

INTERNATIONAL STANDARD

ISO/IEC 10164-17

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Information technology — Open Systems Interconnection — Systems Management: Change over function

*Technologies de l'information — Interconnexion de systèmes ouverts
(OSI) — Gestion-systèmes: Fonction de changement*

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Foreword

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

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

International Standard ISO/IEC 10164-17 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.751.

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

- *Part 1: Object management function*
- *Part 2: State Management function*
- *Part 3: Attributes for representing relationships*
- *Part 4: Alarm reporting function*
- *Part 5: Event report management function*
- *Part 6: Log control function*
- *Part 7: Security alarm reporting function*
- *Part 8: Security audit trail function*
- *Part 9: Objects and attributes for access control*
- *Part 10: Usage metering function for accounting purposes*
- *Part 11: Metric objects and attributes*
- *Part 12: Test management function*
- *Part 13: Summarization function*
- *Part 14: Confidence and diagnostic test categories*
- *Part 15: Scheduling function*
- *Part 16: Management knowledge management function*
- *Part 17: Change over function*
- *Part 18: Software management function*
- *Part 19: Management domain and Management policy management functions*

Annexes A to G form an integral part of this part of ISO/IEC 10164. Annex H is for information only.

Introduction

This Recommendation | International Standard is developed according to ITU-T Rec. X.200 | ISO/IEC 7498-1 and ITU-T Rec. X.700 | ISO/IEC 7498-4. This Recommendation | International Standard is related to the following Recommendations | International Standards:

- CCITT Rec. 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 Rec. X.711 (1991), *Common management information protocol specification for CCITT applications*.
ISO/IEC 9596-1:1991, *Information technology – Open Systems Interconnection – Common management information protocol – Part 1: Specification*.
- CCITT Rec. X.701 (1992) | ISO/IEC 10040:1992, *Information technology – Open Systems Interconnection – Systems management overview*.
- CCITT Rec. X.720-Series | ISO/IEC 10165, *Information technology – Open Systems Interconnection – Structure of management information*.

OSI management standardization inevitably involves coordinated work by a number of standards bodies. ITU-T SG 7 and ISO/IEC JTC1/SC21/WG4 are jointly responsible for the development of Recommendations | International Standards that describe the architecture for OSI management, the services, protocols and functions that are used for systems management, and the structure of management information. Other groups, in ITU-T, ISO/IEC JTC1/SC21, ISO/IEC JTC1/SC6 and elsewhere, are responsible for the development of Recommendations | International Standards that describe the management aspects of particular layers of the OSI Basic Reference Model; these may describe (N)-layer management protocols, management aspects of (N)-layer operation, and managed objects that provide a “management view” of aspects of the layer operation and are visible to systems management.

INTERNATIONAL STANDARD

ITU-T RECOMMENDATION

INFORMATION TECHNOLOGY – OPEN SYSTEMS INTERCONNECTION – SYSTEMS MANAGEMENT: CHANGE OVER FUNCTION

1 Scope

This Recommendation | International Standard defines a systems management function which may be used by an application 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 services for managing one to one back-up relationships and specifies a set of generic definitions. It is positioned in the application layer of ITU-T Rec. X.200 | ISO/IEC 7498-1 and is defined according to the model provided by ITU-T Rec. X.207 | 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 service definition needed to support the change over function;
- establishes models that relate the service provided by the function to the user requirements;
- defines the services provided by the function;
- defines a managed relationship class documented in accordance with ITU-T Rec. X.725 | ISO/IEC 10165-7;
- defines managed object classes and associated management information 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;
- specifies the conformance requirements;
- specifies the ICS proforma for this function documented in accordance with ITU-T Rec. X.724 | ISO/IEC 10165-6 and ITU-T Rec. X.725 | ISO/IEC 10165-7.

This Recommendation | International Standard does not:

- define the nature of any implementation intended to provide this function;
- specify the manner in which management is accomplished by the user of this function;
- define the nature of any interactions that result in the use of this function;
- specify the services necessary for the establishment, normal and abnormal release of a management association;
- define relationship mappings that are dependent on the implementation of this function.

2 Normative references

The following Recommendations and International Standards contain provisions which, through reference in this text, constitute provisions of this Recommendation and International Standard. At the time of publication, the editions indicated were valid. All Recommendations and International Standards are subject to revision, and parties to agreements based on this Recommendation | International Standard are encouraged to investigate the possibility of applying the most recent edition of the Recommendations and International Standards listed below. Members of IEC and ISO maintain registers of currently valid International Standards. The Telecommunications Standardization Bureau of the ITU maintains a list of currently valid CCITT and ITU-T Recommendations.

