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OSI management – Management functions and ODMA
functions

Guidelines for implementation conformance statements proformas associated with SNMP-based management systems

Recommendation ITU-T X.784



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Recommendation ITU-T X.784

Guidelines for implementation conformance statements proformas associated with SNMP-based management systems

Summary

Recommendation ITU-T X.784 proposes guidelines for implement conformance statement (ICS) proformas for simple network management protocol (SNMP)-based interface systems.

SNMP is widely used to manage nodes such as servers, workstations, routers and switches in IP networks. When SNMP-based management systems need to be interconnected, system testing is required in order to ensure operability among them. ICS proformas are a way for implementers to claim conformance to a standardized SNMP interface specification.

This Recommendation provides an overview and constructions for the management information base (MIB) and the structure of management information (SMI) and provides several proformas (tables) for each of the SMI components to be used in an interface. Instructions on how to fill in each column in the tables are also provided. Finally some examples of the SNMP interface ICS are provided in Appendix I while additional information about the conformance test methodology for SNMP-based interfaces is provided in Appendix II.

History

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FOREWORD

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

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

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

NOTE

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

Compliance with this Recommendation is voluntary. However, the Recommendation may contain certain mandatory provisions (to ensure, e.g., interoperability or applicability) and compliance with the Recommendation is achieved when all of these mandatory provisions are met. The words "shall" or some other obligatory language such as "must" and the negative equivalents are used to express requirements. The use of such words does not suggest that compliance with the Recommendation is required of any party.

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

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Recommendation ITU-T X.784

Guidelines for implementation conformance statements proformas associated with SNMP-based management systems

1 Scope

This Recommendation provides guidelines for simple network management protocol (SNMP)-based interface implementation conformance statement (SIICS) proformas and the specification of these proformas. The SIICS is a statement made by an implementer to claim conformance to a structure of management information (SMI)-based interface definition.

2 References

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

- [ITU-T X.290] Recommendation ITU-T X.290 (1995), *OSI conformance testing methodology and framework for protocol Recommendations for ITU-T applications – General concepts*.
- [ITU-T X.291] Recommendation ITU-T X.291 (1995), *OSI conformance testing methodology and framework for protocol Recommendations for ITU-T applications – Abstract test suite specification*. (Twinned to [ISO 9646-2])
- [ITU-T X.296] Recommendation ITU-T X.296 (1995), *OSI conformance testing methodology and framework for protocol Recommendations for ITU-T applications – Implementation conformance statements*. (Twinned to [ISO 9646-7])
- [ITU-T X.724] Recommendation ITU-T X.724 (1996), *Information technology – Open Systems Interconnection – Structure of management information: Requirements and guidelines for implementation conformance statement proformas associated with OSI management*.
- [ITU-T X.781] Recommendation ITU-T X.781 (2001), *Requirements and guidelines for Implementation Conformance Statements proformas associated with CORBA-based systems*.
- [ISO 9646-2] ISO/IEC 9646-2:1994, *Information technology – Open Systems Interconnection – Conformance testing methodology and framework – Part 2: Abstract Test Suite specification*. (Twinned to [ITU-T X.291])
- [ISO 9646-7] ISO/IEC 9646-7:1995, *Information technology – Open Systems Interconnection – Conformance testing methodology and framework – Part 7: Implementation Conformance Statements*. (Twinned to [ITU-T X.291])
- [IETF RFC 1157] IETF RFC 1157 (1990), *A Simple Network Management Protocol (SNMP)*.
- [IETF RFC 1212] IETF RFC 1212 (1991), *Concise MIB Definitions*.
- [IETF RFC 1902] IETF RFC 1902 (1996), *Structure of Management Information for Version 2 of the Simple Network Management Protocol (SNMPv2)*.

- [IETF RFC 2578] IETF RFC 2578 (1999), *Structure of Management Information Version 2 (SMIv2)*.
- [IETF RFC 2580] IETF RFC 2580 (1999), *Conformance Statements for SMIv2*.
- [IETF RFC 3410] IETF RFC 3410 (2002), *Introduction and Applicability Statements for Internet Standard Management Framework (SNMPv3)*.

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 implementation conformance statement (ICS) [ITU-T X.290]: A statement made by the supplier of an implementation or system claimed to conform to a given specification, stating which capabilities have been implemented. The ICS can take several forms: protocol ICS, profile ICS, profile specific ICS, and information object ICS.

