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**Information technology — Open Systems
Interconnection — Systems Management:
Metric objects and attributes**

*Technologies de l'information — Interconnexion de systèmes ouverts
(OSI) — Gestion-système: Objets et attributs métriques*



Reference number
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CONTENTS

	<i>Page</i>
1 Scope	1
2 Normative references	1
2.1 Identical Recommendations International Standards	2
2.2 Paired Recommendations International Standards equivalent in technical content	2
2.3 Additional references	2
3 Definitions.....	3
3.1 Basic reference model definitions	3
3.2 Management framework definitions	3
3.3 Systems management overview definitions	3
3.4 Definition of management information definitions.....	3
3.5 Standard definitions of statistics	3
3.6 CMIS definitions.....	4
3.7 Additional definitions	4
4 Abbreviations	4
5 Conventions.....	5
6 Requirements.....	5
7 Models.....	5
7.1 The Metric object model	5
7.2 Supporting metric objects	7
7.3 Severity indicating gauge-threshold model.....	8
7.4 Metric objects and models for workload monitoring.....	9
7.5 Use of metric objects for workload monitoring	11
8 Generic definitions	12
8.1 Managed objects	12
8.2 Imported generic definitions	25
8.3 Compliance	26
9 Service definition	26
10 System management functional units.....	26
11 Protocol and abstract syntax.....	26
11.1 Abstract syntax.....	26
11.2 Negotiation of functional units	30

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12	Relationships with other functions	30
13	Conformance	30
13.1	General conformance class requirements	30
13.2	Dependent conformance class requirements	31
13.3	Conformance to support managed object definitions	31
Annex A	Metric objects	32
A.1	Managed object class definitions	32
A.2	Package definitions	34
A.3	Attribute definitions	36
A.4	Name binding definitions	39
A.5	ASN.1 definitions	39
Annex B	EWMA data enhancement algorithms	41
B.1	Introduction	41
B.2	Algorithm behaviour	41
Annex C	Uniformly weighted moving average smoothing algorithm	44
C.1	Uniformly weighted moving average	44
C.2	UWMA gauge mean behaviour	44
Annex D	Workload reporting requirements	46

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 10164-11 was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 21, *Open Systems Interconnection, data management and open distributed processing*, in collaboration with ITU-T. The identical text is published as ITU-T Recommendation X.739.

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: Accounting metering function*
- *Part 11: Metric objects and attributes*
- *Part 12: Test management function*
- *Part 13: Summarisation function*
- *Part 14: Confidence and diagnostic test categories*
- *Part 15: Scheduling function*

Annexes A and B of this part of ISO/IEC 10164 are for information only.

Introduction

This Recommendation | International Standard specifies performance tools to observe characteristics of resources either directly within managed objects or through the use of metric objects. The tools also include provision of statistics, such as mean and percentile calculations, and thresholds to generate notifications.

INTERNATIONAL STANDARD**CCITT RECOMMENDATION****INFORMATION TECHNOLOGY – OPEN SYSTEMS INTERCONNECTION –
SYSTEMS MANAGEMENT: METRIC OBJECTS AND ATTRIBUTES****1 Scope**

This Recommendation | International Standard defines the metric objects and attributes function. The metric objects and attributes function is a systems management function which may be used by an application process in a centralised or decentralised management environment to interact for the purpose of systems management, as defined by CCITT Rec. X.700 | ISO/IEC 7498-4. This Recommendation | International Standard defines a function which consists of generic definitions. This function is positioned in the application layer of the OSI reference model, CCITT Rec. X.200 | ISO 7498, 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

- identifies the set of requirements satisfied by the function;
- provides a model for the behaviour of general metric objects;
- provides a model for the behaviour of the metric objects defined in this Recommendation | International Standard;
- specifies the management requirements of the function and how these are realised by specification of managed objects and their behaviour;
- specifies the abstract syntax of the parameters of the MAPDUs that will be used to refer to managed objects and their attributes; and
- defines managed objects.