2.1 Identical Recommendations | International Standards

- ITU-T Recommendation X.200 (1994) | ISO/IEC 7498-1:1994, *Information technology – Open Systems Interconnection – Basic Reference Model: The Basic Model.*
- ITU-T Recommendation X.207 (1993) | ISO/IEC 9545:1994, *Information technology – Open Systems Interconnection – Application Layer structure.*
- ITU-T Recommendation X.210 (1993) | ISO/IEC 10731:1994, *Information technology – Open Systems Interconnection – Basic Reference Model – Conventions for the definition of OSI services.*
- CCITT Recommendation X.701 (1992) | ISO/IEC 10040:1992, *Information technology – Open Systems Interconnection – Systems management overview.*
- CCITT Recommendation X.720 (1992) | ISO/IEC 10165-1:1993, *Information technology – Open Systems Interconnection – Structure of management information: Management Information Model.*
- CCITT Recommendation X.721 (1992) | ISO/IEC 10165-2:1992, *Information technology – Open Systems Interconnection – Structure of management information: Definition of management information.*
- CCITT Recommendation X.722 (1992) | ISO/IEC 10165-4:1992, *Information technology – Open Systems Interconnection – Structure of management information: Guidelines for the definition of managed objects.*
- ITU-T Recommendation X.724 (1993) | ISO/IEC 10165-6:1994, *Information technology – Open Systems Interconnection – Structure of management information: Requirements and guidelines for implementation conformance statement proformas associated with OSI management.*
- ITU-T Recommendation X.725 (1995) | ISO/IEC 10165-7...¹⁾, *Information technology – Open Systems Interconnection – Structure of management information: General Relationship Model.*
- CCITT Recommendation X.730 (1992) | ISO/IEC 10164-1:1993, *Information technology – Open Systems Interconnection – Systems management: Object management function.*
- CCITT Recommendation X.731 (1992) | ISO/IEC 10164-2:1993, *Information technology – Open Systems Interconnection – Systems management: State management function.*
- CCITT Recommendation X.732 (1992) | ISO/IEC 10164-3:1993 *Information technology – Open Systems Interconnection – Systems management: Attributes for representing relationships.*
- CCITT Recommendation X.734 (1992) | ISO/IEC 10164-5:1993, *Information technology – Open Systems Interconnection – Systems management: Event report management function.*

2.2 Paired Recommendations | International Standards

- CCITT Recommendation X.209 (1988), *Specification of basic encoding rules for Abstract Syntax Notation One (ASN.1).*
ISO/IEC 8825:1990, *Information technology – Open Systems Interconnection – Specification of Basic Encoding Rules for Abstract Syntax Notation One (ASN.1).*
- ITU-T Recommendation X.290 (1995), *OSI conformance testing methodology and framework for protocol Recommendations for ITU-T applications – General concepts.*
ISO/IEC 9646-1:1994, *Information technology – Open Systems Interconnection – Conformance testing methodology and framework – Part 1: General concepts.*
- ITU-T Recommendation X.291 (1995), *OSI conformance testing methodology and framework for protocol Recommendations for ITU-T applications – Abstract test suite specification.*
ISO/IEC 9646-2:1994, *Information technology – Open Systems Interconnection – Conformance testing methodology and framework – Part 2: Abstract Test Suite specification.*
- ITU-T Recommendation X.296 (1995), *OSI conformance testing methodology and framework for protocol Recommendations for ITU-T applications – Implementation conformance statements.*
ISO/IEC 9646-7:1995, *Information technology – Open Systems Interconnection – Conformance testing methodology and framework – Part 7: Implementation Conformance Statements.*

¹⁾ To be published.

- CCITT Recommendation X.700 (1992), *Management framework for Open Systems Interconnection (OSI) for CCITT applications.*
ISO/IEC 7498-4:1989, *Information processing systems – Open Systems Interconnection – Basic Reference Model – Part 4: Management framework.*
- CCITT Recommendation X.710 (1991), *Common management information service definition for CCITT applications.*
ISO/IEC 9595:1991, *Information technology – Open Systems Interconnection – Common management information service definition.*

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 term defined in ITU-T Rec. X.200 | ISO/IEC 7498-1:

- systems management.

