INTERNATIONAL STANDARD

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Information technology — Open Systems Interconnection — Systems Management: Time management function

Technologies de l'information — Interconnexion de systèmes ouverts (OSI) — Gestion-systèmes: Fonction de gestion du temps

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Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work.

In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1. Draft International Standards adopted by the joint technical committee are circulated to national bodies for voting. Publication as an International Standard requires approval by at least 75 % of the national bodies casting a vote.

International Standard ISO/IEC 10164-20 was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 33, *Distributed application services*, in collaboration with ITU-T. The identical text is published as ITU-T Recommendation X.743.

ISO/IEC 10164 consists of the following parts, under the general title *Information technology — Open Systems Interconnection — Systems Management*:

— *Part 1: Object management function*

— *Part 2: State management function*

— *Part 3: Attributes for representing relationships*

— *Part 4: Alarm reporting function*

— *Part 5: Event report management function*

— *Part 6: Log control function*

— *Part 7: Security alarm reporting function*

— *Part 8: Security audit trail function*

— *Part 9: Objects and attributes for access control*

— *Part 10: Usage metering function for accounting purposes*

— *Part 11: Metric objects and attributes*

— *Part 12: Test management function*

— *Part 13: Summarization function*

— *Part 14: Confidence and diagnostic test categories*

— *Part 15: Scheduling function*

— *Part 16: Management knowledge management function*

— *Part 17: Change over function*

— *Part 18: Software management function*

— *Part 19: Management domain and management policy management functions*

— *Part 20: Time management function*

— *Part 21: Command sequencer for Systems Management*

— *Part 22: Response time monitoring function*

Annexes A, B, D and F to G form a normative part of this part of ISO/IEC 10164. Annexes C, H and I are for information only.

Introduction

ITU-T Rec. X.700 series | ISO/IEC 10164 is a Series of Recommendations | International Standards developed according to ITU-T Rec X.200 | ISO/IEC 7498-1 and ITU-T Rec. X.700 | ISO/IEC 7498-4. ITU-T Rec. X.700 series | ISO/IEC 10164 is related to the following International Standards:

- CCITT X.710 | ISO/IEC 9595:1990, Information technology – Open System Interconnection – Common management information service definition;
- CCITT X.711 and CCITT X.712 | ISO/IEC 9596:1990, Information technology – Open System Interconnection – Common management information protocol specification;
- CCITT X.701 | ISO/IEC 10040:1992, Information technology – Open Systems Interconnection – Systems management overview;
- CCITT Recs. X.730, X.740 series and ITU-T Rec. X.750 series | ISO/IEC 10064:1992, Information technology – Open Systems Interconnection – Systems Management.

OSI management standardization inevitably involves coordinated work by a number of standards bodies. ITU-T SG 7 and ISO/IEC JTC 1 SC 21/WG 4 are jointly responsible for the development of Recommendations | International Standards that describe the architecture for OSI managemnt, the services, protocols, and functions that are used for systems management, and the structure of management information. Other working groups, in ITU-T, ISO/IEC JTC 1 SC 21, ISO/IEC JTC 1 SC 6 and elsewhere, are responsible for the development of Recommendations | International Standards that describe the management aspects of particular layers of the OSI Basic Reference Model; these may describe (N)-layer management protocols, management aspects of (N)-layer operation, and managed objects that provide a "management view" of aspects of the layer operation and are visible to systems management.

INTERNATIONAL STANDARD

ITU-T RECOMMENDATION

INFORMATION TECHNOLOGY – OPEN SYSTEMS INTERCONNECTION – SYSTEMS MANAGEMENT: TIME MANAGEMENT FUNCTION

1 Scope

This Recommendation | International Standard defines a Systems Management Function that may be used by an application process in a centralized or decentralized management environment to interact for the purpose of systems management, as defined by ITU-T Rec. X.200 | ISO/IEC 7498-1. This Recommendation | International Standard defines a function which consists of generic definitions, services, and functional units. This function is positioned in the application layer of ITU-T Rec.X.200 | ISO/IEC 7498-1 and is defined according to the model provided by ISO 9545. The role of systems management functions is described by CCITT Rec. X.701 | ISO /IEC 10040.