This Recommendation | International Standard

- does not define the nature of any implementation of this Recommendation | International Standard;
- does not specify the manner in which management is to be accomplished by the user of this Recommendation | International Standard;
- does not define the nature of any interactions which result in the use of this Recommendation | International Standard;
- does not specify the services necessary for the establishment, normal and abnormal release of a management association;
- does not define the interactions which result by the simultaneous use of several management functions; and
- does not define connection establishment or authorization requirements for the use of these functions or for any associated activity.

2 Normative references

The following CCITT 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 editions of the Recommendation and Standards listed below. Members of IEC and ISO maintain registers of currently valid International Standards. The CCITT Secretariat maintains a list of the currently valid CCITT Recommendations.

2.1 Identical Recommendations | International Standards

- CCITT Recommendation X.701 (1992) | ISO/IEC 10040:1992, *Information technology – Open Systems Interconnection – Systems management overview.*
- 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.*
- CCITT Recommendation X.730 (1992) | ISO/IEC 10164-1:1992, *Information technology – Open Systems Interconnection – Systems Management: Object management function.*
- CCITT Recommendation X.731 (1992) | ISO/IEC 10164-2:1992, *Information technology – Open Systems Interconnection – Systems Management: State management function.*
- CCITT Recommendation X.733 (1992) | ISO/IEC 10164-4:1992, *Information technology – Open Systems Interconnection – Systems Management: Alarm reporting function.*

2.2 Paired Recommendations | International Standards equivalent in technical content

- CCITT Recommendation X.200 (1989), *Reference model of Open Systems Interconnection for CCITT Applications.*
ISO 7498:1984, *Information processing systems – Open Systems Interconnection – Basic Reference Model.*
- 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.*
ISO 8825:1990, *Information technology – Open Systems Interconnection – Specification of Basic Encoding Rules for Abstract Syntax Notation One (ASN.1).*
- CCITT Recommendation X.700 (1992), *Management framework definition for Open Systems Interconnection (OSI) for CCITT applications.*
ISO 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 specification.*

2.3 Additional references

- ISO 3534-1:1993, *Statistics – Vocabulary and symbols – Part 1: Probability and general statistical terms.*
- ISO/IEC 9545:1989, *Information processing systems – Open Systems Interconnection – Application Layer structure.*
- CCITT Recommendation M.3100 (1992), *Generic Network Information Model.*

3 Definitions

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

3.1 Basic reference model definitions

This Recommendation | International Standard makes use of the following terms defined in CCITT Rec. X.200 | ISO 7498:

- a) open system;
- b) OSI resource;
- c) systems management.

3.2 Management framework definitions

This Recommendation | International Standard makes use of the following terms defined in CCITT Rec. X.700 | ISO/IEC 7498-4:

- a) managed object;
- b) management information;
- c) OSI management.

3.3 Systems management overview definitions

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

- a) agent;
- b) agent role;
- c) managed system;
- d) management application protocol data unit;
- e) management operation;
- f) manager;
- g) manager role;
- h) managing system;
- i) notification;
- j) systems management functional unit.

3.4 Definition of management information definitions

This Recommendation | International Standard makes use of the following terms defined in CCITT Rec. X.721 | ISO/IEC 10165-2:

- a) counter;
- b) gauge;
- c) threshold;
- d) counter-threshold;
- e) gauge-threshold.

3.5 Standard definitions of statistics

This Recommendation | International Standard makes use of the following terms defined in ISO 3534-1:

- a) fractile of a probability distribution;
- b) mean of a random variable;
- c) variance.

3.6 CMIS definitions

This Recommendation | International Standard makes use of the following terms defined in CCITT Rec. X.710 | ISO/IEC 9595:

- a) attribute;
- b) Common Management Information Service;
- c) invoker;
- d) performer.

3.7 Additional definitions

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

3.7.1 capacity: The current amount of resource (e.g. octets per second) available to users, including resources already allocated for use, as well as resources available for future allocation.

3.7.2 granularity period: The time between the initiation of two successive scans.

3.7.3 metric: A value calculated from observed attribute values.