3.2 Service convention definitions

This Recommendation | International Standard makes use of the following term defined in ITU-T Rec. X.210 | ISO/IEC 10731:

- primitive.

3.3 Management framework definitions

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

- managed object.

3.4 Systems management overview definitions

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

- a) managed object class;
- b) Managed Object Conformance Statement (MOCS);
- c) Management Information Conformance Statement (MICS);
- d) MICS proforma;
- e) MOCS proforma;
- f) MIS-User;
- g) notification;
- h) (systems management) operation.

3.5 Common management information service definitions

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

- attribute.

3.6 Management information model definitions

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

- a) behaviour;
- b) characteristic;
- c) inheritance;
- d) invariant;
- e) post-condition;
- f) pre-condition;
- g) specialization;
- h) subclass;
- i) superclass;
- j) packages.

3.7 OSI conformance testing definitions

This Recommendation | International Standard makes use of the following terms as defined in ITU-T Rec. X.290 | ISO/IEC 9646-1.

- a) system conformance statement;
- b) PICS proforma;
- c) protocol implementation conformance statement.

3.8 Implementation conformance statement proforma definitions

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

- a) Managed Relationship Conformance Statement (MRCS);
- b) Management Conformance Summary (MCS);
- c) Management Information Definition Statement (MIDS) proforma;
- d) MCS proforma;
- e) MRCS proforma.

3.9 Attributes for representing relationships definitions

This Recommendation | International Standard makes use of the following terms as defined in CCITT Rec. X.732 | ISO/IEC 10164-3:

- a) fallback relationships;
- b) back-up relationships.

3.10 General relationship model definitions

This Recommendation | International Standard makes use of the following terms as defined in ITU-T Rec. X.725 | ISO/IEC 10165-7:

- a) managed relationship;
- b) managed relationship class;
- c) relationship cardinality;

- d) role;
- e) role cardinality;
- f) role cardinality constraint.

3.11 Additional definitions

3.11.1 change over relationship: A managed relationship that can control a managed object to back up another managed object and to terminate this back-up.

3.11.2 change over action: A management operation that causes a managed object to back up another managed object.

3.11.3 change back action: A management operation that causes a managed object backing up another managed object to terminate the back-up.

4 Symbols and abbreviations

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

ASN.1	Abstract Syntax Notation One
CMIS	Common Management Information Service
CMISE	Common Management Information Service Element
Cnf	Confirm
ICS	Implementation Conformance Statement
Ind	Indication
MAPDU	Management Application Protocol Data Unit
MCS	Management Conformance Summary
MICS	Management Information Conformance Statement
MIDS	Management Information Definition Statement
MOCS	Managed Object Conformance Statement
MRCS	Managed Relationship Conformance Statement
PICS	Protocol Implementation Conformance Statement
Req	Request
Rsp	Response
SMAPM	Systems Management Application Protocol Machine

5 Conventions

This Recommendation | International Standard defines services for establishing and terminating change over relationship following the descriptive conventions defined in ITU-T Rec. X.210 | ISO/IEC 10731.

The following notation is used in this Recommendation | International Standard service parameter tables:

- 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

6 Requirements

There is a requirement:

- to standardize the management where the change over relationship is manageable;
- to provide for the identification of the change over relationship;
- to allow a managing system to control the change over relationship;
- to provide for control of the provision of the change over relationship.

7 Model

7.1 Change over relationship

The change over relationship is a composition of the fallback and back-up relationships described in CCITT Rec. X.732 | ISO/IEC 10164-3 that allow one managed object to back up another managed object and to release this back-up. A managed object participating in this relationship with back-up control functionality can initiate the back-up as a result of receiving a change over action and can release the back-up as a result of receiving a change back action.

7.1.1 Composition of fallback and back-up relationships

CCITT Rec. X.732 | ISO/IEC 10164-3 defines two types of relationships: fallback and back-up. As described in CCITT Rec. X.732 | ISO/IEC 10164-3, it is assumed that managed objects subject to back-up control are participating in a fallback relationship. When a managed object is backed up by another managed object, a back-up relationship is established. When the managed object is released from the back-up, the back-up relationship is terminated.

Resources are often configured to provide *back-up capability* to achieve availability goals. A *primary* resource may have one or more designated *secondary* resources, which can provide back-up capability for the primary resource. The back-up capability can be provided, for example, when the primary resource is administratively prohibited from use (i.e. the administrative state is locked) or when it becomes inoperable (i.e. the operational state is disabled).