3.1.2 (ICS (proforma)) item [ITU-T X.290]: A row in an ICS (proforma) table.

3.1.3 (ICS (proforma)) question [ITU-T X.290]: The question to be answered in the intersection of an ICS item and either a support column (i.e., "Is this item supported in the context applying to this table and column?") or supported values column (i.e., "What values are supported for this item in the context applying to this table and column?") in an ICS proforma table.

3.1.4 status (value) [ITU-T X.290]: An allowed entry in the status column for an item in an ICS proforma table.

3.1.5 structure of management information (SMI) [b-ITU-T H.341]: The rules used to define objects which can be accessed via a network management protocol.

3.1.6 (support) answer [ITU-T X.290]: An allowed entry in the support or supported values columns for an item in an ICS, in answer to an ICS question.

3.2 Terms defined in this Recommendation

None.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

ASN.1	Abstract Syntax Notation One
CORBA	Common Object Request Broker Architecture
ICS	Implementation Conformance Statement
IUT	Implementation Under Test
MIB	Management Information Base
OID	Object Identifier
PDU	Protocol Data Unit
SIICS	SNMP-based Interface Implementation Conformance Statement
SMI	Structure of Management Information
SNMP	Simple Network Management Protocol

5 Conventions

None.

6 Basis of conformance test methodology for SNMP-based management system interface

6.1 Overview

Conformance relates an implementation to a standard. It states in which way systems, implemented with respect to a standard, can vary without errors occurring in their cooperation. If an implementation fulfills these requirements, then it conforms to the standard. The check of the statements is the conformance test. The starting point is the definition of conformance requirements in implementation independent interface specifications on the basis of an identification of reference points. A management interface specification shall define conformance reference points at which an object must be tested to check if it fulfils a set of conformance criteria. During the test, a number of stimuli and events are observed and evaluated at these conformance points. Management interface specifications shall include conformance statements which identify conformance reference points at every interface of the specified objects. In general, the information flow between two system components is realized through several reference points, thus the conformance test has to take into consideration the following:

- a) the test of such information flow at each reference point; and
- b) the test of consistency between the combinations.

Therefore, a coordinated test at all identified reference points is necessary.

6.2 Methodology of conformance test for SNMP-based interfaces

This Recommendation provides guidelines for a conformance test of SNMP-based interfaces. In order to ensure consistency of testing methods for network management interfaces, the testing methodology and process for SNMP-based interfaces shall be consistent with the testing process of a common object request broker architecture (CORBA)-based interface as defined in [ITU T-X.781]. [IETF RFC 2580] gives conformance statements for SMIv2 by defining several macros, and Appendix II provides information on the differences between [IETF RFC 2580] and this Recommendation.

7 SMI-based management interface ICS proforma

The structure of management information (SMI) is used to define interfaces of objects as a management information base (MIB) in SNMP-based systems. This clause first introduces the features of MIB and SMI, then specifies the SIICS proformas according to these language features.

7.1 MIB and SMI overview

A MIB is a database used for managing the entities in a communications network. MIB is most often associated with the simple network management protocol (SNMP).

SNMP is an Internet-standard protocol for managing devices on IP networks. SNMP itself does not define which information (which variables) a managed system shall offer. Rather, SNMP uses an extensible design, where the available information is defined by a MIB. The MIB describes the structure of the management data of a device subsystem.

SNMPv1 specifies five core protocol data units (PDUs): GetRequest, SetRequest, GetNextRequest, Response and Trap. Two other PDUs, GetBulkRequest and InformRequest were added in SNMPv2 and the Report PDU was added in SNMPv3. Since the implementation conformance statement (ICS) proformas are used by an implementer to claim conformance to an information model

described in a MIB, so ICS proformas provided in this Recommendation are suitable to be used for any version of SNMP-based interface.

Objects in the MIB are defined using a subset of Abstract Syntax Notation One (ASN.1) called the structure of management information (SMI). The database is hierarchical (tree-structured) and each entry is addressed through an object identifier (OID).

