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DATA COMMUNICATION NETWORKS

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

Recommendation X.731

Foreword

"ITU (International Telecommunication Union) is the United Nations Specialized Agency in the field of telecommunications. The CCITT (the International Telegraph and Telephone Consultative Committee) is a permanent organ of the ITU. Some 166 member countries, 68 telecom operating entities, 163 scientific and industrial organizations and 39 international organizations participate in CCITT which is the body which sets world telecommunications standards (Recommendations).

The approval of Recommendations by the members of CCITT is covered by the procedure laid down in CCITT Resolution No. 2 (Melbourne, 1988). In addition, the Plenary Assembly of CCITT, which meets every four years, approves Recommendations submitted to it and establishes the study programme for the following period".

In some areas of information technology which fall within CCITT's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC. The text of CCITT Recommendation X.731 was approved on 17th of January 1992. The identical text is also published as ISO/IEC International Standard 10164-2.

CCITT NOTE

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

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INFORMATION NOTE

The following table gives a list of X.700 Series Recommendations which were developed in collaboration with the ISO/IEC and are identical to the corresponding International Standard. Cross-references to the corresponding ISO/IEC International Standard number and the short title of the Recommendation | International Standard are provided.

CCITT Recommendation ISO/IEC International Standard	Short Title
X.700 | 7498-4 (Note)	Management Framework
X.701 | 10040	System Management Overview
X.710 | 9595 (Note)	Common Management Information Service Definition
X.711 | 9596-1 (Note)	Common Management Information Protocol Specification
X.712 | 9596-2	CMIP PICS
X.720 | 10165-1	Management Information Model
X.721 | 10165-2	Definition of Management Information
X.722 | 10165-4	Guidelines for the Definition of Managed Objects
X.730 | 10164-1	Object Management Function
X.731 | 10164-2	State Management Function
X.732 | 10164-3	Attributes for Representing Relationships
X.733 | 10164-4	Alarm Reporting Function
X.734 | 10164-5	Event Management Function
X.735 | 10164-6	Log Control Function
X.736 | 10164-7	Security Alarm Reporting Function
X.740 | 10164-8	Security Audit Trail Function
NOTE – This Recommendation and International Standard are not identical, but are technically aligned.	

INTERNATIONAL STANDARD

CCITT RECOMMENDATION

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

1 Scope

This Recommendation | International Standard defines a systems management function which 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 CCITT Rec. X.700 | ISO/IEC 7498-4. This Recommendation | International Standard defines the state management function and consists of service and generic definitions. It is positioned in the application layer of CCITT Rec. X.200 | ISO/IEC 7498 and is defined according to the model provided by ISO/IEC 9545. The role of systems management functions are described by CCITT Rec. X.701 | ISO/IEC 10040.

This Recommendation | International Standard

- establishes user requirements for the state management function;
- establishes models that relate the service and generic definitions provided by this function to user requirements;
- defines the services provided by the function;
- defines generic attribute types, notification types and parameters documented in accordance with CCITT Rec. X.722 | ISO/IEC 10165-4;
- specifies the protocol that is necessary in order to provide the services;
- defines the relationship between the service and management operations and notifications;
- specifies compliance requirements placed on other standards that makes use of these generic definitions;
- defines relationships with other systems management functions;
- specifies conformance requirements.

This Recommendation | International Standard does not

- define the nature of any implementation intended to provide the state management function;
- specify the manner in which management is accomplished by the user of the state management function;
- define the nature of any interactions that result in the use of the state management function;
- specify the services necessary for the establishment, normal and abnormal release of a management association;
- preclude the definition of further notification types;
- define managed objects.

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 Recommendations and Standards indicated 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.732 (1992) | ISO/IEC 10164-3:1993, *Information technology – Open Systems Interconnection – Systems Management: Attributes for representing relationships.*
- CCITT Recommendation X.733 (1992) | ISO/IEC 10164-4:1992, *Information technology – Open Systems Interconnection – Systems Management: Alarm reporting function.*
- CCITT Recommendation X.734 (1992) | ISO/IEC 10164-5:1993, *Information technology – Open Systems Interconnection – Systems Management: Event report management function.*
- CCITT Recommendation X.735 (1992) | ISO/IEC 10164-6:1993, *Information technology – Open Systems Interconnection – Systems Management: Log control function.*

2.2 Paired Recommendations | International Standards equivalent in technical content

- CCITT Recommendation X.200 (1988), *Reference Model of Open Systems Interconnection for CCITT Applications.*

  ISO 7498:1984, *Information processing systems – Open Systems Interconnection – Basic Reference Model.*

- 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).*

- CCITT Recommendation X.210 (1988), *Open Systems Interconnection Layer Service Definition Conventions.*

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

- CCITT Recommendation X.290 (1992), *OSI conformance testing methodology and framework for protocol Recommendations for CCITT applications – General concepts.*

  ISO/IEC 9646-1:1991, *Information technology – Open Systems Interconnection – Conformance testing methodology and framework – Part 1: General concepts.*

- CCITT Recommendation X.700 (1992), *Management Framework Definition 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.*

2.3 Additional references

– ISO/IEC 9545:1989, *Information technology – Open Systems Interconnection – Application layer structure.*

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) systems management.

3.2 Management framework definitions

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

managed object

3.3 CMIS definitions

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

attribute

3.4 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) dependent conformance;

d) general conformance;

e) generic definitions;

f) managed object class;

g) manager;

h) manager role;

i) notification;

j) systems management functional unit;

k) systems management function;

l) systems management application protocol;

m) (systems management) operation.

3.5 Management information model definitions

This Recommendation | International Standard makes use of the following term defined in CCITT Rec. X.720 | ISO/IEC 10165-1:

managed object boundary

3.6 Service conventions definitions

This Recommendation | International Standard makes use of the following terms defined in CCITT Rec. X.210 | ISO/TR 8509:

a) confirm (primitive);

b) confirmed-service;

c) indication (primitive);

d) non-confirmed-service;

e) request (primitive);

f) response (primitive).

3.7 OSI conformance testing definitions

This Recommendation | International Standard makes use of the following term defined in CCITT Rec. X.290 | ISO/IEC 9646-1:

system conformance statement

4 Abbreviations

ASN.1	Abstract Syntax Notation One
CMIS	Common Management Information service
Conf	Confirmation
Ind	Indication
MAPDU	Management application protocol data unit
OSI	Open systems interconnection
Req	Request
Rsp	Response
SMAPM	Systems management application protocol machine
SMI	Structure of management information

5 Conventions

This Recommendation | International Standard defines services for the state management function following the descriptive conventions defined in CCITT Rec. X.210 | ISO/TR 8509. In clause 9, the definition of each service includes a table that lists the service parameters. For a given service primitive, the presence of each parameter is described by one of the following values:

M	the parameter is mandatory;
(=)	the value of the parameter is equal to the value of the parameter in the column to the left;
U	the use of the parameter is a Service-user option;
–	the parameter is not present in the interaction described by the primitive concerned;
C	the parameter is conditional;
P	the parameter is subject to the constraints imposed by CCITT Rec. X.710	ISO/IEC 9595.