A secondary resource that is able to provide back-up capability for a primary resource, without the need for initialization activity is defined as being in a *hot standby state*. A secondary resource that requires initialization activity before it can provide back-up capability is defined as being in a *cold standby state*.

The potential to provide back-up capability is represented by the *fallback* relationship. The primary object represents the resource that is to be *backed up*; the secondary object represents the resource that can provide *back-up* capability.

The fallback relationship may be one-way. A primary object could have an attribute that lists its secondary objects, but the secondary objects need not “point back” to the primary object. Similarly, a secondary object could have an attribute that lists its primary objects, but the primary objects need not point back to the secondary object. In some cases, neither the primary object nor the secondary object may have the knowledge of when back-up capability should be provided. A third object is needed that can be requested to establish the back-up relationship.

Considering that the existence of a fallback relationship is the precondition for establishing a back-up relationship, the change over relationship is defined as the composition of the fallback and back-up relationships.

7.1.2 Roles in change over relationship

A managed object being backed up participates in the primary role of the change over relationship and a managed object doing back-up participates in the secondary role of the relationship. These roles are characterized by the following managed object classes,

- primary-backed-up managed object class; and
- secondary-back-up managed object class, respectively.

Any other managed object class that is compatible with the above object classes could participate in the corresponding role.

A managed object in the primary role may have the secondary attribute containing names of managed objects (one of which does back-up). A managed object in the secondary role may have the primary attribute containing names of managed objects (one of which is backed-up). The role cardinality of primary role and secondary roles are (1..1) and (1..n), respectively. The relationship cardinality of primary role and secondary role are (1..1) and (1..n), respectively.

A backed-up managed object participates in the backed-up role, a back-up managed object participates in the back-up role, and a managed object controlling this back-up participates in the change over control role. These roles are characterized by the following compatible managed object classes:

- primary-backed-up managed object class;
- secondary-back-up managed object class; and
- change over control object class.

A managed object in the backed-up role may have the back-up object attribute to contain the name of a managed object which participates in the back-up role of this relationship. A managed object in the back-up role may have the backed-up object attribute to contain the name of a managed object which participates in the backed-up role of this relationship. A managed object in the backed-up role must fulfill the primary role while a managed object in the back-up role must fulfill the secondary role. The role cardinality of both the back-up and the backed-up roles is (0..1). The relationship cardinality of both the back-up and the backed-up roles is (0..1). When the role cardinalities of both the back-up and backed-up roles have the value of "0", it implies that this relationship is not backing up. The role cardinality of the change over control role is (1..1) and its relationship cardinality is constrained to (1..1) in order to avoid complexity of this model.

Figure 1 depicts the change over relationship among managed objects participating in the roles. Only a managed object in the primary role can participate in the backed-up role, while any of the managed objects in the secondary role can participate in the back-up role. The managed object in the change over control role is coordinating the change over relationship. Object entry to the backed-up and back-up roles and object departure from backed-up and back-up roles are controlled by the managed object in the change over control role. A managed object in the change over control role may also participate in other roles in the relationship.

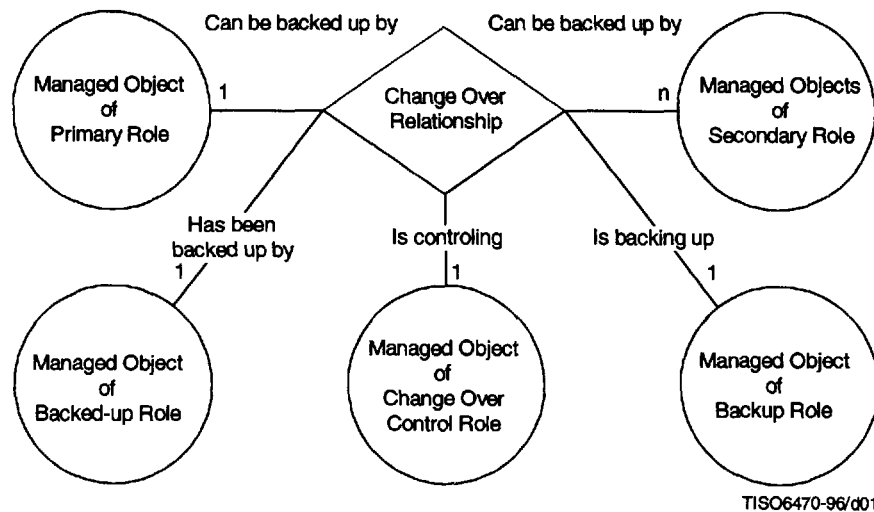


Figure 1 – Change over relationship among managed objects

7.1.3 Attributes in change over relationship

The following attributes are used to represent the change over relationship in compatible managed objects characterizing roles of the relationship: 1) - 4) are defined in CCITT Rec. X.732 | ISO/IEC 10164-3.

