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M.3100

Amendment 3
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SERIES M: TMN AND NETWORK MAINTENANCE: INTERNATIONAL TRANSMISSION SYSTEMS, TELEPHONE CIRCUITS, TELEGRAPHY, FACSIMILE AND LEASED CIRCUITS

Telecommunications management network

Generic network information model

Amendment 3: Definition of the management interface for a generic alarm reporting control (ARC) feature

ITU-T Recommendation M.3100 – Amendment 3

(Formerly CCITT Recommendation)

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TMN AND NETWORK MAINTENANCE: INTERNATIONAL TRANSMISSION SYSTEMS, TELEPHONE CIRCUITS, TELEGRAPHY, FACSIMILE AND LEASED CIRCUITS

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ITU-T Recommendation M.3100

Generic network information model

AMENDMENT 3

Definition of the management interface for a generic alarm reporting control (ARC) feature

Summary

This amendment provides a new generic capability for controlling alarm reporting. This amendment has been cast in the ITU-T M.3020 (2000), *TMN interface specification methodology* format. This amendment includes the requirements, analysis, and applicable designs for this feature. These generic managed object definitions defined in both the analysis and design sections are intended to be applicable across different technologies, architectures and services. The managed object classes in this amendment may be specialized to support the management of various telecommunications networks.

Source

Amendment 3 to ITU-T Recommendation M.3100 was prepared by ITU-T Study Group 4 (2001-2004) and approved under the WTSA Resolution 1 procedure on 19 January 2001.

Keywords

Actions, ARC, ASN.1, attributes, generic Alarm Reporting Control information model, Managed Object Class, notifications, requirements, UML, use cases.

FOREWORD

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

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

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

NOTE

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

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Definition of the management interface for a generic alarm reporting control (ARC) feature

1 Introduction

This feature provides, among other capabilities, an automatic in-service provisioning capability. Alarm reporting is turned off on a per-managed entity basis to allow sufficient time for customer testing and other maintenance activities in an "alarm-free" state. Once a managed entity is ready, alarm reporting is automatically turned on.

It is critical, during maintenance activities, that alarm monitoring of the managed entity continues to occur. By maintaining managed entity monitoring, technicians can retrieve alarm and performance information to troubleshoot during the provisioning or maintenance process or later during a post mortem on a provisioning task gone awry. The requirements in this Recommendation support this need.

This feature applies to all managed entities that provide alarm reporting and especially to all managed resources autonomously provisioned by the managed system/managed application and all managed entities that may be pre-provisioned via a management interface.

By activating Alarm Reporting Control, the technicians and OS systems will not be flooded with unnecessary work items during operations activities such as service provisioning and network setup/teardown activities. This will reduce maintenance costs and improve the operation and maintenance of these systems.

Alarm Reporting Control requirements as defined by this Recommendation may not be the only set of requirements for controlling alarm reporting.

1.1 Scope

This feature applies to any managing entity to managed entity interface where it is deemed necessary to throttle autonomous alarm messaging under some circumstance but yet remain to have current information available if necessary.

1.2 References

The following ITU-T Recommendations and other references contain provisions, which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published.

[1] ITU-T M.3010 (2000), *Principles for a telecommunications management network.*

[2] ITU-T M.3020 (2000), *TMN interface specification methodology*.

[3] ITU-T M.3100 (1995), *Generic network information model*.

[4] ITU-T M.3120 (2001), *CORBA generic network and NE level information model*.

[5] ITU-T M.3400 (2000), *TMN management functions*.

[6] ITU-T Q.811 (1997), *Lower layer protocol profiles for the Q3 and X interfaces*.

[7] ITU-T Q.812 (1997), *Upper layer protocol profiles for the Q3 and X interfaces*.

[8] ITU-T Q.821 (2000), *Stage 2 and Stage 3 description for the Q3 interface – Alarm surveillance*.

[9] ITU-T X.208 (1988), *Specification of Abstract Syntax Notation One (ASN.1)*.

[10] ITU-T X.209 (1988), *Specification of basic encoding rules for Abstract Syntax Notation One (ASN.1)*.

[11] ITU-T X.680 (1994) | ISO/IEC 8824-1:1995, *Information technology – Abstract Syntax Notation One (ASN.1): Specification of basic notation*.