NOTE – The parameters that are marked "P" in service tables of this Recommendation | International Standard are mapped directly onto the corresponding parameters of the CMIS service primitive, without changing the semantics or syntax of the parameters. The remaining parameters are used to construct an MAPDU.

6 Requirements

The MIS-User needs the ability to examine and be notified of changes in state, to monitor overall operability and usage of resources in a consistent manner, and to control the general availability of specific resources.

This Recommendation | International Standard defines the generic attributes and operations that can be part of any managed object definition in order to provide a standardized OSI management technique for dealing with management states.

The state management provides for

- the reporting of changes in the state attributes;
- reading the state attributes;
- changing the state attributes.

7 Model

The management state of a managed object represents the instantaneous condition of availability and operability of the associated resource from the point of view of management. Different classes of managed object have a variety of state attributes that express and control aspects of the operation of their associated resource that are peculiar to each class. However, the management state is expected to be common to a large number of resources and for this reason is standardized; it expresses key aspects of their usability at any given time. Its purpose is to control the general availability of a resource and to make visible information about that general availability.

7.1 Generic states

Three primary factors affect the management state of a managed object with regard to its corresponding resources' availability. Some managed objects may not be affected by all three of these factors. These are

- operability: whether or not the resource is physically installed and working, if applicable;
- usage: whether or not the resource is actively in use at a specific instant, and if so, whether or not it has spare capacity for additional users at that instant. A resource is said to be "in use" when it has received one or more requests for service that it has not yet completed or otherwise discharged, or when some part of its capacity has been allocated, and not yet reclaimed, as a result of a previous service request;
- administration: permission to use or prohibition against using the resource, imposed through the management services.

The state of a managed object does not affect its ability to respond to management operations.

7.1.1 Operational state

The operability of a resource is described by the operational state attribute, which has two possible values: disabled and enabled. These are described in 8.1.1.1.

Some classes of managed object exhibit only a constant enabled value for the operational state. When a resource has no visible dependencies on other resources, and no components that can develop visible defects, the managed object may not exhibit the disabled operational state. Likewise, managed objects that cease to exist when the resource becomes inoperable do not exhibit the disabled operational state during their existence. When a resources ceases to exist, but there is still a managed object maintaining state attributes about that resource, then the operational state will be disabled. The set of operational state values supported is specified in each individual managed object class definition.

When a managed object is unable to reflect the operational state of its associated resource and the unknown status attribute defined in 8.1.2.6 is supported, the unknown status attribute value will be true.

It is the natural operation of the resource that causes operational state transitions to occur, and therefore, management cannot request a managed object to change from one operational state to another. Management can only gather information about the operational state of a managed object; i.e. the operational state is read-only in nature.

Specific events associated with the resource cause specific transitions from one operational state value to the other. These events and transitions are summarised in Figure 1, and are described below.

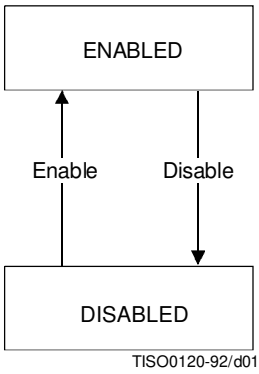


Figure 1 – Operational state diagram

7.1.1.1 Enable

This event consists of action being taken to render the resource partially or fully operable. This event can occur only if the managed object's operational state is disabled. The enable event causes a transition to the enabled operational state.

7.1.1.2 Disable

This event consists of some occurrence that renders the resource totally inoperable. The disable event causes a transition to the disabled operational state.

7.1.2 Usage state

The usage of a resource is described by the usage state attribute, which has three possible values: idle, active and busy. These are described in 8.1.1.2. The set of usage state values supported is specified in each individual managed object class definition.

Some classes of managed object exhibit only a subset of the possible usage state values. Managed objects whose associated resource supports only one user do not exhibit the active usage state, being either idle or busy. Managed objects whose resource has no practical limit on the number of users do not exhibit the busy usage state.

When a managed object is unable to reflect the usage state of its associated resource and the unknown status attribute defined in 8.1.2.6 is supported, the unknown status attribute value will be true.

It is the natural operation of the resource that causes usage state transitions to occur, and therefore management cannot request a managed object to change from one usage state to another. Management can only gather information about the usage state of a managed object; the usage state is read-only in nature.

Specific events associated with the resource cause transitions from one usage state value to another. These events and transitions are summarised in Figure 2 and are described below.

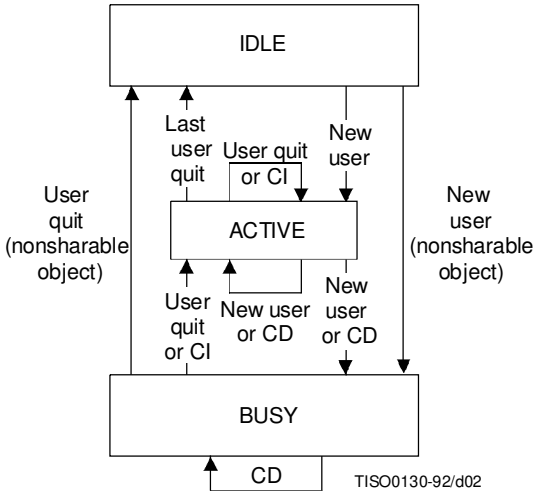


Figure 2 – Usage state diagram

7.1.2.1 New user

This event consists of some agency commencing to use the resource. It can occur only if the managed object's operational state is enabled and its usage state is either idle or active. The new user event causes a transition as follows:

- if, after the event, the resource still has sufficient operating capacity to provide for additional users, the usage state becomes or remains active,
- if, after the event, the resource has no operating capacity to spare for additional users, the usage state becomes busy.

7.1.2.2 User quit

This event consists of an existing user of the resource terminating its use. It can occur only if the managed object's usage state is either active or busy. It can result from a change of operational state from enabled to disabled. The user quit event causes a transition as follows:

- if, after the event, the resource still has existing users, the usage state becomes or remains active;
- if, after the event, the resource has no users, the usage state becomes idle.

