagementProxy specificExtension(0)}

-- for ISO/CCITT-Internet proxy object class
iimcProxyObjectClass OBJECT IDENTIFIER
             ::={iimcManagementProxy managedObjectClass(3)}

-- for ISO/CCITT-Internet proxy package
iimcProxyPackage OBJECT IDENTIFIER
             ::={iimcManagementProxy package(4)}

-- for ISO/CCITT-Internet proxy parameter
iimcProxyParameter OBJECT IDENTIFIER
     ::={iimcManagementProxy parameter(5)}
```

```
-- for ISO/CCITT-Internet proxy name bindings
iimcProxyNameBinding OBJECT IDENTIFIER
             ::={iimcManagementProxy nameBinding(6)}

-- for ISO/CCITT-Internet proxy attribute
iimcProxyAttributeID OBJECT IDENTIFIER
             ::={iimcManagementProxy attribute(7)}

-- SNMP Protocol version
iimcSnmpProtocol OBJECT IDENTIFIER
          ::= { iimcProxySpecificExtension snmpProtocol(1) }

-- the OID for SNMPv1
snmpV1 OBJECT IDENTIFIER ::= {iimcSnmpProtocol snmpV1(1) }

-- the OID for SNMPv2
snmpV2 OBJECT IDENTIFIER ::= {iimcSnmpProtocol snmpV2(2) }

AccessControlEnforcement ::= INTEGER {
                         agent   (0), -- default value
                         proxy   (1),
                         both    (2)}

agentOnlyAccessControl INTEGER ::= 0

CmipsnmpProxyAgentId ::= CHOICE {
                name             GraphicString,
                number           INTEGER,
                distinguishedName DistinguishedName,
                oid              OBJECT IDENTIFIER
}

CmipsnmpProxyId ::= NULL

PollPeriod ::= INTEGER(0..MAX) -- seconds

ProtoNotImplErrorInfo ::= INTEGER {
                         transportProtocol(0),
                         authenticationProtocol(1),
                         privacyProtocol(2)  }

RetryLimit ::= INTEGER(0..100) -- retries

SnmpOpType ::= BIT STRING {
             getReqPdu(0),
             getNextReqPdu(1),
             getRespPdu(2),
             setReqPdu(3),
             trapPdu(4),
             getBulk(5),
             informReq(6)     }
```

```
SnmpSecurity ::=  SET OF SEQUENCE {
                snmpOperation    SnmpOpType,
                snmpSecurityInfo AccessControlInfo }

SnmpSecurityParameterId ::= NULL

SupportedMIBs ::= SET OF   OBJECT IDENTIFIER

TimeoutInterval  ::= INTEGER(1..MAX) -- milliseconds

END
```

8 Conformance Requirements

8.1 Management Communication Requirements

An implementation of the ISO/Internet proxy shall satisfy the following management communication requirements.

- The ISO/Internet proxy shall conform to ISO/CCITT CMIP in the agent role, as specified by [ISO9596-1] and [ISO9595], and profiled by AOM12 [ISO11183-1,2].

- The ISO/Internet proxy shall conform to either Internet SNMPv1 or SNMPv2 in the manager role, as specified by [RFC1157] or [RFC1448].

- The ISO/Internet proxy shall conform to all mandatory security requirements specified by [IIMCSEC] for each supported version of SNMP (SNMPv1 and/or SNMPv2). If proxy supports only SNMPv1, then enforcement of access control and Party MIB support is optional.

8.2 Management Function Requirements

An implementation of the ISO/Internet proxy shall satisfy the following management function requirements.

- The ISO/Internet proxy may optionally conform to ISO/CCITT system management functions in the agent role, as specified by either [ISO10164-5] or [ISO10164-6], and profiled by AOM221 [ISO12060-4] or AOM231 [ISO12060-5].

8.3 Management Information Requirements

An implementation of the ISO/Internet proxy shall satisfy the following management information requirements. For each MIB identified below, an implementation shall conform to all of the requirements stated in the corresponding MOCS proforma.

- The ISO/Internet proxy shall support the "system" object specified by [ISO10165-2], in the agent role.

- The ISO/Internet proxy shall support the translated MIB-II "internetSystem" object specified by [IIMCMIB-II], in the manager role.

- The ISO/Internet proxy shall support the IIMC Proxy MIB definitions specified by section 7 of this document, in the agent role.

- The ISO/Internet proxy shall support the IIMC Party MIB definitions specified by [IIMCSEC], in the agent role.

- The ISO/Internet proxy shall support the Internet Party MIB definitions specified by [RFC1447], in the manager role.

- The ISO/Internet proxy shall support one or more translated MIBs, derived in accordance with the procedures specified by [IIMCIMIBTRANS]. For each supported MIB, the ISO/CCITT GDMO translation shall be supported in the agent role, and the Internet MIB shall be supported in the manager role.

- The ISO/Internet proxy shall comply with the information models specified by [ISO10165-1,4] and either [RFC1155], [RFC1212], or [RFC1442].

- The ISO/Internet proxy may optionally support the "OP1 Library Vol.4":capabilityObject" specified by [NMF006], in the agent role.

8.4 Service Emulation Requirements

An ISO/Internet proxy implementation that claims conformance to this specification must state the level of CMIS service emulation that it supports. Two levels are defined:

a) a basic proxy which emulates CMIS kernel services, plus support for scoped CMIS Get and single-assertion filtered CMIS M-GET on the objectClass attribute; and

b) an enhanced proxy which emulates all CMIS services, including scoping and filtering on all applicable CMIS services.

As noted in section 8.1, the proxy requires support for the Enhanced Management Communications Profile AOM12. That is, the proxy is required to support CMIP kernel, multiple object selection, filtering, and multiple reply functional units. However, a basic proxy is not required to required to carry out scoping or filtering for CMIS services other than M-GET, or filtering for CMIS M-GET with complexity greater than a single attribute value assertion involving the objectClass attribute. A basic proxy returns the CMIS error "complexity limitation" for any other CMIS service request which contains a filter

parameter or scope parameter value not equal to "base object alone", and for any CMIS M-GET service request which contains a filter parameter more complex than the minimal requirement stated above. These limitations do not apply to the enhanced proxy, which is required to carry out both scoping and filtering for all CMIS service requests.

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Appendix A (Normative): Managed Object Conformance Statements (MOCS)

Editor's Note: [This section will be filled in prior to publication. When completed, this section will contain a tabular representation of the managed object classes, attributes, notifications, and name bindings defined in this document. The format of these program tables will be as defined by ISO/IEC 10165-6.]

Appendix B (Informative) Example Operation