- 1) **Primary Attribute:** This attribute lists the prioritized object instances which are primary objects from a managed object in the secondary role. Each value in this attribute list represents a distinct change over relationship instance (i.e. the relationship cardinality for a secondary object is the number of values in this list).
- 2) **Secondary Attribute:** This attribute lists the prioritized object instances which are secondary objects from a managed object in the primary role.
- 3) **Backed-up Object Attribute:** This attribute indicates the managed object which is backing up the managed object in the backed-up role. This attribute takes the value "NULL" or the name of an object instance.

- 4) *Back-up Object Attribute*: This attribute indicates the managed object which is backed up by the managed object in the back-up role. This attribute takes the value "NULL" or the name of an object instance.
- 5) *Primary Object Attribute*: This attribute indicates the managed object subject to change over control in the managed object in the change over control role. This attribute always takes the name of an object instance.

7.2 Conditions over the change over relationship

The change over relationship handles the nine possible combinations of one-way and reciprocal relationships of the fallback and back-up relationships as described in CCITT Rec. X.732 | ISO/IEC 10164-3. Table 1 indicates the possible relationship combinations. The attributes supported by role participants vary depending on combinations indicated in Table 1.

Table 1 – Possible combinations in the change over relationship

		Fallback relationship		
		Primary to secondary one-way	Secondary to primary one-way	Reciprocal
Back-up relationship	Backed-up to back-up one-way	Type 1	Type 4	Type 7
	Back-up to backed-up one-way	Type 2	Type 5	Type 8
	Reciprocal	Type 3	Type 6	Type 9

Table 2 depicts the requirements for participants to support the change over relationship related attributes. For each combination type, the participants fulfilling a role in the change over relationship must have the attributes indicated in the corresponding cell of the table.

Table 2 – Attribute support requirements for role participants

Combination type	Primary role	Secondary role	Backed-up role	Back-up role	Control role
1	Ss	–	B	–	P
2	Ss	–	–	Bd	P, B
3	Ss	–	B	Bd	P
4	–	Ps	B	–	P, Ss
5	–	Ps	–	Bd	P, B, Ss
6	–	Ps	B	Bd	P, Ss
7	Ss	Ps	B	–	P
8	Ss	Ps	–	Bd	P, B
9	Ss	Ps	B	Bd	P
Ss Secondary Attribute Ps Primary Attribute B Back-up Object Attribute Bd Backed-up Object Attribute P Primary Object Attribute					

Table 3 indicates the attributes being supported by the compatible managed object class and whether the managed object in the primary role or the secondary role can also participate in the change over control role. Accordingly, when the fallback relationship is reciprocal or one-way from the primary to the secondary and the back-up relationship is reciprocal or one-way from backed-up to back-up, the managed object in the primary role is allowed to participate in the change over control role by fulfilling the role requirements. When the fallback relationship is reciprocal or one-way from the secondary to the primary and the back-up relationship is reciprocal or one-way from the back-up to the backed-up, the managed object in the secondary role is allowed to participate in the change over control role by fulfilling the role requirements.

Table 3 – Attribute support requirements for compatible object classes

Combination type	Primary-Backed-up Object	Secondary-Back-up Object	Control Object	Control role participation
1	Ss, B	–	P	Primary participant
2	Ss	Bd	P, B	–
3	Ss, B	Bd	P	Primary participant
4	B	Ps	P, Ss	–
5	–	Ps, Bd	P, B, Ss	Secondary participant
6	B	Ps, Bd	P, Ss	Secondary participant
7	Ss, B	Ps	P	Primary participant
8	Ss	Ps, Bd	P, B	Secondary participant
9	Ss, B	Ps, Bd	P	Primary participant Secondary participant
Ss Secondary Attribute B Back-up Object Attribute Bd Backed-up Object Attribute Ps Primary Attribute P Primary Object Attribute				

7.3 Change over operations

7.3.1 Change over operations for change over relationship

7.3.1.1 Change over action

An MIS-User can request that back-up capability be provided via the *change over* action. This operation is directed to a managed object in the change over control role. The managed object participating in the change over control role must verify that the preconditions of the change over action are met, perform any necessary initialization activity, and ensure that the postconditions of the change over action will be met.