This Recommendation | International Standard:

– defines a service for the management of clocks for use by OSI management and available for use by OSI applications and others;

– establishes user requirements for this Recommendation | International Standard;

– establishes a time management function model, addressing the components of a generic time service involving communication between systems, that relates the service and generic definitions provided by this function to the user requirements;

– defines generic object classes, attribute types, operation types, notification types, and parameters documented in accordance with CCITT Rec. X.722 | ISO/IEC 10165-4;

– specifies compliance requirements placed on other standards that make use of these generic definitions;

– defines the services provided by the function;

– specifies the management protocol that is necessary in order to provide the services;

– defines the relationship between these services and systems management operations and notifications;

– specifies the abstract syntax necessary to identify and negotiate the function unit in the protocol;

– defines relationships with other systems management functions;

– specifies conformance requirements to be met by implementation of this Recommendation | International Standard;

– identifies time synchronization protocols.

This Recommendation | International Standard does not:

– address the provision of time information within a local system;

– define the nature of any implementation intended to provide the Time Management Function;

– specify the manner in which management is accomplished by the user of the Time Management Function;

– define the nature of any interaction which results in the use of the Time Management Function;

– specify the services necessary for the establishment, use, and normal or abnormal release of a management association.

2 Normative references

The following Recommendations and International Standards contain provisions which, through reference in this text, constitute provisions of this Recommendation | International Standard. At the time of publication, the editions indicated were valid. All Recommendations and Standards are subject to revision, and parties to agreements based on this Recommendation | International Standard are encouraged to investigate the possibility of applying the most recent

edition of the Recommendations and International Standards listed below. Members of IEC and ISO maintain registers of currently valid International Standards. The Telecommunications Standardizations Bureau of the ITU maintains a list of currently valid ITU-T Recommendations.

2.1 Identical Recommendations | International Standards

- ITU-T Recommendation X.210 (1993) | ISO/IEC 10731:1994, *Information technology – Open Systems Interconnection – Basic Reference Model – Conventions for the definition of OSI services.*
- CCITT Recommendation X.701 (1992) | ISO/IEC 10040:1992, *Information technology – Open Systems Interconnection – Systems management overview*[1].
- CCITT Recommendation X.720 (1992) | ISO/IEC 10165-1:1993, *Information technology – Open Systems Interconnection – Structure of management information: Management Information Model.*
- CCITT Recommendation X.721 (1992) | ISO/IEC 10165-2:1992, *Information technology – Open Systems Interconnection – Structure of management information: Definition of management information.*
- CCITT Recommendation X.722 (1992) | ISO/IEC 10165-4:1992, *Information technology – Open Systems Interconnection – Structure of management information: Guidelines for the definition of managed objects.*
- ITU-T Recommendation X.723 (1993) | ISO/IEC 10165-5:1994, *Information technology – Open Systems Interconnection – Structure of management information: Generic management information.*
- ITU-T Recommendation X.724 (1996) | ISO/IEC 10165-6:1997, *Information technology – Open Systems Interconnection – Structure of management information: Requirements and guidelines for implementation conformance statement proformas associated with OSI management.*
- CCITT Recommendation X.730 (1992) | ISO/IEC 10164-1:1993, *Information technology – Open Systems Interconnection – Systems Management: Object management function.*
- CCITT Recommendation X.731 (1992) | ISO/IEC 10164-2:1993, *Information technology – Open Systems Interconnection – Systems Management: State management function.*
- CCITT Recommendation X.732 (1992) | ISO/IEC 10164-3:1993, *Information technology – Open Systems Interconnection – Systems Management: Attributes for representing relationships.*
- ITU-T Recommendation X.738 (1993) | ISO/IEC 10164-13:1995, *Information technology – Open Systems Interconnection – Systems Management: Summarization function.*
- ITU-T Recommendation X.739 (1993) | ISO/IEC 10164-11:1994, *Information technology – Open Systems Interconnection – Systems Management: Metric objects and attributes.*
- CCITT Recommendation X.740 (1992) | ISO/IEC 10164-8:1993, *Information technology – Open Systems Interconnection – Systems Management: Security audit trail function.*
- ITU-T Recommendation X.741 (1995) | ISO/IEC 10164-9:1995, *Information technology – Open Systems Interconnection – Systems Management: Objects and attributes for access control.*
- ITU-T Recommendation X.742 (1995) | ISO/IEC 10164-10:1995, *Information technology – Open Systems Interconnection – Systems Management: Usage metering function for accounting purposes.*
- ITU-T Recommendation X.745 (1993) | ISO/IEC 10164-12:1994, *Information technology – Open Systems Interconnection – Systems Management: Test management function.*
- ITU-T Recommendation X.746 (1995) | ISO/IEC 10164-15:1995, *Information technology – Open Systems Interconnection – Systems Management: Scheduling function.*

[1] As amended by ITU-T Rec. X.701/Cor.2 | ISO/IEC 10040/Cor.2.