3.7.4 metric attribute: An attribute of a metric object whose value is either used as a parameter of one or more metric algorithms or whose value represents the output of such an algorithm.

3.7.5 metric algorithm: The behaviour of a metric object which models a formalized process to calculate specified results.

3.7.6 metric object: A managed object that contains at least one attribute whose value is calculated from values of attributes observed in managed objects.

3.7.7 observed attribute: An attribute of a managed object whose value is being scanned by a metric object or summarization object.

3.7.8 observed object: A managed object with one or more observed attributes.

3.7.9 percentile: The K-percentile of a probability distribution is the K/100 fractile of the distribution.

3.7.10 period synchronization time: The time to which the start of a repeating time period (e.g. granularity period) is synchronized.

3.7.11 rate: The change in a value over a specified interval of time.

NOTE – Instantaneous rate is the derivative of the value with respect to time and cannot generally be measured. The measured rate approaches the instantaneous rate as the specified interval of time approaches zero.

3.7.12 rejection rate: The rate of the number of requests rejected or the rate of the amount of requested resources but rejected due to non-available capacity.

3.7.13 resource request rate: The rate of the number of requests or the rate of the amount of resources requested.

3.7.14 resource utilization: The amount of capacity in use. Resource utilization can be measured as instantaneous or as an estimate of the mean over a time interval. Instantaneous resource utilization is the amount of capacity in use at a given point in time. Estimated mean resource utilization is an estimate of the mean resource utilization, taken over a time interval.

3.7.15 scan: A sampling process of observing attribute values at a specified point in time.

4 Abbreviations

CMIS	Common Management Information Service
EWMA	Exponentially Weighted Moving Average
GP	Granularity Period
MAPDU	Management Application Protocol Data Unit

max	maximum
min	minimum
MOCS	Managed Object Conformance Statement
MTP	Moving Time Period
PCT	A value for which a percentile is calculated
TPDU	Transport Protocol Data Unit
SMTP	Second Moving Time Period
UWMA	Uniformly Weighted Moving Average

5 Conventions

This Recommendation | International Standard does not define any services.

6 Requirements

In terms of functionality, the requirements to be satisfied are:

- the definition of statistical monitoring tools to derive metrics to characterize performance;
- the definition of a monitoring function which provides metrics which can be used to determine the resource request rate, resource rejection rate, and resource utilization;
- the specification of mechanisms to obtain these metrics;
- the specification of notifications to be generated when these metrics exceed threshold values, and the ability to include additional performance information into those notifications;
- the specification of mechanisms to control the operation of this function;
- the ability of an external managing system to modify parameters defined and used in this monitoring function;
- the ability to model either physical capacity limitations or those limitations imposed by administrative decisions;
- the scheduling of metric monitoring over a specified interval of time; and
- the ability for a managing system to enable and disable performance measurements independent of the managed objects under observation.

7 Models

This Recommendation | International Standard provides managers of performance with tools to observe characteristics of resources either directly within observable managed objects or through the use of metric objects. The tools include methods to observe resources and to provide statistics. These tools also include thresholds to generate notifications.

7.1 The Metric object model

The metric object model defines the basic concepts of OSI metric objects and their operation in open systems.

7.1.1 Metric monitoring process

The monitoring process for the metric objects in general can be divided into the steps described in 7.1.1.1 through 7.1.1.4.

7.1.1.1 Data capture

The data necessary to compute the observed values are extracted from the observed managed objects. The observed values are monitored by sampling at intervals specified by a granularity period.

7.1.1.2 Data conversion

The extracted data are converted to the forms suitable for their intended use. The conversion algorithm may be specified by metric objects. If the conversion algorithm is absent, conversion is not performed.

Metric monitoring uses counters, gauges, or derivatives of gauges to compare measures against given criteria. The observed values may be converted from counters to gauges or from gauges to derivatives of gauges. A simple method for these two types of conversions is to take two readings of a value (e.g. a counter) over an interval of time and compute their difference (a rate). Every time this is repeated a new value of the rate is obtained. This method, often referred to as the fixed time window, is a simple way of deriving a gauge value from a counter value or computing a derivative of a gauge from a gauge value. In some cases this may be the only processing required on the observed data by the metric object.