[12] ITU-T X.680/Amd.1 (1995) | ISO/IEC 8824-1/Amd.1:1995, *Information technology – Abstract Syntax Notation One (ASN.1): Specification of basic notation – Amendment 1: Rules of extensibility*.

[13] ITU-T X.681 (1994) | ISO/IEC 8824-2:1995, *Information technology – Abstract Syntax Notation One (ASN.1): Information object specification*.

[14] ITU-T X.690 (1994) | ISO/IEC 8825-1:1995, *Information technology – ASN.1 encoding rules: Specification Of Basic Encoding Rules (BER), Canonical Encoding Rules (CER) and Distinguished Encoding Rules (DER)*.

[15] ITU-T X.700 (1992) | ISO/IEC 7498-4:1989, *Management framework for Open Systems Interconnection (OSI) for CCITT Applications*.

[16] ITU-T X.701 (1997) | ISO/IEC 10040:1998, *Information technology – Open Systems Interconnection – System management overview*.

[17] ITU-T X.710 (1997) | ISO/IEC 9595:1998, *Information technology – Open Systems Interconnection – Common Management Information Service*.

[18] ITU-T X.711 (1997) | ISO/IEC 9596-1:1998, *Information technology – Open Systems Interconnection – Common Management Information Protocol: Specification*.

[19] ITU-T X.720 (1992) | ISO/IEC 10165-1:1993, *Information technology – Open Systems Interconnection – Structure of management information: Management information model*.

[20] ITU-T X.721 (1992) | ISO/IEC 10165-2:1992, *Information technology – Open Systems Interconnection – Structure of management information: Definition of management information*.

[21] ITU-T X.722 (1992) | ISO/IEC 10165-4:1992, *Information technology – Open Systems Interconnection – Structure of management information: Guidelines for the definition of managed objects*.

[22] ITU-T X.724 (1996) | ISO/IEC 10165-6:1997, *Information technology – Open Systems Interconnection – Structure of management information: Requirements and guidelines for implementation conformance statement proformas associated with OSI management*.

[23] ITU-T X.730 (1992) | ISO/IEC 10164-1:1993, *Information technology – Open Systems Interconnection – Systems management: Object management function*.

[24] ITU-T X.731 (1992) | ISO/IEC 10164-2:1993, *Information technology – Open Systems Interconnection – Systems management: State management function*.

[25] ITU-T X.733 (1992) | ISO/IEC 10164-4:1992, *Information technology – Open Systems Interconnection – Systems management: Alarm reporting function*.

[26] ITU-T X.734 (1992) | ISO/IEC 10164-5:1993, *Information technology – Open Systems Interconnection – Systems management: Event report management function*.

[27] ITU-T X.735 (1992) | ISO/IEC 10164-6:1993, *Information technology – Open Systems Interconnection – Systems management: Log control function*.

[28] ITU-T X.738 (1993) | ISO/IEC 10164-13:1995, *Information technology – Open Systems Interconnection – Systems management: Summarization function*.

[29] ISO/IEC ISP 11183-1 (1992), *Information technology – International Standardized Profiles AOM1n OSI Management – Management Communications – Part 1: Specification of ACSE, presentation and session protocols for the use by ROSE and CMISE*.

[30] ISO/IEC ISP 11183-2 (1992), *Information technology – International Standardized Profiles AOM1n OSI Management – Management Communications – Part 2: CMISE/ROSE for AOM12 – Enhanced Management Communications*.

[31] ISO/IEC ISP 11183-3 (1992), *Information technology – International Standardized Profiles AOM1n OSI Management – Management Communications – Part 3: CMISE/ROSE for AOM11 – Basic Management Communications*.

1.3 Abbreviations

This Recommendation uses the following abbreviations:

ANSI American National Standards Institute

ARC Alarm Reporting Control

ASAP Alarm Severity Assignment Profile

ASN.1 Abstract Syntax Notation One

ATIS Alliance for Telecommunications Industry Solutions

AVC Attribute Value Change Notification

CCITT International Telegraph and Telephone Consultative Committee (replaced by ITU-T)

CMIP Common Management Information Protocol

CMISE Common Management Information Service Element

DCN Data Communications Network

EFD Event Forwarding Discriminator

ET Event Time

GDMO Guidelines for the Definition of Managed Objects

Ind Indication

ISO International Organization for Standardization

ISP International Standardized Profile

ITU International Telecommunication Union

ITU-T International Telecommunication Union – Telecommunication Standardization Sector