7.1.2.3 Capacity increase (CI)

This event consists of an increase in the maximum operating capacity of the resource. It is significant only if the managed object's usage state is busy. The capacity increase event causes a transition to the active state if the managed object was in the busy state.

7.1.2.4 Capacity decrease (CD)

This event consists of a decrease in the maximum operating capacity of the resource. It is significant only if the managed object's usage state is active. The capacity decrease event causes a transition as follows:

- if, after the event, the resource still has spare operating capacity, the usage state remains active;
- if, after the event, the resource has no spare operating capacity, the usage state becomes busy;
- if the managed object is in the busy state when a capacity decrease occurs, the managed object will continue to reside in the busy state until either a capacity increase or a user quit event occurs.

7.1.3 Administrative state

The administration of managed objects operates independently of the operability and usage of managed objects and is described by the administrative state attribute, which has three values. These are represented in a third state diagram in Figure 3. These administrative states are called locked, unlocked and shutting down and are described in 8.1.1.3.

Some classes of managed object exhibit only a subset of the possible administrative state values. Some resources cannot be locked, and hence their corresponding managed objects exhibit only the unlocked state. Other resources can not be shut down gracefully, and hence their corresponding managed objects do not exhibit the shutting down state. The actual subset of administrative state values supported varies from one class of managed object to another, and is specified in each individual managed object definition.

Specific events associated with the managed object cause specific transitions from one administrative state value to another, depending upon the original value of the administrative state, the specific event, and also upon the number of users of the resource. These events and transitions are summarised in Figure 3, and are described below.

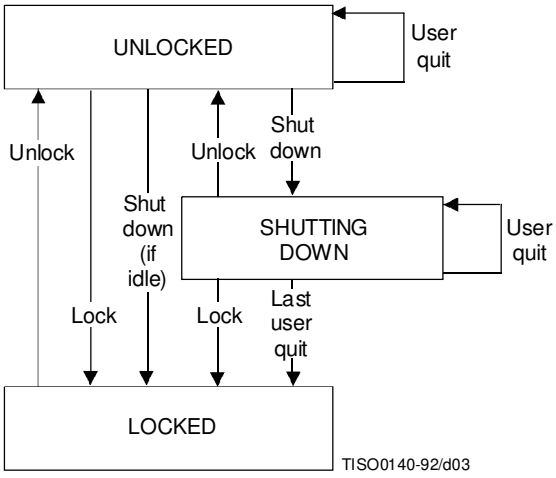


Figure 3 – Administrative state diagram

7.1.3.1 Unlock

This event consists of an operation being performed at the managed object boundary to unlock the managed object's corresponding resource. It can occur only if the managed object's administrative state is locked or shutting down. It causes a transition to the unlocked administrative state.

7.1.3.2 Lock

This event consists of an operation being performed at the managed object boundary to lock the managed object's corresponding resource. It can occur only if the managed object's administrative state is unlocked or shutting down. It causes a transition to the locked administrative state.

7.1.3.3 Shut down

This event consists of an operation being performed at the managed object boundary to shut down the managed object's corresponding resource. It can occur only if the managed object's administrative state is unlocked. It causes a state transition as follows:

- if, at the time of the event, the resource has existing users, the administrative state becomes shutting down;
- if, at the time of the event, the resource has no users, the administrative state becomes locked.

7.1.3.4 User quit

This event consists of an existing user of the resource terminating its use. It can occur only if the managed object's administrative state is unlocked or shutting down. If the administrative state is unlocked, no administrative state transition occurs. If the administrative state is shutting down, the user quit event causes a transition as follows:

- if, after the event, the resource still has existing users, the administrative state remains as shutting down;
- if, after the event, the resource has no users, the administrative state becomes locked.

7.1.4 Dependencies among generic states

It is the responsibility of the managed object class definer to specify which combinations of state values are, and which are not, supported by each individual managed object class.

When all three state attributes are supported by a managed object, the following are the possible combinations of values for the three state attributes (see also Figure 4).

- disabled, idle, locked: The resource is totally inoperable, it is not servicing any users and it is also administratively prohibited from use. To make it available for use, both management permission (an unlock operation) and some corrective action are necessary.
- enabled, idle, locked: The resource is partially or fully operable, it is not servicing any users but is administratively prohibited from use. To make it available for use, only management permission (an unlock operation) is required.
- enabled, active, shutting down: The resource is partially or fully operable and in use, but usage is administratively limited to current instances of use. For an additional user to gain access, management permission (an unlock operation) is required. Otherwise, when all current users have terminated their use of the resource, the managed object will automatically transit to the enabled, idle, locked state.
- enabled, busy, shutting down: The resource is partially or fully operable and in use, but usage is administratively limited to current instances of use; in addition, it has no spare capacity to provide for additional users. For an additional user to gain access, beside waiting for an existing user to terminate, management permission (an unlock operation) is also required. Otherwise, when all current users have terminated their use of the resource, the managed object will automatically transit to the enabled, idle, locked state.
- disabled, idle, unlocked: The resource is totally inoperable, it is servicing no users but it is not administratively prohibited from use. To make it available for use, some corrective action is required.
- enabled, idle, unlocked: The resource is partially or fully operable, it is not actually in use and is not administratively prohibited from use.
- enabled, active, unlocked: The resource is partially or fully operable, it is currently in use and is not administratively prohibited from use. It has sufficient spare capacity to provide for additional users simultaneously.
- enabled, busy, unlocked: The resource is partially or fully operable, it is currently in use and it is not administratively prohibited from use. Currently it has no spare capacity to provide for additional users. For an additional user to gain access, it is necessary to wait for an existing user to terminate or for some capacity increase to occur.

Figure 5 illustrates the combined state diagram of operational and administrative states.

Figure 6 illustrates the combined state diagram of administrative and usage states.

Figure 7 illustrates the combined state diagram of operational and usage states.