7.1.1.3 Data enhancement

If required, the information content of the data may be enhanced by reducing the effect of random variations. Data enhancement is performed according to an arithmetic algorithm. After data enhancement, the enhanced data are visible externally in gauge attributes.

A preliminary form of analysis, data enhancement extracts the information content from the data using an arithmetic algorithm. Data enhancement techniques include smoothing to filter out the stochastic variations of the value of the monitored attribute, to find trends within the data.

7.1.1.4 Data analysis

The information is analysed and used to fulfill a performance requirement. In metric monitoring, the analysis is simple comparison of the calculated gauge values with the thresholds to trigger the generation of alarms.

Metric objects are defined to fulfill some general or specific metric monitoring objectives. The data conversion and data enhancement steps may be absent in a particular metric object. The required monitoring process is set up at the metric object creation time by setting: the observed attribute identifiers (data capture), data conversion algorithm, data enhancement algorithm, and data analysis specification. The process is controlled during the lifetime of the metric managed object by: adjusting the data enhancement algorithm (e.g. changing a moving time period), and adjusting the data analysis algorithm (e.g. adding or modifying threshold levels).

7.1.2 Requirements on metric object classes

One performance management requirement is to provide statistical measurement of the performance of resources. Metric objects have attributes representing such statistical measurements. The basic variables from which the statistics are derived can be defined by reference to attribute definitions corresponding to those variables in managed object definitions representing the resource in question. In this way, metric objects are related (statically or dynamically) to observed managed objects representing the underlying resources. The behaviour of metric objects is controlled by their attributes including a defined class of algorithm. Metric objects are defined consistent with the guidelines of CCITT Rec. X.722 | ISO/IEC 10165-4.

7.1.3 Characteristics of metric objects

The metric objects may have characteristics to provide, for example:

- the identification of the metric object;
- the identification of observed managed objects and one or more of their observed attributes;
- the identification of the metric algorithm used in the observations;
- the number of samples, frequency of observations, and the time of the last observation;
- the scheduling of the observations;
- the indication of the results of its metric algorithms;
- the threshold values at which to report alarms; and
- the management of administrative state.

A managing system may request a managed system to create a metric object. If a metric object is created, a notification indicating the managed object creation may be emitted by the metric object.

A managing system may request a managed system to delete a metric object. If a metric object is deleted, a notification indicating the managed object deletion may be emitted by the metric object.

7.1.4 Relationships of metric objects to other managed objects

The managed system uses internal mechanisms for conveying the observed attribute values to the metric object.

Metric objects have one or more relationship attributes to allow the identification of observed managed objects and their attributes to be observed. The values of each of these relationship attributes shall be read-only and are set at the time of metric object creation. However, additional attributes of a metric object may be defined to be modifiable. The relationship of a metric object with an observed managed object is a one-way asymmetric relationship.

7.1.4.1 Containment relationships

The metric object may either be contained in the observed managed object or within some other managed object.

7.1.5 Use of smoothing algorithms in metric objects

The derived gauge attribute of a metric object may be regarded as a random variable having a probability distribution that is parameterised by time. At a given time, characteristics of the probability distribution can be estimated by applying smoothing algorithms to observations of the derived gauge attribute.

Time-oriented smoothing algorithms for estimating mean, variance and percentiles are described in Annexes B and C. These algorithms are based on weighted averages of observations taken in a moving time period.

The quality of estimates given by these algorithms depends upon:

- the relative variation of the probability distribution during the moving time period;
- the number of observations during the moving time period; and
- the independence of observations.

Optimal values for the moving time period and the number of observations within that period depend upon the characteristics of the probability distribution of the derived gauge attribute.

7.2 Supporting metric objects

This clause describes the metric objects which are defined by this Recommendation | International Standard. These managed objects are the monitor metric, mean monitor, algorithm indicating mean monitor, moving average mean monitor, mean and variance monitor, mean and percentile monitor, and mean and min max monitor metric objects.