2.2 Paired Recommendations | International Standards equivalent in technical content

– CCITT Recommendation X.208 (1988), *Specification of Abstract Syntax Notation One (ASN.1).*

  ISO/IEC 8824:1990, *Information technology – Open Systems Interconnection – Specification of Abstract Syntax Notation One (ASN.1).*

– CCITT Recommendation X.209 (1988), *Specification of basic encoding rules for Abstract Syntax Notation One (ASN.1).*

  ISO/IEC 8825:1990, *Information technology – Open Systems Interconnection – Specification of Basic Encoding Rules for Abstract Syntax Notation One (ASN.1)*

– ITU-T Recommendation X.291 (1995), *OSI conformance testing methodology and framework for protocol Recommendations for ITU-T applications – Abstract test suite specification.*

  ISO/IEC 9646-2:1994, *Information technology – Open Systems Interconnection – Conformance testing methodology and framework – Part 2: Abstract Test Suite specification.*

– ITU-T Recommendation X.296 (1995), *OSI conformance testing methodology and framework for protocol Recommendations for ITU-T applications – Implementation conformance statements.*

  ISO/IEC 9646-7:1995, *Information technology – Open Systems Interconnection – Conformance testing methodology and framework – Part 7: Implementation Conformance Statements.*

– CCITT Recommendation X.700 (1992), *Management framework for Open Systems Interconnection (OSI) for CCITT applications.*

  ISO/IEC 7498-4:1989, *Information processing systems – Open Systems Interconnection – Basic Reference Model – Part 4: Management framework.*

– CCITT Recommendation X.710 (1991), *Common management information service definition for CCITT applications.*

  ISO/IEC 9595:1991, *Information technology – Open Systems Interconnection – Common management information service definition.*

– CCITT Recommendation X.711 (1991), *Common management information protocol specification for CCITT applications.*

  ISO/IEC 9596-1:1991, *Information technology – Open Systems Interconnection – Common management information protocol – Part 1: Specification.*

2.3 Additional references

– ITU-T Recommendation M.3100 (1995), *Generic Network Information Model.*

– ITU-T Recommendation M.3101 (1995), *Managed object conformance statements for the Generic Network Information Model.*

– ISO/TR 8509:1987, *Information processing systems – Open Systems Interconnection – Service conventions.*

3 Definitions

For the purposes of this Recommendation | International Standard, the following definitions apply.

3.1 Management framework definitions

This Recommendation | International Standard uses the following term defined in CCITT Rec. X.700 | ISO/IEC 7498-4:

– managed object;

3.2 Systems management overview definitions

This Recommendation | International Standard uses the following terms defined in CCITT Rec. X.701 | ISO/IEC 10040:

a) managed object class;

b) Management Information Conformance Statement (MICS);

c) Managed Object Conformance Statement (MOCS);

d) MICS proforma;

e) MOCS proforma;

f) notification.

3.3 CMIS definitions

This Recommendation | International Standard uses the following term defined in CCITT Rec. X.710 | ISO/IEC 9595:

– attribute.

3.4 Management information model definitions

This Recommendation | International Standard uses the following terms defined in CCITT Rec. X.720 | ISO/IEC 10165-1:

a) action;

b) behaviour;

c) name binding;

d) package;

e) superclass.

3.5 Guidelines for the definition of managed objects definitions

This Recommendation | International Standard uses the following term defined in CCITT Rec. X.722 | ISO/IEC 10165-4:

– template.

3.6 Implementation conformance statement proforma definitions

This Recommendation | International Standard uses the following terms defined in ITU-T Rec.X.724 | ISO/IEC 10165-6:

a) Managed Relationship Conformance Statement (MRCS);

b) Management Conformance Summary (MCS);

c) MCS proforma;

d) MRCS proforma.

3.7 Additional definitions

For the purposes of this Recommendation | International Standard, the following definitions apply.