The change over action can be requested only in the confirmed mode. It has the following parameters:

- **primary:** The managed object that is in the primary role. This is the managed object that is to be backed up. This argument must be specified to confirm the managed object to be backed up. The managed object specified by this argument must be bound in the primary role. In addition, this parameter specifies any further changes that are to be made to the attributes of the specified managed object as part of the change over action as it assumes the backed-up object role.
- **secondary:** The managed object that is in the secondary role. If this argument is present, the specified object must be bound to the secondary role of the relationship with the primary resource. If this argument is not present, a managed object will be selected according to the priorities for objects in the secondary role, as specified in the “secondary” attribute in the object in the primary role or change over control role. In addition, this parameter specifies any further changes that are to be made to the attributes of the specified object as part of the change over action as it assumes the back-up role.

7.3.1.2 Change back action

An MIS-User can request that back-up capability be terminated via the change back action. This action is directed to the managed object participating in the change over control role. The managed object in the change over control role must verify that the preconditions of the change back action are met and perform any necessary initialization activity, ensuring that the postconditions of the change back action will be met.

The change back action can be requested only in the confirmed mode. It has the following parameters:

- **backedUpObject:** The managed object that is participating in the backed-up role. This argument must be specified. In addition, this parameter specifies any changes that are to be made to the attributes of the backed-up object as part of the change back action as it leaves the backed-up role.
- **backUpObject:** The managed object that is acting in the back-up role. This argument is optional. In addition, this parameter specifies any further changes that are to be made to the attributes of the back-up object as part of the change back action as it leaves the back-up role.

7.3.2 Change over function model

Figure 2 depicts a change over function model. The change over and change back actions are directed to the managed object compatible with the change over control managed object. The managed object compatible with the primary-backed-up managed object can fulfill the primary role and the backed-up role of the relationship. Managed objects compatible with the secondary-back-up managed object can fulfill the secondary role, any one of which can fulfill the back-up role. The managed object fulfills the back-up role back-ups the managed object of the primary role as a result of a change over action. The managed object fulfilling the back-up role terminates back-up of the managed object in the backed-up role as the result of a change back action.

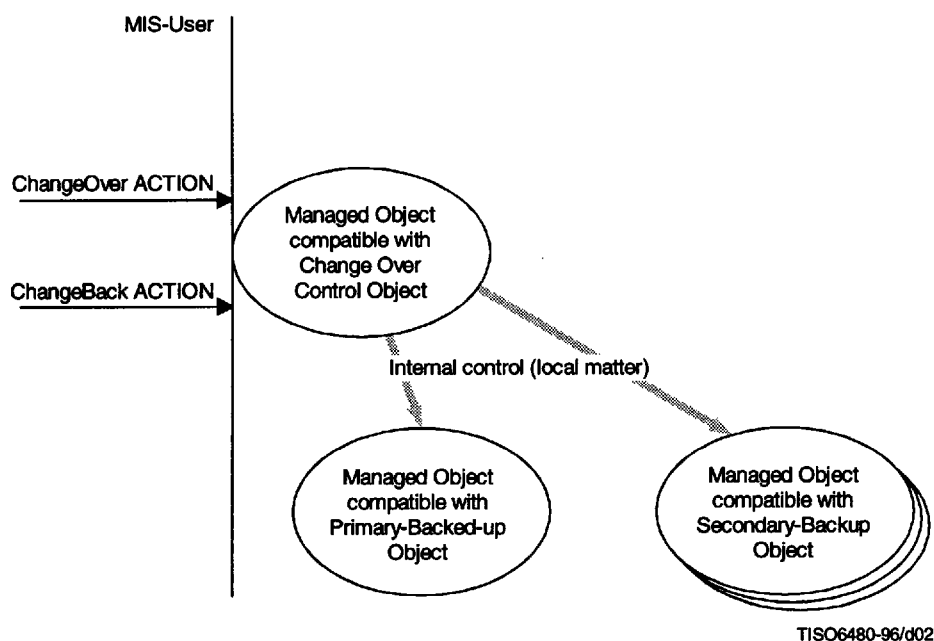


Figure 2 – Change over function model

Change over functions use instances of the change over relationship to perform the back-up. The following are relationship operations for the change over relationship.

ESTABLISH operation establishes an instance of the change over relationship. It does not have any preconditions. The postconditions of ESTABLISH operation are the existence of one managed object in the primary role, one managed object in the change over control and at least one managed object in the secondary role.