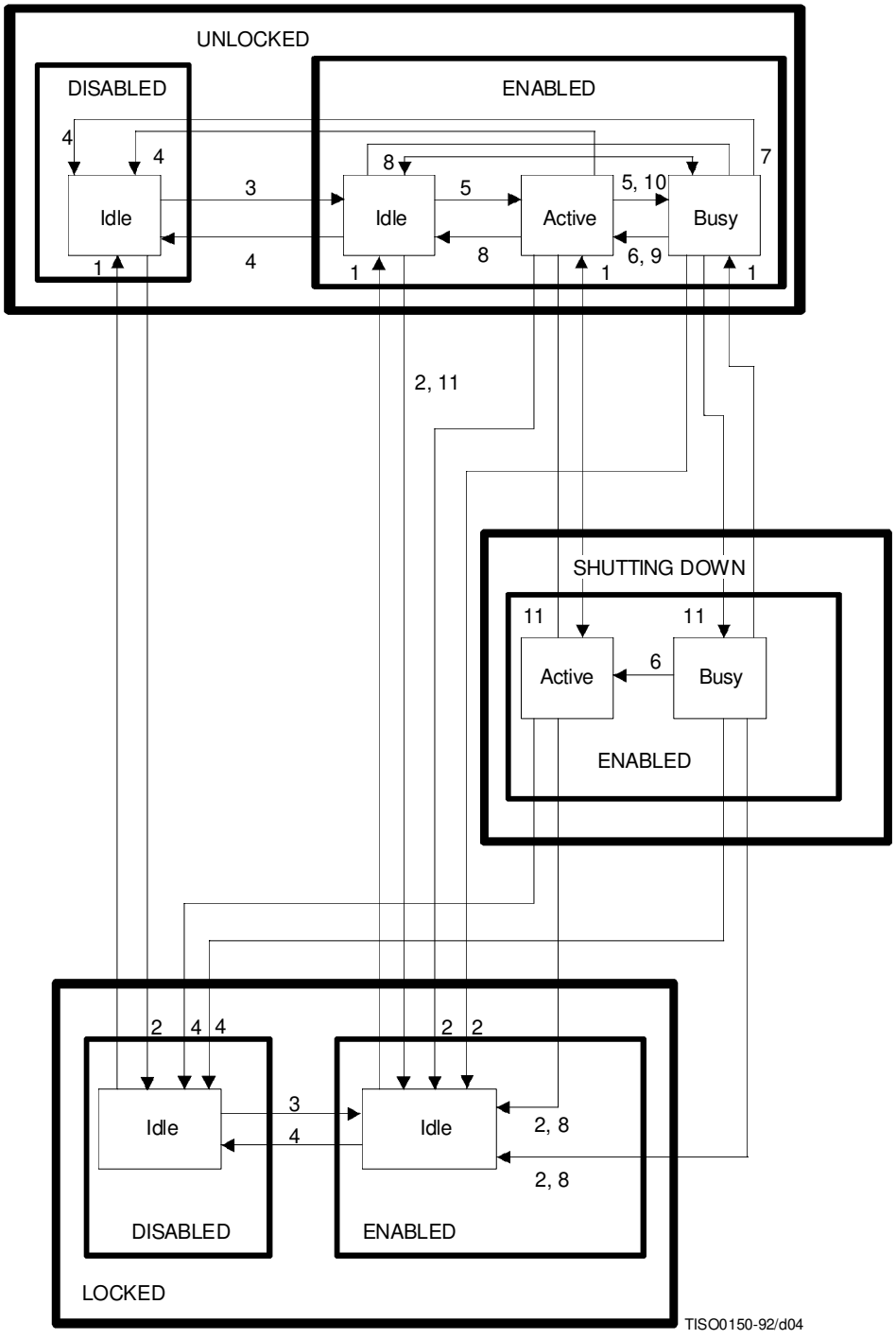


Figure 4 – Combined state diagram

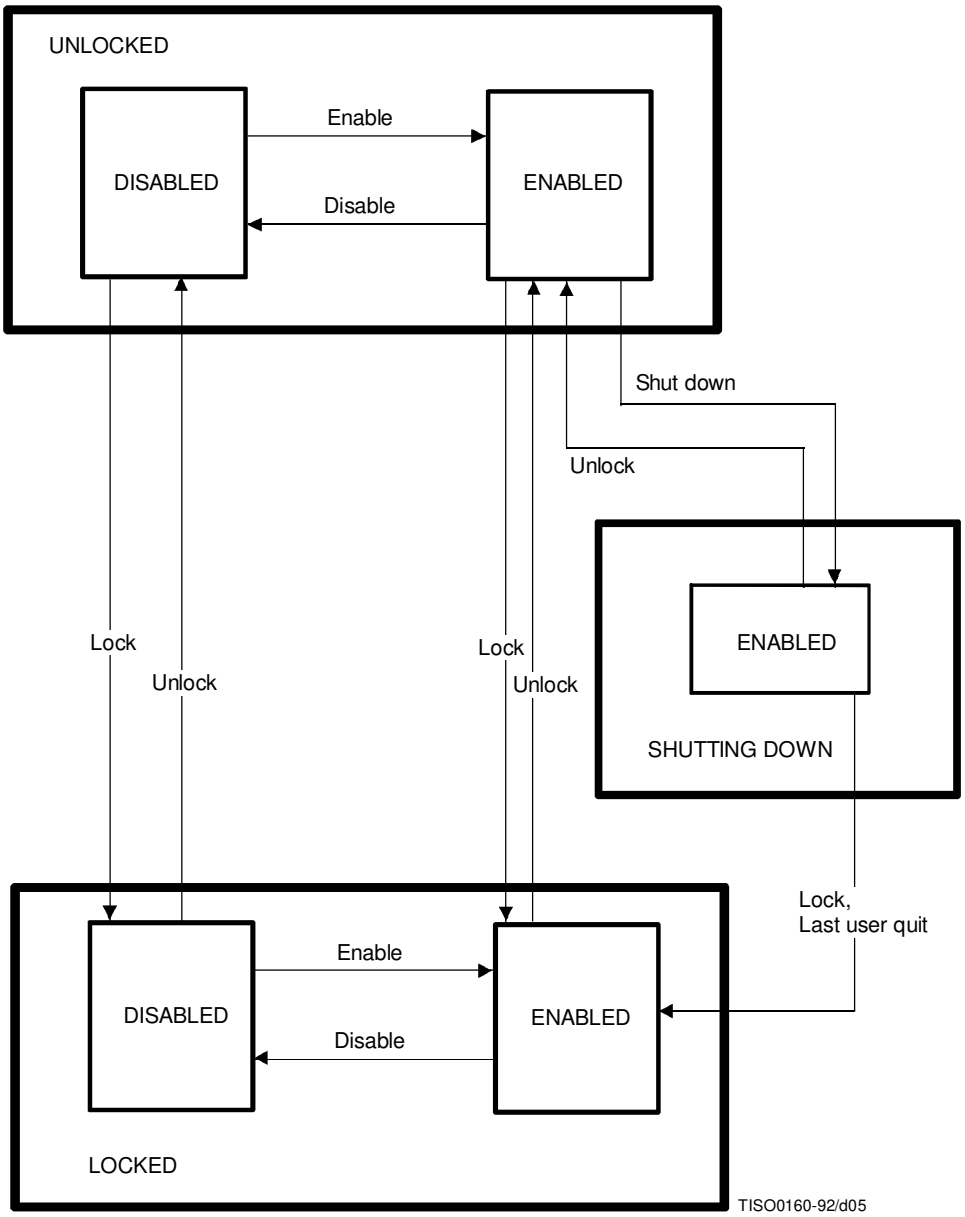


Figure 5 – Operational and administrative states

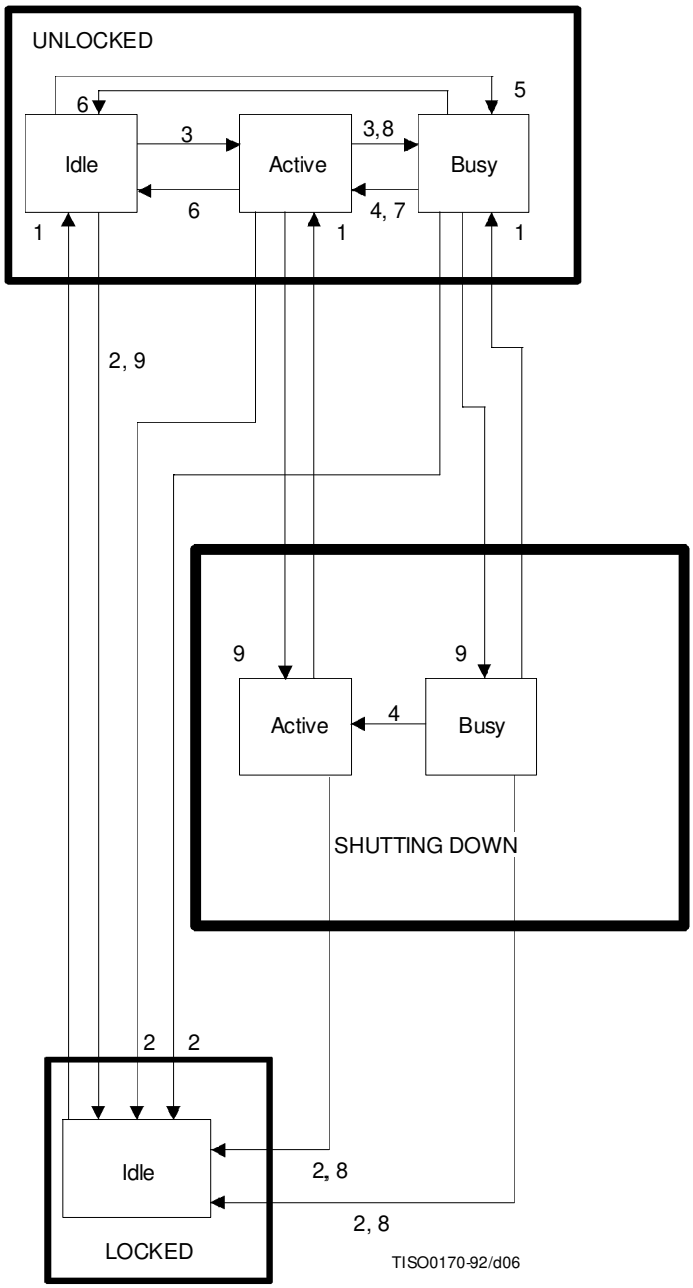
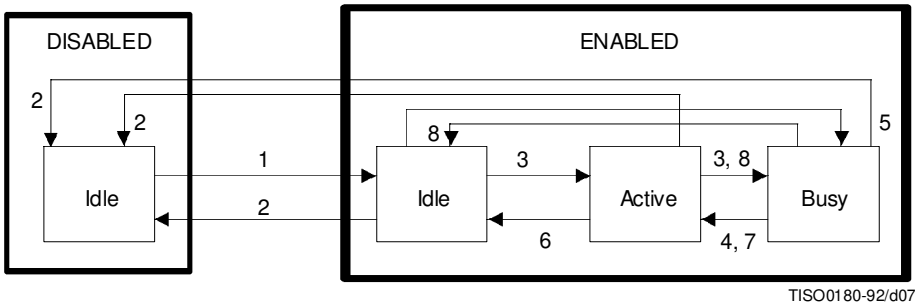


Figure 6 – Administrative and usage states



1 Enable
2 Disable
3 New user
4 User quit
5 New user (non-sharable resource)
6 Last user quit
7 Capacity increase
8 Capacity decrease

Figure 7 – Operational and usage states

7.2 Status attributes

Status attributes may contain more detailed information about other aspects of the state of the corresponding resource that may affect its operability and usage. They also contain more detailed information about the administrative constraints on its operation that are controlled by a manager. The status attributes are defined in 8.1.2.

7.3 Object class specific state information

Managed objects can have other class-specific attributes that describe aspects of a resource state but that do not map onto the generic states defined in this Recommendation | International Standard. Although separate, these attributes may affect the values of the generic state attributes. Each individual managed object class definition shall specify the applicable generic state values resulting from particular combinations of values of other attributes.

When a managed object is in the disabled operational state, other attributes may express the reason why the corresponding resource is inoperable. The disablement may or may not be related to processes under the control of management.

If the resource is inoperable because another resource on which it is dependent is administratively prohibited from use, or some other configured information is incompatible with operation, then the resource can be made operable through management procedures. The handling of information showing that a resource is inoperable because of some specific physical defect, and the method of repairing the defect, are outside the scope of the state management function.