The first version of the SMI (SMIv1) specifies the use of a number of SMI-specific data types. The second version of the SMI (SMIv2) enhances and adds to the SMIv1-specific data types and also specifies information modules. In this Recommendation, ICS proformas for SMIv2-based management interface are mainly provided since this version is commonly used nowadays when managing nodes in IP networks.

The SMI is divided into three parts: module definitions, object definitions and notification definitions [IETF RFC 2578]. According to the SMI syntax specification, the containment relationship among these constructions can be illustrated as in Figure 1.

1) Module definitions are used when describing information modules. An ASN.1 macro, MODULE-IDENTITY, is used to concisely convey the semantics of an information module. The MODULE-IDENTITY macro is used to provide contact and revision history for each information module. MIB modules, which contain definitions of inter-related managed objects, make use of the OBJECT-TYPE and NOTIFICATION-TYPE macros.

2) Object definitions are used when describing managed objects. An ASN.1 macro, OBJECT-TYPE, is used to concisely convey the syntax and semantics of a managed object.

It is sometimes convenient for developers of management applications to impose tabular structure on an ordered collection of objects within the MIB. Each such conceptual table contains zero or more rows, and each row may contain one or more scalar objects, termed columnar objects. This conceptualization is formalized by using the OBJECT-TYPE macro to define both an object which corresponds to a table and an object which corresponds to a row in that table. A conceptual table has SYNTAX of the form SEQUENCE OF <EntryType>, where <EntryType> refers to the SEQUENCE type of its subordinate conceptual row. A conceptual row has SYNTAX of the form <EntryType>, where <EntryType> is a SEQUENCE type.

Another type of object is leaf objects, which are not columnar objects and are not contained within a conceptual table. Instances of the leaf object are identified by appending a sub-identifier of zero to the name of that object.

3) Notification definitions are used when describing unsolicited transmissions of management information. An ASN.1 macro, NOTIFICATION-TYPE, is used to concisely convey the syntax and semantics of a notification.

For SNMP-based interface implementation conformance testing, the SIICS proforma shall support the above SMI features such as the conceptual table, entry, column, leaf and notification. Thus SIICS proformas shall include three sub proformas: a conceptual table object support proforma, a leaf object support proforma and a notification support proforma. The conceptual table object support proforma can be divided into the conceptual table object support table, the column support table, the entry support table and the conceptual table index support table, which are used to test whether the operations (such as read, write, create) are supported for each object instance. The notification support proforma is used to test whether the notification could be sent out with the correct format. The leaf object support proforma is used to test whether the operations (such as read, write) are supported for each leaf object instance.