BIND to back-up role or **BIND** to backed-up role operation establishes the back-up. The preconditions of this relationship operation are that no object is fulfilling the back-up and backed-up roles, the managed object to be backed up fulfills the primary role and the managed object subject to back-up fulfills the secondary role. The postconditions of this relationship operation are that one managed object fulfills both the backed-up and secondary roles and another managed object fulfills both the back-up and secondary roles.

UNBIND from back-up role or **UNBIND** from backed-up role operation releases the back-up. The preconditions of this relationship operation are that one object is fulfilling the back-up role and one object is fulfilling the backed-up role. The postconditions of this relationship operation are that no object is fulfilling the back-up and backed-up roles.

BIND to secondary role operation binds at least one managed object to the secondary role. It does not have any preconditions. The postconditions of this relationship operation are that the number of managed objects fulfilling the secondary role is increased by at least one.

UNBIND from secondary role operation unbinds at least one managed object from the secondary role. The preconditions of this relationship operation are that at least two managed objects are participating in the secondary role. The postconditions of this relationship operation are that the unbound managed object does not exist in the secondary role and that at least one participant exists in the secondary role.

TERMINATE operation deletes an instance of change over relationship. It does not have any preconditions. The postconditions of this relationship operation are that the existence of the relationship instance ends.

The change over action defined in the change over control managed object class can be mapped to “**BIND** to backed-up” or “**BIND** to back-up” relationship operations.

The change back action conditionally defined in the change over control managed object class can be mapped to “**UNBIND** from backed-up” or “**UNBIND** from back-up” relationship operations.

8 Generic definitions

8.1 Management information required for change over function

To define management information for the change over function, a managed relationship, managed objects, packages, attributes and management actions are defined.

8.2 Managed relationship classes

8.2.1 Change over managed relationship class

8.2.1.1 Relationship description

The change over relationship is the composition of the fallback relationship and the back-up relationship and provides the back-up control function that makes a managed object that is fallbacked by one or more managed objects to be backed up by one of the fallbacking managed object based upon receiving the change over operation. The semantics of the fallback relationship and the back-up relationship is used to describe this relationship.

The semantics of fallback relationship is defined in 7.3.3 of CCITT Rec. X.732 | ISO/IEC 10164-3, as follows:

“A fallback relationship is an asymmetric relationship denoting that the second of a pair of managed objects (the secondary object) has been designated as a fallback or “next preferred choice” to the first managed object (the primary object). The existence of a fallback relationship implies that the secondary resource is capable of providing Back-up service to the primary resource if the latter is unable to fulfill its function. It does not necessarily imply that the secondary resource is currently active and performing its Back-up function in place of the primary resource.

Primary and secondary are two roles in a fallback relationship. A one-way fallback relationship exists if a managed object designates a second managed object to be in the secondary role, or if the second managed object designates the first managed object to be in the primary role. A reciprocal fallback relationship exists if both managed objects designate each other to be in the complementary roles.

The order of preference in which the secondary objects are selected to provide Back-up service to the primary object is expressed as a priority value attached to each secondary object.

The order of preference in which primary objects are selected for the provision of Back-up service by the secondary object is expressed as a priority value attached to each primary object."

The semantics of the back-up relationship is defined in 7.3.4 of CCITT Rec. X.732 | ISO/IEC 10164-3, as follows:

"A back-up relationship is an asymmetric relationship denoting that the second of a pair of managed objects (the back-up object) is currently active and performing a back-up function in place of the first managed object (the backed-up object).

Back-up object and backed-up object are two roles in a back-up relationship. A one-way back-up relationship exists if a managed object designates a second managed object to be in the back-up role, or if the second managed object designates the first managed object to be in the backed-up role. A reciprocal back-up relationship exists if both managed objects designate each other to be in the complementary roles.

A back-up relationship is created as a result of a pre-existing fallback relationship between two managed objects. The back-up relationship comes into existence when the backed-up resource is not fulfilling its function, and the back-up resource is activated to provide the same service. The back-up resource ceases to provide that service. Creation and deletion of the back-up relationship has no effect on the existence of the fallback relationship between the two managed objects.

A backed-up object may be in the disabled or enabled operational state. The administrative state of the back-up object must be unlocked to allow the back-up relationship to exist. When a managed object is being backed up for any reason (i.e. a back-up relationship exists), the back-up object is in use as long as it is not disabled. The operational and administrative states are defined in CCITT Rec. X.731 | ISO/IEC 10164-2."