The monitor metric managed object is used to observe a counter or a gauge type attribute and update the derived gauge attribute after each observation. If the observed attribute is a counter, the monitor metric managed object may derive a gauge value from the counter. In this case the derived gauge value is the difference between successive observations of the counter. If the observed attribute is a gauge the derived gauge value will be equal to the observed attribute at the time of each observation. The monitor metric managed object's activity can be scheduled. The monitor metric managed object may have a severity indicating gauge-threshold applied to the derived gauge attribute. The managed object may emit a quality of service alarm notification whenever the threshold value is crossed. The notification may also indicate the specific problem related to the observed attribute (e.g. rejection rate).

The mean monitor managed object class is derived from the monitor metric managed object class. In addition to the characteristics of the monitor metric managed object, the mean monitor managed object has an estimate of mean attribute used to provide the estimate of the mean of the derived gauge attribute value. The severity indicating gauge-threshold value in this managed object is applied to the estimate of the mean attribute. If enabled the managed object will emit a quality of service alarm notification whenever the threshold value is crossed. The notification may also indicate the specific problem related to the observed attribute (e.g. rejection rate).

The algorithm indicating mean monitor managed object class is derived from the mean monitor managed object class. In addition to the characteristics of the mean monitor managed object, the algorithm indicating mean monitor managed object provides the identifier of an algorithm used to derive the estimate of the mean.

The moving average mean monitor managed object class is derived from the mean monitor managed object class. In addition to the characteristics of the mean monitor managed object, the moving average mean monitor managed object specifies the EWMA algorithm used to estimate the mean value.

The mean and variance monitor managed object provides estimates of the mean and the variance of an observed attribute. This managed object class is derived from the moving average mean monitor managed object class. In addition to the characteristics of the moving average mean monitor managed object, the mean and variance monitor managed object has an attribute needed for the algorithm used to evaluate the variance.

The mean and percentile monitor managed object provides estimates of the mean, median, nth percentile, largest in a replication and the smallest in a replication values of an observed attribute. This managed object class is derived from moving average mean monitor managed object class. In addition to the characteristics of the moving average mean monitor managed object, the mean and percentile monitor managed object has attributes needed for the algorithm used to evaluate the percentile.

The mean and min max monitor managed object provides estimates of the mean, as well as the smallest and largest values of an observed attribute. The managed object class is derived from the mean monitor managed object class. In addition to the characteristics of the moving average mean monitor managed object, the mean and min max monitor managed object has attributes needed to provide the largest and smallest values.

7.3 Severity indicating gauge-threshold model

This Recommendation | International Standard defines a severity indicating gauge-threshold attribute type which is used to trigger notifications for monitoring resources. This attribute type has behaviour similar to that of a gauge-threshold attribute type, as defined in 9.3.2 of CCITT Rec. X.721 | ISO/IEC 10165-2. The syntax of the severity indicating gauge-threshold is that of the gauge-threshold enhanced to associate an optional severity indication parameter with each of the notify-high and notify-low submembers of each threshold level member.

If the severity indication parameter is present, its value is used in the perceived severity parameter of all alarms associated with that threshold's submember.

An optional mechanism is provided for determining the value of the specific problems parameter of emitted quality of service alarm notifications.

The example in Figure 1 illustrates three threshold levels. Threshold levels 1 and 2 are triggered in the increasing direction while threshold level 3 is triggered when the gauge value is decreasing. The emission of the notifications associated with the severity indicating gauge-threshold is as follows:

- initially, if notify-high's on/off switch is true and the gauge value becomes equal to or greater than threshold level 1, in a positive going direction, then the defined event notification is triggered; subsequent crossings of notify-high's gauge value shall not cause further generation of event notifications unless the gauge value becomes equal to or less than threshold level 1-clear value.
- initially if notify-low's on/off switch is true and the gauge value becomes equal to or less than threshold level 1-clear, in a negative going direction and the gauge value has been greater than or equal to threshold level 1, then the defined event notification is triggered if there is an outstanding event notification for threshold level 1; subsequent crossings of notify-low's gauge value shall not cause further generation of event notifications unless the gauge value becomes equal to or greater than threshold level 1 value.