3.7.1 actual clock rate: The actual clock rate is the frequency or rate at which a clock increments, including any modifications resulting from frequency adjustment or clock training. The actual clock rate is equivalent to the basic clock rate in the absence of or prior to any frequency adjustment modifications.

3.7.2 accuracy: Accuracy is a measure of how well a local clock's time value and frequency compare to UTC.

3.7.3 adjustment rate: Adjustment rate is the frequency or rate at which a single time adjustment is applied to the local clock.

3.7.4 basic clock rate: The basic clock rate is the frequency or rate at which a clock increments in the absence of any modifications resulting from frequency adjustment.

3.7.5 Coordinated Universal Time (UTC): The time reference that is assumed to be universally correct. UTC was adopted by CCIR Recommendation 470 and described in CCIR Report 517. This is not the ASN.1 representation of generalized time.

3.7.6 correct clock: A clock where the absolute value of the error is less than its maximum error.

3.7.7 frequency offset: The first derivative of the clock's error. That is, the frequency offset is the actual rate of change of error of the clock.

3.7.8 **error of a clock**: The time offset between the clock's reading and UTC at a given instant.

3.7.9 **functioning clock**: A clock in which either the frequency offset is within the maximum frequency error of the clock or the clock is undergoing an adjustment. A functioning clock may be correct or incorrect.

3.7.10 **granularity**: The maximum precision permitted by a representation of time.

3.7.11 **local clock**: The collection of hardware and software that comprises a local source of time for a system.

3.7.12 **maximum drift of a clock**: The manufacturer's specified maximum value of frequency offset.

3.7.13 **maximum error of a clock**: The maximum error bound of the absolute value of the error of a clock.

3.7.14 **precision**: The smallest value by which a clock changes.

3.7.15 **rapport**: The state when the local clock is correct and the maximum error of the clock is within the user specified maximum error.

3.7.16 **synchronization domain**: The set of local clocks involved in the exchange of time information for the purposes of coordination. This includes local clock and clock coordination resources. The members of this set are defined by administrative, platform, or environmental considerations.

3.7.17 **synchronization source**: The source chosen by an algorithm of policy for time synchronization.

3.7.18 **time offset**: The algebraic difference between the readings of two clocks at a given instant in time.

4 Abbreviations

For the purposes of this Recommendation | International Standard, the following abbreviations apply:

DTS Distributed Time Service

GPS Global Positioning System

LAN Local Area Network

NTP Network Time Protocol

PCS Probabilistic Clock Synchronization

RPC Remote Procedure Call

UTC Coordinated Universal Time

5 Conventions

This Recommendation | International Standard defines services for the Time Management function following the descriptive conventions defined in ISO/TR 8509.

The following notation is used in the service parameter tables:

M The parameter is mandatory

C The parameter is conditional

(=) The value of the parameter is identical to the corresponding parameter in the interaction described by the preceding related service primitive

U The use of the parameter is a service-user option

– The parameter is not present in the interaction described by the primitive concerned

6 Requirements

Systems management functions have requirements to record accurately the time of occurrence of alarm notifications, fault event notifications, summarization notifications, and accesses of attribute values of managed objects. Observations of attribute values of managed objects can be observation time of attribute value, time that attribute value was changed, and time interval calculations. Also, system management includes the scheduling of managed objects. Scheduling includes the control of object attributes such as start-time, stop-time, begin-time, and end-time, and involves the tracking of seconds, hours, weeks, months, and years. In addition, applications beyond the scope of systems management require a stable robust time service.

The service objective of the Time Management function is to provide correct, accurate, and stable time among systems. The implementation of the Time Management function shall be consistent with the user's communication system application.

The derived requirements are summarized below and detailed in the following subclauses:

The time management function shall:

- define a representation of time that incorporates both a time value and an accuracy, has a granularity of at least 1 nanosecond, has a range of at least AD 1 to AD 3000, and represents time instants that occur with leap days;
- provide accurate and correct time;
- minimize the time and frequency error of each system;
- accommodate the distribution of time-related information to other systems;
- preserve the correctness of clocks;
- be robust against single failures;
- provide mechanisms to set or adjust the time value of the local clock;
- provide mechanisms to automatically configure the synchronization subnet; and/or
- provide mechanisms to adjust the frequency of the local clock.

6.1 Time representation requirements

The time management function shall define a representation of time that incorporates both a time value and an accuracy. The time representation shall have a granularity equal to or smaller than 1 nanosecond. The time representation range shall cover the period AD 1 to AD 3000.