MCS Management Conformance Summary

MIB Management Information Base

MICS Management Information Conformance Statement

MIDS Management Information Definition Statement

MIM Management Information Model
MOC Managed Object Class
MOCS Managed Object Conformance Statement
MOI Managed Object Instance
MRCS Managed Relationship Conformance Statement
OS Operations System
OSI Open Systems Interconnection
PC Probable Cause
PDU Protocol Data Unit
PICS Protocol Implementation Conformance Statement
RDN Relative Distinguished Name
Req Request
ROSE Remote Operations Services Element
Rsp Response
SCN State Change Notification
SMAP System Management Application Protocol
SP Specific Problems
TMN Telecommunications Management Network

1.4 Definitions and conventions

1.4.1 Defined in other Recommendations

The following terms, used in this amendment, can be found in the identified references:

Term	Reference (clause 1.2)
Agent	[1]
Alarm	[25]
Alarm reporting	[25]
AlarmInfo	[20]
Correlated notifications	[25]
Inheritance hierarchy	[19]
Managed object class	[8]
Managed object instance	[8]
Management information model	[1]
Manager	[1]
Naming Tree	[19]
Notification identifier	[25]

Term	Reference (clause 1.2)
Subordinate objects	[19]
Superior object	[19]
Alarm Synchronization	[8]
Current Alarm	[8]

1.4.2 Defined in this amendment

1.4.2.1 General ARC definitions

1.4.2.1.1 alarm reporting: Process of alerting, for the purposes of management, external systems and users regarding alarms.

1.4.2.1.2 aggregate audible/visual indicators: An audible/visual alarm indicator that reflects information about a set of managed resources.

1.4.2.1.3 alarm reporting control: Involves the turning off of alarm reporting which includes inhibiting new autonomous alarm indication notification, and inhibiting the use of managed resource-specific/unit alarm information for the determination of aggregate audible/visual indicators. Autonomous alarm clear notification for previously reported alarms will not be suppressed. Alarm reporting "on" is supported by the "ALM" state. Alarm reporting "off" is supported by the "NALM-QI", "NALM-TI", and "NALM" states.

1.4.2.1.4 ARC interval: Generic term that applies to both the persistence and timed intervals.

1.4.2.1.5 inhibited: This term is used throughout this feature description to identify that reporting is off (or in other words, is not allowed).

1.4.2.1.6 management interface: Any managed entity interface that is defined for the purpose of management (e.g. OS interface, craft interface, LED indicator).

1.4.2.1.7 managed entity: A managed entity may be a managed system, a managed application, or a managed resource. This definition is dependent upon the context in which it is used.

1.4.2.1.8 managed resource: A specific component of a managed system/managed application (e.g. a specific circuit pack, termination point).

1.4.2.1.9 managed resource-specific/unit audible/visual indicator: An audible/visual alarm indicator that is specific to a single managed resource.

1.4.2.1.10 persistence interval: A period of time for which a managed entity must be free of qualified problems.

1.4.2.1.11 timed interval: A period of time.

1.4.2.1.12 TR: Threshold Report (a.k.a. quality of service alarm).

1.4.2.1.13 RTR: Reset Threshold Report.

1.4.2.1.14 qualified problem: A problem that affects the operability of the managed entity and used to qualify transitions between the "NALM-NR" and "NALM-CD" states. Additional detail for this definition is managed resource specific and is to be defined by the managed resource.

1.4.2.2 ARC state definitions

1.4.2.2.1 ALM **ALarM reporting**: Alarm Reporting is turned on.

1.4.2.2.2 NALM **No ALarM reporting**: Alarm Reporting is turned off.

1.4.2.2.3 NALM-TI **No ALarM reporting, Timed Inhibit**: Alarm Reporting is turned off for a specified timed interval.

1.4.2.2.4 NALM-QI **No ALarM reporting, Qualified Inhibit**: Alarm Reporting is turned off until the managed entity is qualified problem-free for a specified persistence interval.

1.4.2.2.5 NALM-CD **No ALarM reporting, CountDown**: This is a substate of NALM-QI and performs the persistence timing countdown function when the managed entity is qualified problem-free.