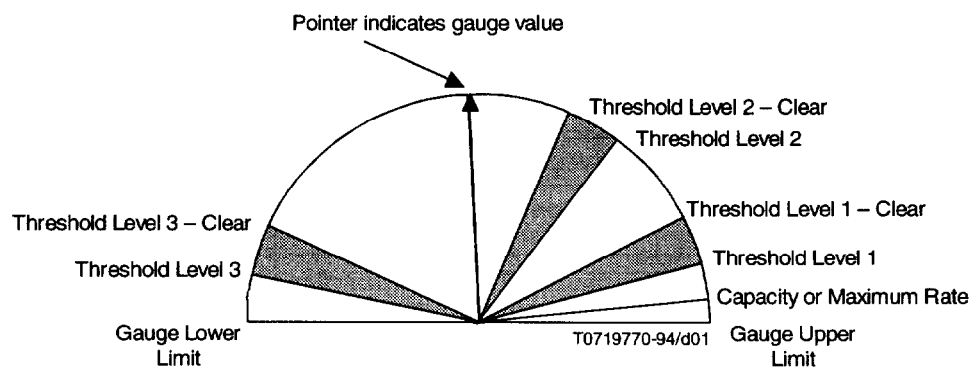


Figure 1 – Example severity indicating gauge-threshold

If the notification switch for threshold level 3 is set to “true” a notification will be emitted as follows:

- initially, if notify-low’s on/off switch is true and the gauge value becomes equal to or less than threshold level 3, in a negative going direction, then the defined event notification is triggered; subsequent crossings of notify-low’s gauge value shall not cause further generation of event notifications unless the gauge value becomes equal to or greater than threshold level 3-clear value.
- initially, if notify-high’s on/off switch is true and the gauge value becomes equal to or greater than threshold level 3-clear, in a positive going direction and the gauge value has been less than or equal to threshold level 3, then the defined event notification is triggered; subsequent crossings of notify-high’s gauge value shall not cause further generation of event notifications unless the gauge value becomes equal to or less than threshold level 3 value.

7.4 Metric objects and models for workload monitoring

This Recommendation 1 International Standard provides for resource monitoring. Monitoring of resources includes monitoring of resource utilization, rejection rate, and resource request rate. Additionally, this Recommendation 1 International Standard provides for setting of threshold values, reporting of early warning and severe warning conditions, and the clearing of those conditions.

NOTE 1 – The unit for utilization and capacity can be the amount of resources in use or a rate derived from the cumulative amount of resources used.

Three models are defined to fulfill OSI workload monitoring requirements:

- the resource utilization model provides monitoring of the amount of resource in use;
- the rejection rate model provides monitoring of service request rejection rate; and
- the resource request rate model provides monitoring of requests for usage of resources.

In some cases, it is possible that the service requests are rejected before the capacity is fully utilized. For example, this happens when the amount of resource requested exceeds the remaining available capacity.

Systems can support one or more models to fulfill their management requirements. When more than one model is supported there are relationships among them. These relationships exist because each model is associated with the use of the same resource. The resource utilization model indicates the variation of usage of the resource. When the request cannot be fulfilled, the rejection rate model provides information concerning rejection rate conditions. The resource request rate model provides information concerning request rates.

Users of this management service must be aware that capacity could decrease (e.g. because of a system fault).

The relationship between the resource utilization, rejection rate, and resource request rate of the same (hypothetical) resource is illustrated in Figure 2. Together, these three quantities provide an estimate of the workload for that resource.

Each of these quantities is modelled as a gauge. A severity indicating gauge-threshold, illustrated in the figure below, is defined in Annex A. Each gauge has a severity indicating gauge-threshold, which is a set of threshold levels. Each threshold level contains a pair of (high and low) threshold values.