If the state of a resource is dependent upon the state of another resource, the nature of the dependency may be specified in the behaviour of the managed object representing the dependent resource, or both. A state change in a supporting managed object can, through a relationship, cause a specific state transition in a dependent managed object.

8 Generic definitions

This clause specifies a set of generic attributes and notification and their applicable parameters and semantics.

8.1 Generic attributes

This Recommendation | International Standard defines the following specific management attributes, the abstract syntax of which is specified in CCITT Rec. X.721 | ISO/IEC 10165-2.

8.1.1 State attributes

The following state attributes are defined by this Recommendation | International Standard:

- administrative state;
- operational state;
- usage state.

8.1.1.1 Operational state attribute

The operational state attribute is single-valued and read-only. It can have one of the following values.

- disabled: The resource is totally inoperable and unable to provide service to the user(s).
- enabled: The resource is partially or fully operable and available for use.

See 8.1.2 for status attributes that may further qualify the above values of the operational state.

8.1.1.2 Usage state attribute

The usage state attribute is single-valued and read-only. It can have one of the following values, not all of which are applicable to every class of managed object:

- idle: The resource is not currently in use.
- active: The resource is in use, and has sufficient spare operating capacity to provide for additional users simultaneously.
- busy: The resource is in use, but it has no spare operating capacity to provide for additional users at this instant.