NOTE – The following information is provided to illustrate the period of time and granularity that can be represented in 64 bits. A time representation of 64 bits with a granularity of 100 nanoseconds will cover approximately 59,973 years. Reducing the granularity to 1 nanosecond will reduce the time range represented to approximately 600 years.

The time representation shall represent time instants that occur within leap days.

The time representation need not permit the direct representation of time instants that occur within leap seconds.

6.2 Time accuracy and precision requirements

Each time value shall have an accuracy and precision associated with it. The precision is reflected in the accuracy as well as being a separate parameter. The accuracy can be represented in terms of an estimated error.

NOTE – For specialized environments, it may be necessary for accuracy and precision requirements to be specified. This is discussed under the context of the user time service in Annex I.

The accuracy of any system's clock shall not be constrained by parameters in the time management function or the underlying time synchronization protocol. A time synchronization protocol will minimize the error and maximum error of a system's clock, subject to the limitations of the underlying hardware and networks.

The bound on the deviation of any two system's clocks shall not be constrained by parameters in the time management protocol. The time management protocol will minimize the deviation between any two system's clocks, subject to the limitations of the underlying hardware and networks.

The time management protocol shall provide an indication of the maximum error at each system. (This implicitly bounds the maximum possible deviation, since it is the sum of the two maximum errors.)

Optionally, the time management function will provide the user with a management parameter that allows the required accuracy of the local clock to be specified.

6.3 Time distribution requirements

The time management function shall allow for the distribution of time management information between systems. The time management function shall be capable of operating over a wide-area network that may have large stochastic delays on the transmission paths.

The time management function shall have a mechanism for accommodating leap seconds.

6.4 Time service reliability requirements

The time management function shall preserve the correctness of clocks. If all the clocks in a synchronization domain are functioning and are correct at some time, they will remain correct at future times.

The time management function shall be configurable such that it will be robust against single failures, including intentionally induced failures. More precisely, it should be possible to configure the time management function such that in a managed network if the clock on a single system fails or is compromised, this will not affect the correctness of the clocks on any other system. This should include the failure of an external reference clock.

Each local time system shall maintain information about the state of its own time service as well as that of time services with which it is exchanging time information. Upon detection of a fault within itself or at a remote system, notifications shall be raised for potential transmission to a managing system.

The time management function shall be self-correcting in the presence of single failures. Specifically, if a single system in a managed network has an incorrect but functioning clock, it will converge to become a correct clock.

The local clocks shall be able to provide accurate and correct time even with relatively large stochastic delays on the transmission paths.

6.5 Local clock requirements

The implementation of a local clock is outside the scope of this Recommendation | International Standard. However, in order to support the time management function, a local clock has the following requirements.

A local clock shall provide mechanisms to set its time in the event of initialization or fault and to adjust its time periodically during normal operation.

As part of the procedures for periodically adjusting the time during normal operation, a local clock shall provide mechanisms to prevent itself from running backward. A local clock which has a positive error shall temporarily slow down, and a local clock which has a negative error shall temporarily speed up. The adjustment rate of the local clock must be greater than the maximum drift rate of the clock. A local clock shall converge to correct time.

NOTE 1 – Care must be taken to correctly tune the adjustment rate. An adjustment rate that is too fast will result in an unstable clock, and an adjustment rate that is too small will never converge.

Optionally, a local clock shall provide mechanisms to effect permanent adjustment of the basic clock rate of the local clock. This adjustment is reflected in a new actual clock rate for the local clock. This may be accomplished using mechanisms either within or outside of the time management function protocol.

In order to minimize the human configuration management of local clocks, the time management function shall have an automatic mechanism to configure their local clocks to the most accurate and stable clock (reference source) within its synchronization domain. A mechanism to allow a method for a new local clock to request information on available references shall be provided. Frequent changing among reference sources shall be minimized.

NOTE 2 – A directory service mechanism may be used here.

The time management function shall compensate for the expected frequency offset of the local clock used in the local system.

The local clock shall be able to switch reference clocks in the event that:

a) the current reference fails to respond for a period of time that threatens the accuracy of the local clock; or

b) the synchronizing dispersion indicates that statistical tolerance limits have been exceeded at the current reference.

7 Model

The purpose of the time management function is to manage the resources related to the provision of quality time information in a system. In this clause, the generic functionality involved in the provision of time information is defined