For example, threshold level 1 in Figure 2 may be associated with a more severe condition than threshold level 2, which may be regarded as an early warning. Then, each of the high values is used to trigger a notification indicating the corresponding condition and the low values are used to trigger a notification indicating the clearing of the condition.

Although not shown in Figure 2, there may be instances when the manager needs to be aware of the under-utilization of resources, possibly to allocate them for service for other use. In such a case, the manager may be made aware by a downward triggered threshold level event notification.

In addition to resource utilization gauge-thresholds, similar gauge-thresholds are defined for the rejection rate and resource request rate. These operate as described for the resource utilization gauge-threshold, although, in general, only the increasing gauge-thresholds would be required.

To support resource utilization, resource request rate and rejection rate monitoring using metric objects the observed managed object must provide gauge or counter attributes for deriving the resource utilization, the resource request rate and the rejection rate respectively.

NOTE 2 – There are several possible ways to handle a user request if the request cannot be fully satisfied:

- a) the request is totally rejected;
- b) the request is partially satisfied;
- c) the request is queued and will eventually be satisfied;
- d) the request is queued for a maximum amount of waiting time.

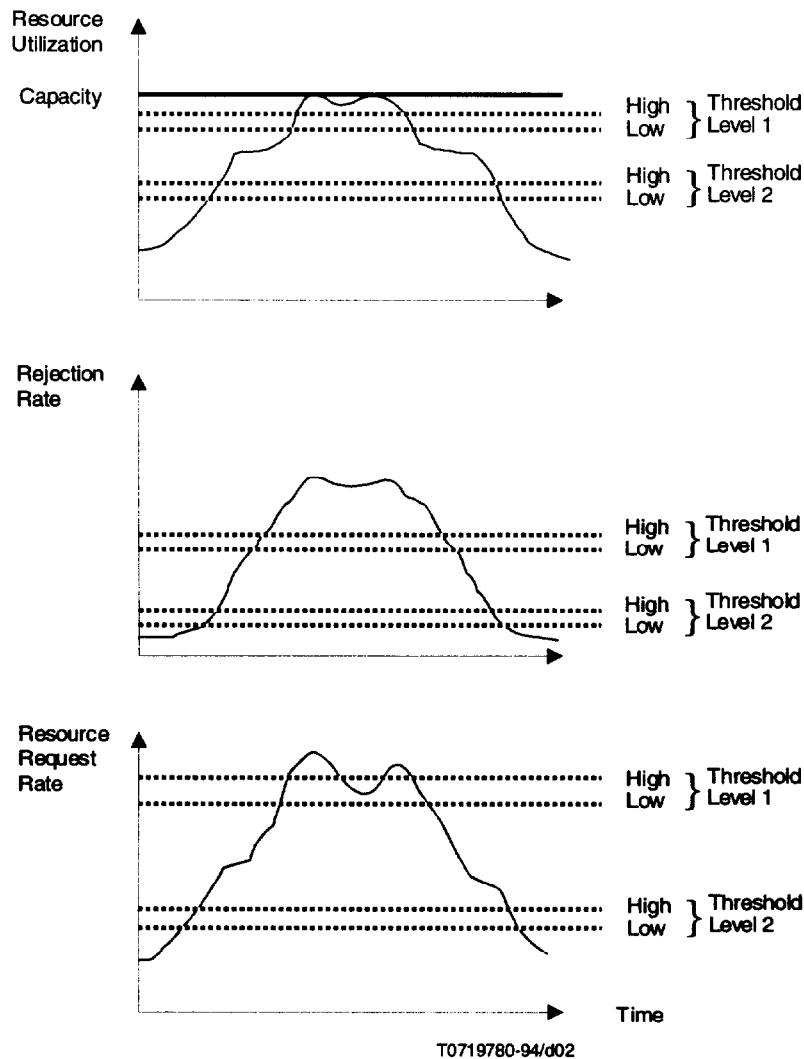


Figure 2 – Resource utilization, rejection rate and resource request rate

In the first case the semantics of resource request rate and rejection rate are obvious and no further explanation is needed. However in all other cases the precise semantics of resource request rate and rejection rate is dependent on the behaviour of the observed managed object.