The change over managed relationship class represents the managed change over relationship between managed object classes. This managed relationship class has the following roles:

- primary role;
- secondary role;
- backed-up role;
- back-up role;
- change over control role.

This managed relationship supports the following relationship management operations:

ESTABLISH operation establishes an instance of change over relationship. It does not have any preconditions. The postconditions of **ESTABLISH** operation are the existence of one managed object in the primary role, one managed object in the change over control and at least one managed object in the secondary role.

BIND to back-up role or BIND to backed-up role operation establishes the back-up. The preconditions of this relationship operation are that no object is fulfilling the back-up and backed-up roles, the managed object subject to be backed up fulfills the primary role and the managed object subject to back-up fulfills the secondary role. The postconditions of this relationship operation are that one managed object fulfills both the backed-up and secondary roles and one managed object fulfills both the back-up and secondary roles.

UNBIND from back-up role or UNBIND from backed-up role operation releases the back-up. The preconditions of this relationship operation are that one object is fulfilling the back-up role and one object is fulfilling the backed-up role. The postconditions of this relationship operation are that no object is fulfilling the back-up and backed-up roles.

BIND to secondary role operation binds at least one managed object to the secondary role. It does not have any preconditions. The postconditions of this relationship operation are that the number of managed objects fulfilling the secondary role is increased by at least one.

UNBIND from secondary role operation unbinds at least one managed object from the secondary role. The preconditions of this relationship operation are that at least two managed objects are participating in the secondary role. The postconditions of this relationship operation are that the unbound managed object does not exist in the secondary role and at least one participant exists in the secondary role.

TERMINATE operation deletes an instance of change over relationship. It does not have any preconditions. The postconditions of this relationship operation are the non-existence of the relationship instance.

QUERY operation obtains the information regarding the change over relationship. It does not have any preconditions and postconditions.

The change over action defined in the change over control managed object class can be mapped to “BIND to backed-up” or “BIND to back-up” relationship operation.

The change back action conditionally defined in the change over control managed object class can be mapped to “UNBIND from backed-up” or “UNBIND from back-up” relationship operation.

8.2.1.2 Primary role

The semantics of primary role is defined in 7.3.3 of CCITT Rec. X.732 | ISO/IEC 10164-3.

The primary role for the change over managed relationship is characterized by the following compatible object:

- primary-backed-up object.

The required role cardinality of this role is (1..1) and the permitted relationship cardinality of the participant is (1..1).

8.2.1.3 Secondary role

The semantics of secondary role is defined in 7.3.3 of CCITT Rec. X.732 | ISO/IEC 10164-3.

The secondary role for the change over managed relationship is characterized by the following compatible object:

- secondary-back-up object.

This role supports “bind secondary” and “unbind secondary” operations.

The required role cardinality of this role is (1..n) and the permitted relationship cardinality of the participant is (1..n).

8.2.1.4 Backed-up role

The semantics of backed-up role is defined in 7.3.4 of CCITT Rec. X.732 | ISO/IEC 10164-3.

The backed-up role for the change over managed relationship is characterized by the following compatible object:

- primary-backed-up object.

The participant in this role has to be the participant in the primary role.

This role supports “bind backed-up” and “unbind backed-up” operations.

The required role cardinality of this role is (1..1) and the permitted relationship cardinality of the participant is (1..1).

8.2.1.5 Back-up role

The semantics of back-up role is defined in 7.3.4 of CCITT Rec. X.732 | ISO/IEC 10164-3.

The back-up role for the change over managed relationship is characterized by the following compatible object:

- secondary-back-up object.

The participant in this role has to have been the participant in the secondary role.

This role supports “bind back-up” and “unbind back-up” operations.

The required role cardinality of this role is (1..1) and the permitted relationship cardinality of the participant is (1..1).

8.2.1.6 Change over control role

The change over control role represents the back-up control capabilities to BIND (changeOver) and UNBIND (changeBack) a managed object in the secondary role to the back-up role in the change over relationship.

The change over control role for the change over managed relationship is characterized by the following compatible object:

- change over control object.

The required role cardinality of this role is (1..1) and the permitted relationship cardinality of the participant is (1..1).

8.3 Managed object classes

8.3.1 Primary-backed-up object

The primary-backed-up object managed object class represents the primary-backed-up managed object that characterizes the primary and backed-up roles participant in the change over managed relationship as the compatible managed object.