See 8.1.2 for status attributes that may further qualify the above values of the usage state.

8.1.1.3 Administrative state attribute

The administrative state attribute is single valued and read-write. It can have one of the following values, not all of which are applicable to every class of managed object:

- locked: The resource is administratively prohibited from performing services for its users.
- shutting down: Use of the resource is administratively permitted to existing instances of use only. While the system remains in the shutting down state the manager may at any time cause the managed object to revert to the unlocked state.
- unlocked: The resource is administratively permitted to perform services for its users. This is independent of its inherent operability.

See 8.1.2 for status attributes that may further qualify the above values of administrative state.

8.1.2 Status attributes

The status attributes are provided to qualify the operational, usage and/or administrative state attributes. The value of each status attribute may denote the presence of one or more particular conditions applicable to the resource. The presence of any one of these conditions may imply, directly or indirectly, some corresponding value in the operational state, usage state, or administrative state attributes, or in any combination of them. These implications are described separately for each status condition.

The following status attributes are defined by this Recommendation | International Standard:

a) alarm status;

b) procedural status;

c) availability status;

d) control status;

e) standby status;

f) unknown status.

8.1.2.1 Alarm status attribute

The alarm status attribute is set-valued and read-write. It can have zero or more of the following values, not all of which are applicable to every class of managed object.

When the value of this attribute is empty set, this implies that none of the status conditions described below are present.

- under repair: The resource is currently being repaired. When under repair value is present, the operational state is either disabled or enabled.

- critical: One or more critical alarms indicating a fault have been detected in the resource, and have not been cleared. The operational state of the managed object can be disabled or enabled.

- major: One or more major alarms indicating a fault have been detected in the resource, and have not yet been cleared. The operational state of the managed object can be disabled or enabled.

- minor: One or more minor alarms indicating a fault have been detected in the resource, and have not yet been cleared. The operational state of the managed object can be disabled or enabled.

- alarm outstanding: One or more alarms have been detected in the resource. The condition may or may not be disabling. If the operational state is enabled, additional attributes, particular to the managed object class, may indicate the nature and cause of the condition and the services that are affected.

The presence of the above alarm state conditions do not suppress the generation of future fault related notifications.

NOTE – Alarm reports are defined in CCITT Rec. X.733 | ISO/IEC 10164-4.

8.1.2.2 Procedural status attribute

The procedural status attribute is supported only by those classes of managed objects that represent some procedure (e.g., a test process) which progresses through a sequence of phases. Depending upon the managed object class definition, the procedure may be required to reach certain phase for the resource to be operational and available for use (i.e. for the managed object to be enabled). Not all phases may be applicable to every class of managed object. If the value of this attribute is an empty set the managed object is ready, for example, the initialization is complete.

When the value of this attribute is empty set, this implies that none of the status conditions described below are present.

- initialization required: The resource requires initialization to be invoked by the manager before it can perform its normal functions, and this procedure has not been initiated. The manager may be able to invoke such initialization through an action. The terminating condition may also be present. The operational state is disabled.

- not initialized: The resource requires initialization before it can perform its normal functions, and this procedure has not been initiated. The resource initializes itself autonomously, but the operational state may be either disabled or enabled, depending upon the managed object class definition.

- initializing: The resource requires initialization before it can perform its normal functions, and this procedure has been initiated but is not yet complete. When this condition is present, the initialization required condition is absent, since initialization has already begun. The operational state may be disabled or enabled, depending upon the managed object class definition.

- reporting: The resource has completed some processing operation and is notifying the results of the operation, e.g., a test process is sending its results. the operational state is enabled.

- terminating: The resource is in a termination phase. If the resource does not reinitialize itself autonomously, the Initialization Required condition is also present and the operational state is disabled. Otherwise, the operational state may be either disabled or enabled, depending upon the managed object class definition.

8.1.2.3 Availability status attribute

The availability status attribute is set-valued and read-only. It can have zero or more of the following values, not all of which are applicable to every class of managed object.

When the value of this attribute is empty set, this implies that none of the status conditions described below are present.

- in test: The resource is undergoing a test procedure. If the administrative state is locked or shutting down then normal users are precluded from using the resource and the control status attribute has the value reserved for test. Tests that do not exclude additional users can be present in any operational or administrative state but the reserved for test condition should not be present.
- failed: The resource has an internal fault that prevents it from operating. The operational state is disabled.
- power off: The resource requires power to be applied and is not powered on. For example, a fuse or other protection device is known to have removed power or a low voltage condition has been detected. The operational state is disabled.
- off line: The resource requires a routine operation to be performed to place it online and make it available for use. The operation may be manual or automatic, or both. The operational state is disabled.
- off duty: The resource has been made inactive by an internal control process in accordance with a predetermined time schedule. Under normal conditions the control process can be expected to reactivate the resource at some scheduled time, and it is therefore considered to be optional. The operational state is enabled or disabled.
- dependency: The resource cannot operate because some other resource on which it depends is (i.e. a resource not represented by the same managed object) unavailable. For example, a device is not accessible because its controller is powered off. The operational state is disabled.
- degraded: The service available from the resource is degraded in some respect, such as in speed or operating capacity. Failure of a test or an unacceptable performance measurement has established that some or all services are not functional or are degraded due to the presence of a defect. However, the resource remains available for service, either because some services are satisfactory or because degraded service is preferable to no service at all. Object specific attributes may be defined to represent further information indicating, for example, which services are not functional and the nature of the degradation. The operational state is enabled.
- not installed: The resource represented by the managed object is not present, or is incomplete. For example, a plug-in module is missing, a cable is disconnected or a software module is not loaded. The operational state is disabled.
- log full: This indicates a log full condition the semantics of which are defined in CCITT Rec. X.735 | ISO/IEC 10164-6.

8.1.2.4 Control status attribute

The control status attribute is read-write and set-valued. It can have zero or more of the following values, not all of which are applicable to every class of managed object.

When the value of this attribute is empty set, this implies that none of the status conditions described below are present.

- subject to test: The resource is available to normal users, but tests may be conducted on it simultaneously at unpredictable times, which may cause it to exhibit unusual characteristics to users.
- part of services locked: This value indicates whether a manager has administratively restricted a particular part of a service from the user(s) of a resource. The administrative state is unlocked. Examples are incoming service barred, outgoing service barred, write locked by media key, read locked.
- reserved for test: The resource has been made administratively unavailable to normal users because it is undergoing a test procedure. The administrative state is locked.
- suspended: Service has been administratively suspended to the users of the resource. The resource may retain knowledge of current users and/or requests for usage, depending upon the managed object class definition, but does not resume performing services until the suspended condition is revoked. The administrative state in unlocked.