```
Operation: CMIS M-GET request
Object class: Internet MIB-II ip
Object instance:{ systemTitle = "NetLabs"/ipId = NULL }
Scope: 1st level down
Filter: ipRouteType == indirect
Attribute id list: ipRouteDest
```

Example Internet MIB-II ipRouteEntries:

ipRouteDest	ipRouteType	Other object types
192.95.93.1	direct	
192.95.93.2	indirect	
192.95.93.3	invalid	
192.95.93.4	other	
192.95.93.5	indirect	
(end of the table)		

The following sections show an example of how the ISO/Internet proxy fulfills the above CMIS M-GET request based on the example Internet MIB-II ipRouteEntries.

1. Check the existence of the base object

The ISO/Internet proxy issues an SNMP Get-Next Request.

```
Get-Next Request { ip }
Get Response { ipForwarding = 1 }
```

If the get is successful, the ISO/Internet proxy will have verified that the base object exists.

2. Managed object selection

Based on the name binding definition, the following object classes are found in the "object class group":

a) ipAddrEntry
b) ipRouteEntry
c) ipNetToMediaEntry

For each object in the "object class group", the object instances may be retrieved via SNMP Get-Next Requests.

a) ipAddrEntry: The definition for this object class does not contain the attribute specified in the filter (ipRouteType), therefore the ISO/Internet proxy concludes that there are no object instances with ipAddrEntry object class in the scope.

b) ipRouteEntry: The definition for this object class contains the attribute specified in the filter (ipRouteType),therefore the ISO/Internet proxy issues SNMP Get-Next Requests to retrieve the object instances.

The SNMP requests issued and the responses received would be as follows:

```
Get-Next Request {ipRouteDest, ipRouteType}
Get Response     {ipRouteDest.192.95.93.1 =
                              192.95.93.1,
                  ipRouteType.192.95.93.1 = direct}

Get-Next Request {ipRouteDest.192.95.93.1,
                  ipRouteType.192.95.93.1}
Get Response     {ipRouteDest.192.95.93.2 =
                              192.95.93.2,
                  ipRouteType.192.95.93.2 =
                              indirect}

Get-Next Request {ipRouteDest.192.95.93.2,
                  ipRouteType.192.95.93.2}
Get Response     {ipRouteDest.192.95.93.3 =
                              192.95.93.3,
                  ipRouteType.192.95.93.3 =
                                    invalid}

Get-Next Request {ipRouteDest.192.95.93.3,
                  ipRouteType.192.95.93.3}
Get Response     {ipRouteDest.192.95.93.4 =
                              192.95.93.4,
                  ipRouteType.192.95.93.4 =
                                    other}

Get-Next Request {ipRouteDest.192.95.93.4,
                  ipRouteType.192.95.93.4}
Get Response     {ipRouteDest.192.95.93.5 =
                              192.95.93.5,
                  ipRouteType.192.95.93.5 =
                              indirect}

Get-Next Request {ipRouteDest.192.95.93.5,
                  ipRouteType.192.95.93.5}
Get Response     {ipRouteIfIndex = 5,
                  ipRouteProto = 1}
```

c) ipNetToMediaEntry: The definition for this object class does not contain the attribute specified in the filter (ipRouteType), therefore the ISO/Internet proxy concludes that there are no object instances with ipNetToMediaEntry object class in the scope.

There are a set of five object instances in the scope. After the filter is applied to these five object instances, there are only two object instances left on which the CMIS M-GET operation is performed.

3. Form the response

The following CMIS responses should be formed and sent back to the ISO/CCITT manager

```
CMIS M-GET Response (first linked reply PDU):
     Object class: ipRouteEntry
     Object instance:
       { systemTitle = "NetLabs"/
       ipId = NULL/
       ipRouteEntryId =
            { ipAddress = "192 95 93 2" }
  Attribute list: ipRouteDest = 192.95.93.2


CMIS M-GET Response (second linked reply PDU):
     Object class: ipRouteEntry
     Object instance:
       { systemTitle = "NetLabs"/
   ipId = NULL/
ipRouteEntryId =
            { ipAddress = "192 95 93 5" }
     Attribute list: ipRouteDest = 192.95.93.5

CMIS M-GET Response (final empty response PDU)
```