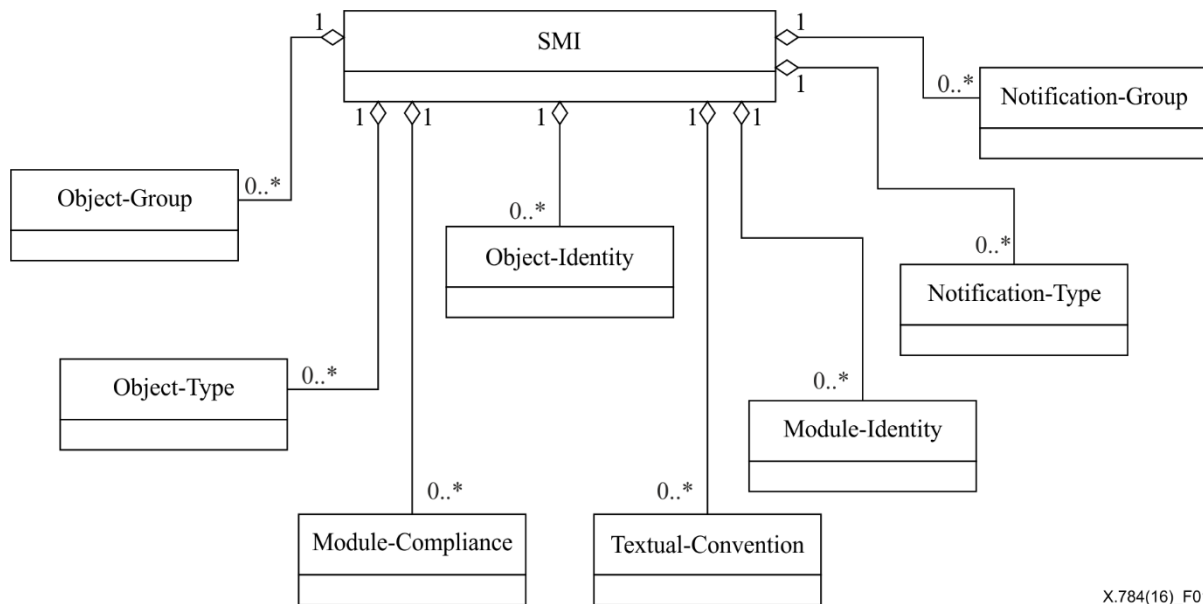


Figure 1 – Containment relationship in SMI specification

7.2 Guidelines for specification of SMI-based interface ICS proformas

Proforma specifications shall follow the style as documented in the following clauses. Proforma specifications shall provide the information required by this Recommendation. Additional tables may be included for other information, if needed.

There are three levels of documentation pertaining to SIICS, namely:

- 1) guidelines or Recommendation tools for the production of SIICS proformas;
- 2) a SIICS proforma, associated with a standard related to SNMP-based network management, which is to be filled in by a supplier of the implementation and which when filled in is a SIICS;
- 3) a SIICS prepared by a supplier of the implementation as part of a conformance claim to a standard related to SNMP-based network management.

7.2.1 General instructions for SMI ICS proforma specification

This Recommendation provides instructions to construct an SNMP-based management system ICS proforma specification. SIICS proformas include three sub proformas: a conceptual table object support proforma, a leaf object support proforma and a notification support proforma. All these proformas are in a tabular form which is similar to the proformas specified in [ITU-T X.781].

Clause 7.2.2 describes the SIICS profile for the interface. Clause 7.2.3 describes the SIICS for conceptual tables. Clause 7.2.4 describes the SIICS for leaves. Clause 7.2.5 describes the SIICS for notifications. Appendix I provides examples of SIICS proformas specifications, which are to be filled in by a supplier of an implementation.

The following common notations, defined in [ITU-T X.291] | [ISO/IEC 9646-2] and in [ITU-T X.296] | [ISO/IEC 9646-7], are used for the "status" value column in this Recommendation:

- m Mandatory
- o Optional
- Not applicable or out of scope

NOTE – The notations "m", "o" are prefixed by a "c:" when nested under an optional item of the same table.

The following common notations, defined in [ITU-T X.291] | [ISO/IEC 9646-2] and in [ITU-T X.296] | [ISO/IEC 9646-7] are used for the support answer column:

- Y Implemented
- N Not implemented
- No answer required
- Ig The item is ignored (i.e., processed syntactically but not semantically)

The SIICS proforma specification is formed by copying clauses 7.2.2, 7.2.3, 7.2.4 and 7.2.5, completing the tables except for the "Support" and "Additional information" columns and by extending the remaining tables to meet the requirements of the specification.

To form a SIICS from a SIICS proforma, the supplier of the implementation shall fill in the "Support" and if appropriate, "Additional information" columns of all the tables in the SIICS proforma.

7.2.2 SIICS profile for the interface

Table 1 is used to give the SIICS profile for the interface to be tested.

Table 1 – SIICS profile for the interface

Index	Name of table	Description of table

where:

- The "Index" field is made up of a consecutive number for readers of the SIICS to refer to each item.
- The "Name of table" field gives the name of the table.
- The "Description of table" field is the descriptor of the corresponding table.

7.2.3 Conceptual table object support proforma

The conceptual table object support proforma is used to check whether the object instance could support operations such as read, write, create. The conceptual table object support proforma can be divided into the conceptual table object support table (see Table 2), the column support table (see Table 3), the entry support table (see Table 4) and the conceptual table index support table (see Table 5).

Table 2 – Conceptual table object support table

Index	Descriptor	OID	Validity	Support all the mandatory attributes? (Y/N)	Implementation conforms to conformance statement? (Y/N)

where:

- For each conceptual table object defined in the MIB, there is a corresponding conceptual table object support table with only one row.
- The "Index" field is made up of a consecutive number for readers of the SIICS to refer to each item.
- The "Descriptor" field is a string that must be unique in the same MIB.
- The "OID" field is the OBJECT IDENTIFIER of the conceptual table object. The OID can uniquely identify the object, such as x.x.x.x (x is a nonnegative integer).