8.1.2.5 Standby status attribute

The standby status attribute is single-valued and read-only. It shall have one of the following values. The value is only meaningful when the back-up relationship role exists.

- hot standby: The resource is not providing service, but is operating in synchronism with another resource that is to be backed-up (e.g., a computer shadowing another computer). A resource with a hot standby status will be immediately able to take over the role of the resource to be backed-up, without the need for initialization activity, and will contain the same information as the resource to be backed up. The hot standby condition is mutually exclusive with the cold standby and providing service conditions.
- cold standby: The resource is to back-up another resource, but is not synchronized with that resource. A resource with a cold standby status will not be immediately able to take over the role of a resource to be backed up, and will require some initialization activity. The cold standby condition is mutually exclusive with the hot standby and providing service conditions.
- providing service: The back-up resource is providing service and is backing up another resource. The providing service condition is mutually exclusive with the hot standby and cold standby conditions.

NOTE – Back-up relationships are defined in CCITT Rec. X.732 | ISO/IEC 10164-3.

Table 1 illustrates the dependencies between the standby status attribute and the operational state, administrative state, procedural status and availability status attributes.

Table 1 – Standby status conditions

Standby status	Hot standby	Cold standby	Providing service
Operational state	Enabled	Enabled or disabled	Enabled
Administrative state	Unlocked	Unlocked or locked	Unlocked
Procedural status	–	Not initialized or initialization required	–
Availability status	Off line	Off line	On line

8.1.2.6 Unknown status attribute

The unknown status attribute is used to indicate that the state of the resource represented by the managed object is unknown. When the unknown status attribute value is true, the value of the state attributes may not reflect the actual state of the resource.

8.1.3 Generic attribute group

The following attribute group is defined by this Recommendation | International Standard:

state

8.1.3.1 State attribute group

The state attribute group is defined as an empty attribute group. It provides a means of referring to the collection of all state attributes of a managed object. The intent of the state attribute group is to contain the generic and specific state attributes of a managed object when included in the managed object class definition. When the state attribute is read, the set of attribute identifiers and values which are members of the state attribute group will be returned.

8.2 Generic notifications

The generic notification, parameters and semantics defined by this Recommendation | International Standard provide the detail for the following general parameters of the M-EVENT-REPORT service as defined by CCITT Rec. X.710 | ISO/IEC 9595:

- Event type;
- Event information;
- Event reply.

All notifications are potential entries in a systems management log and this Recommendation | International Standard defines one managed object class for this purpose. CCITT Rec. X.721 | ISO/IEC 10165-2 defines a generic event log record managed object class from which all entries are derived, the additional information being specified by the event information and event reply parameters.

8.2.1 Event type

This parameter defines the type of the event. The following event type is defined in this Recommendation | International Standard:

state change: This notification type is used to report the change in the value of one or more of the generic and/or specific state attributes of a managed object that result through either the internal operation of the resource or via management operation across the managed object boundary.

8.2.2 Event information

The following parameters constitute the notification specific event information.

8.2.2.1 Source indicator

This parameter, when present, indicates the source of the operation that led to the generation of this notification type. It can have one of the following values.

- resource operation: The notification was generated in response to a state attribute value change effected through the internal operation of the resource.
- management operation: The notification was generated in response to a state attribute value change effected through an SMI management operation applied across the managed object boundary external to the managed object.
- unknown: It is not possible to determine the source of the operation.

8.2.2.2 Attribute identifier list

This parameter, when present, identifies the set of state attributes whose value changes are being reported.

8.2.2.3 State change definition

This parameter set consists of a set of sequences of the three parameters: Attribute identifier, Old attribute value and New attribute value described below. Each individual sequence describes a single state attribute value change. At least one new state attribute value shall be present in this list.

8.2.2.3.1 Attribute identifier

This parameter identifies the state attribute whose value change is being reported.

8.2.2.3.2 Old attribute value

This parameter, when present, identifies the old value of the state attribute.

8.2.2.3.3 New attribute value

This parameter identifies the current value of the state attribute.

8.2.2.4 Other information

The following parameters are also utilised. These parameters are defined by CCITT Rec. X.733 | ISO/IEC 10164-4:

- Additional information;
- Additional text;
- Correlated notifications;
- Notification identifier.

8.2.3 Event reply

This Recommendation | International Standard does not specify information to be used in the Event reply parameter.

8.3 Managed objects

A state change record is a managed object class derived from the event log record object class defined in CCITT Rec. X.735 | ISO/IEC 10164-6. The state change record object class represents information stored in logs resulting from state change notification.

8.4 Compliance

Managed object class definitions support the function defined in this Recommendation | International Standard by incorporating the specification of the notification type and/or of the state attribute types defined in this Recommendation | International Standard through reference to the notification and/or attribute templates defined in CCITT Rec. X.721 | ISO/IEC 10165-2. The reference mechanism is defined in CCITT Rec. X.722 | ISO/IEC 10165-4.

The definition of the managed object class shall, for each imported notification, specify in the behaviour clause which of the optional and conditional parameters are to be utilized and any further restrictions on their use and their values. It is permissible to state that the use of a parameter remains optional.

The managed object class definitions may import one or more of the state attribute types defined in this Recommendation | International Standard. For each imported state attribute the managed object class definition shall state any further restrictions on the use and the values of the attribute.

9 Service definition

9.1 Introduction

This Recommendation | International Standard defines one service which is identified below together with the appropriate parameters.

9.1.1 State Change Reporting service

This service allows an MIS-User, in the agent role, to report the changes in the values of managed object state attributes. It is defined both as a confirmed and as a non-confirmed service.

The state change reporting service uses the parameters defined in clause 8 in addition to the general M-EVENT-REPORT service parameters defined in CCITT Rec. X.710 | ISO/IEC 9595. Table 2 lists the parameters for the state change reporting service.

The Event time, Correlated notifications and Notification identifier parameters may be assigned by the object emitting the notification or by the managed system.

Table 2 – State change reporting parameters

Parameter name	Req/Ind	Rsp/Conf
Invoke identifier	P	P
Mode	P	–
Managed object class	P	P
Managed object instance	P	P
Event type	M	C(=)
Event time	P	–
Event information		
Source indicator	U	–
Attribute identifier list	U	–
State change definition		
Attribute identifier	M	–
Old attribute value	U	–
New attribute value	M	–
Notification identifier	U	–
Correlated notifications	U	–
Additional text	U	–
Additional information	U	–
Current time	–	P
Event reply	–	–
Errors	–	P

9.2 Management of state attributes

This Recommendation | International Standard uses the pass-through services of CCITT Rec. X.730 | ISO/IEC 10164-1 for managing the state attributes of managed objects.