Gauges can be used to model the values of resource utilization, rejection rate, and resource request rate. A generic model of such a gauge is illustrated in Figure 1.

7.4.1 Resource utilization gauge model

In addition to the common characteristics specified in 7.4, the resource utilization gauge has the following specific characteristics:

- The value of the gauge indicates the resource utilization which is the result of calculations over a time interval that may be specified by the manager.
- The utilization will tend to increase as resources are supplied to users.
- The utilization will tend to decrease as resources are released by users.
- There are smoothing algorithms for calculating the value of estimated means. These algorithms are defined in Annexes B and C. If the mean monitor managed object class or any of its subclasses are used, an algorithm is selected for calculating the value of the estimated mean utilization. If the data enhancement process is not required, the monitor metric managed object class can be used.

- e) Resource utilization is measured as an estimate of the mean utilization over a time interval. Estimated mean resource utilization is an estimate of the mean amount of either services supplied or workload (selection depends on units of capacity) utilization.

NOTE – By using the appropriate metric object class, resource utilization can be reported as either instantaneous utilization values or an estimate of the mean utilization over a time interval.

7.4.2 Rejection rate gauge model

In addition to the common characteristics specified in 7.4, the rejection rate gauge has the following characteristics:

- a) The value of the gauge indicates the rejection rate which is the result of calculations over a set of time intervals that may be specified by the manager.
- b) The rejection rate will tend to increase as user requests for resources are denied and will tend to decrease as user requests are granted or users submit less requests for resources.
- c) There are associated algorithms for calculating the value of the rate. The algorithms are defined in Annexes B and C.
- d) Rejection rate is measured as an estimate of the mean rejection rate over a time interval that may be specified by the manager. Estimated mean rejection rate is an estimate of the mean amount of either service requests or workload (selection depends on units of capacity) rejected per unit time due to non-available capacity, taken over a time interval that may be specified by the manager.

7.4.3 Resource request rate gauge model

In addition to the common characteristics specified in 7.4, the resource request rate gauge has the following characteristics:

- a) The value of the gauge indicates the resource request rate which is the result of calculations over a set of time intervals that may be specified by the manager.
- b) The resource request rate will tend to increase as user requests for resources arrive and will tend to decrease as users submit less requests for resources.
- c) There are associated algorithms for calculating the value of the rate. The algorithms are defined in Annexes B and C.
- d) Resource request rate is measured as an estimate of the mean resource request rate over a time interval that is specified by the manager. Estimated mean resource request rate is an estimate of the mean amount of either service requests or workload (selection depends on units of capacity) requested per unit time taken over a time interval that is specified by the manager.

7.5 Use of metric objects for workload monitoring

The monitor metric managed object or any of its subclasses may be used for generating notifications related to resource utilization when it is desired to apply a threshold directly to the derived gauge representing resource utilization. The monitor metric managed object may also be used for generating notifications related to resource request rate and rejection rate when it is desired to apply a threshold to a gauge derived from a counter that counts requests or rejections for the resource. If a counter difference package is included in the monitor metric managed object, the underlying gauge is treated as a counter.

NOTE – The unit for utilization and capacity can be the amount of resources in use or a rate derived from the cumulative amount of resources used.

The mean monitor managed object class or its subclasses may be used for generating notifications related to the average value of the derived gauge derived over time for resource utilization, resource request rate or rejection rate. If the resource request rate and rejection rate are to be calculated from a counter that counts requests or rejections for the resource, or if the resource utilization is derived from a cumulative usage counter, then a counter difference package shall be included in the instances of the mean monitor managed object class or its subclasses.

The moving average mean monitor managed object may also be used for workload monitoring. When the moving average mean monitor managed object is used for workload monitoring it is possible to obtain information about and manage the algorithm used in measurements.

Other managed objects may generate notifications related to resource utilization, resource request rate or rejection rate if their definition includes the appropriate generic definitions defined in this Recommendation | International Standard.