10 Functional units

The State Change Reporting service constitutes a single systems management functional unit.

11 Protocol

11.1 Elements of procedure

11.1.1 Agent role

11.1.1.1 Invocation

The state change reporting procedures are initiated by the state change reporting request primitive. On receipt of a state change reporting request primitive, the SMAPM shall construct an MAPDU and issue a CMIS M-EVENT-REPORT request service primitive with parameters derived from the state change reporting request primitive. In the non-confirmed mode, the procedure in 11.1.1.1.2 does not apply.

11.1.1.2 Receipt of response

On receipt of a CMIS M-EVENT-REPORT confirm primitive containing an MAPDU responding to a state change reporting notification, the SMAPM shall issue a state change reporting confirmation primitive to the reporting service user with parameters derived from the CMIS M-EVENT-REPORT confirm service primitive, thus completing the state change reporting procedure.

NOTE – The SMAPM ignores all errors in the received MAPDU. The State Change Reporting service user may ignore such errors, or abort the association as a consequence of such errors.

11.1.2 Manager role

11.1.2.1 Receipt of request

On receipt of a CMIS M-EVENT-REPORT indication service primitive containing an MAPDU requesting the State Change Reporting service, the SMAPM shall, if the MAPDU is well formed, issue a state change reporting indication primitive to the reporting service user with the parameters derived from the CMIS M-EVENT-REPORT response service primitive. Otherwise, the SMAPM shall in the confirmed mode construct an appropriate MAPDU containing notification of the error, and shall issue a CMIS M-EVENT-REPORT response service primitive with an error parameter present. In the non-confirmed mode, the procedure in 11.1.1.2.2 does not apply.

11.1.2.2 Response

In the confirmed mode, the SMAPM shall accept a state change reporting response primitive and shall construct an MAPDU confirming the notification and issue a CMIS M-EVENT-REPORT response primitive with parameters derived from the state change reporting response primitive.

11.2 Abstract syntax

11.2.1 Managed objects

This Recommendation | International Standard references the following management support object, the abstract syntax of which is specified in CCITT Rec. X.721 | ISO/IEC 10165-2:

stateChangeRecord

11.2.2 Attributes

This Recommendation | International Standard references the following management attributes, the abstract syntax of which is specified in CCITT Rec. X.721 | ISO/IEC 10165-2:

a) administrativeState;

b) alarmStatus;

c) availabilityStatus;

d) controlStatus;

e) operationalState;

f) proceduralStatus;

g) standbyStatus;

h) unknownStatus;

i) usageState.

11.2.3 Parameter to attribute mapping

Table 3 identifies the relationship between the parameters defined in 8.2 and the attributes type specifications in CCITT Rec. X.721 | ISO/IEC 10165-2.

Table 3 – Parameter to attribute mapping

Parameter	Attribute Name
Source indicator	sourceIndicator
Attribute identifier list	attributeIdentifierList
State change definition	stateChangeDefinition

11.2.4 Attribute group

This Recommendation | International Standard references the following state attribute group, the abstract syntax of which is specified in CCITT Rec. X.721 | ISO/IEC 10165-2:

state

11.2.5 Actions

There are no specific actions defined by this Recommendation | International Standard.

11.2.6 Notifications

Table 4 identifies the relationship between the notification defined in 8.1 and the notification type specification in CCITT Rec. X.721 | ISO/IEC 10165-2.

Table 4 – Notifications

Event type	Notification type
State change	stateChange

11.3 Negotiation of functional units

This Recommendation | International Standard assigns the following object identifier value:

{joint-iso-ccitt ms(9) function(2) part2(2) functionalUnitPackage(1)}

as a value of ASN.1 type FunctionalUnitPackageId defined in CCITT Rec. X.701 | ISO/IEC 10040 for negotiating the availability of the following functional unit

0 state change reporting

where the number identifies the bit position assigned to the functional unit as defined in clause 10.

Within the Systems management application context, the mechanism for negotiating functional units is described by CCITT Rec. X.701 | ISO/IEC 10040.

NOTE – The requirement to negotiate functional units is specified by the application context.

12 Relationships with other functions

Control of the state change reporting service defined in this Recommendation | International Standard is provided by mechanisms specified in CCITT Rec. X.734 | ISO/IEC 10164-5. The state change reporting service may exist independently of the control mechanisms of CCITT Rec. X.734 | ISO/IEC 10164-5.

When performing an operation on a state attribute, this Recommendation | International Standard utilises the PT-GET and PT-SET services defined in the CCITT Rec. X.730 | ISO/IEC 10164-1.

13 Conformance

There are two conformance classes: general conformance class and dependent conformance class. A system claiming to implement the elements of procedure for the State Change Reporting service defined in this Recommendation | International Standard shall comply with the requirements for either the general or the dependent conformance class as defined in the following sub-clauses. The supplier of the implementation shall state the class to which conformance is claimed.

13.1 General conformance class requirements

A system claiming general conformance to this Recommendation | International Standard shall support this systems management function for all managed object classes that import the management information defined by this Recommendation | International Standard.

13.1.1 Static conformance

The system shall

a) support the role of manager, agent or both, with respect to the state change reporting functional unit;

b) support the transfer syntax derived from the encoding rules specified in CCITT Rec. X.209 | ISO/IEC 8825 named {joint-iso-ccitt ans1(1) basic encoding(1)}, for the purpose of generating and interpreting the MAPDUs, defined by the abstract data types referenced in 11.2.2, 11.2.4 and 11.2.6 of this Recommendation | International Standard.

13.1.2 Dynamic conformance

The system shall, in the role(s) for which conformance is claimed,

a) support the elements of procedure defined in CCITT Rec. X.730 | ISO/IEC 10164-1 for the PT-GET and the PT-SET services; and

b) support the elements of procedure defined in this Recommendation | International Standard for the state change reporting service.

13.2 Dependent conformance class requirements

13.2.1 Static conformance

The system shall

a) supply a System Conformance Statement which identifies the standardized use of this systems management function;

b) support the transfer syntax derived from the encoding rules specified in CCITT Rec. X.209 | ISO/IEC 8825 and named {joint-iso-ccitt asn1(1) basic encoding(1)}, for the purpose of generating and interpreting the MAPDUs, defined by the abstract data types referenced in 11.2.2, 11.2.4 and 11.2.6 of this Recommendation | International Standard, as required by a Standard use of this systems management function.

13.2.2 Dynamic conformance

The system shall support the element of procedure defined in, or referenced by, this Recommendation | International Standard, as required by a standardized use of this systems management function.