1.4.2.2.6 NALM-NR **No ALarM reporting, NotReady**: This is a substate of NALM-QI and performs a wait function until the managed entity is qualified problem-free.

2 Business requirements

This clause describes the generic Alarm Reporting Control business requirements.

2.1 High-level use cases

The terminology used in the use cases is based on terminology defined in this Recommendation and on terminology defined in ITU-T M.3400, *TMN management functions*.

The set of use cases provided here is not exhaustive and is left as an exercise to the reader. Only that which was deemed necessary to clarify the need and the feature requirements is included.

This use case has been developed to provide a business context for ARC. (See Figure 1.)

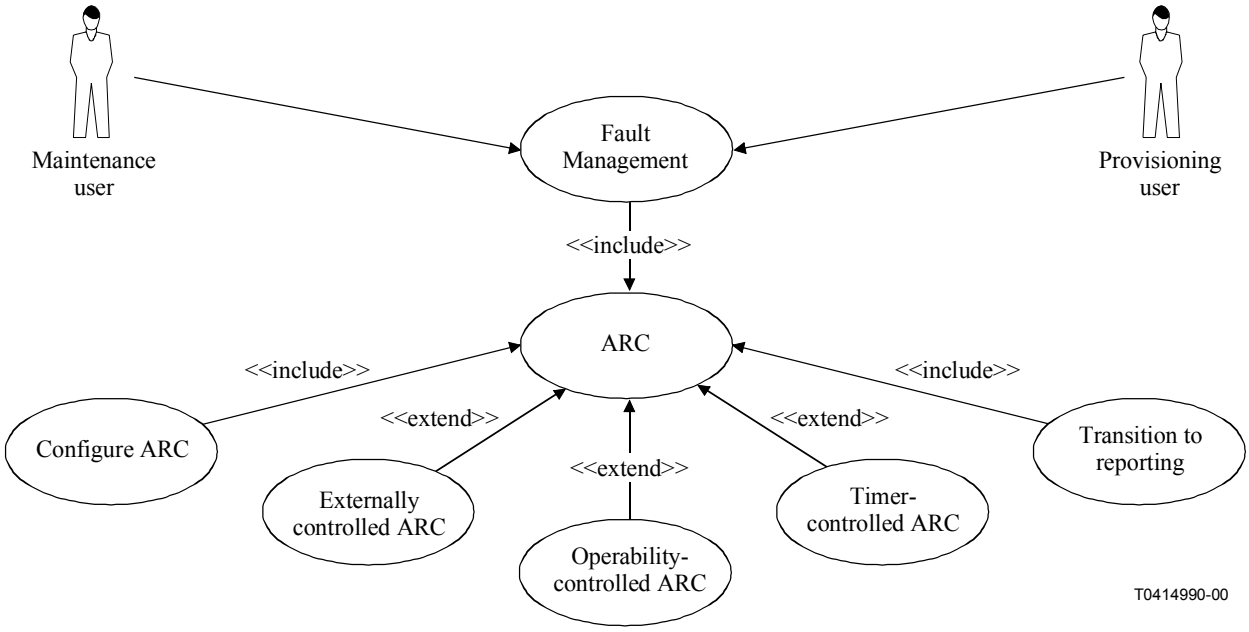


Figure 1/M.3100 – Feature context use case

2.1.1 Fault Management

This use case represents all the functions provided by Fault Management as described in ITU-T M.3400, *TMN management functions*. ARC functions provide additional capability beyond those already defined for Fault Management in other ITU-T Recommendations.

Maintenance and Provisioning Users are expected to make use of the ARC Fault Management capabilities to enable alarm-free setup/teardown, alarm-free provisioning, or alarm-free repair. These three functions are generalizations of the first business requirement.

2.1.2 ARC

In order to provide the needed capabilities and in order to provide these capabilities within different operational environments, the following use cases have been identified: "Configure ARC" and "Transition to reporting" (core functions needed for all operational environments), and "Externally controlled ARC", "Operability-controlled ARC, or "Timer-controlled ARC" (need dependent upon operational environment and/or function).

2.1.3 Configure ARC

This high-level use case represents all of the configuration use cases for ARC.

2.1.4 Externally controlled ARC

This use case describes the case of an external managing entity determining and controlling when resource alarm reporting is to be turned on after having been turned off.

2.1.5 Operability-controlled ARC

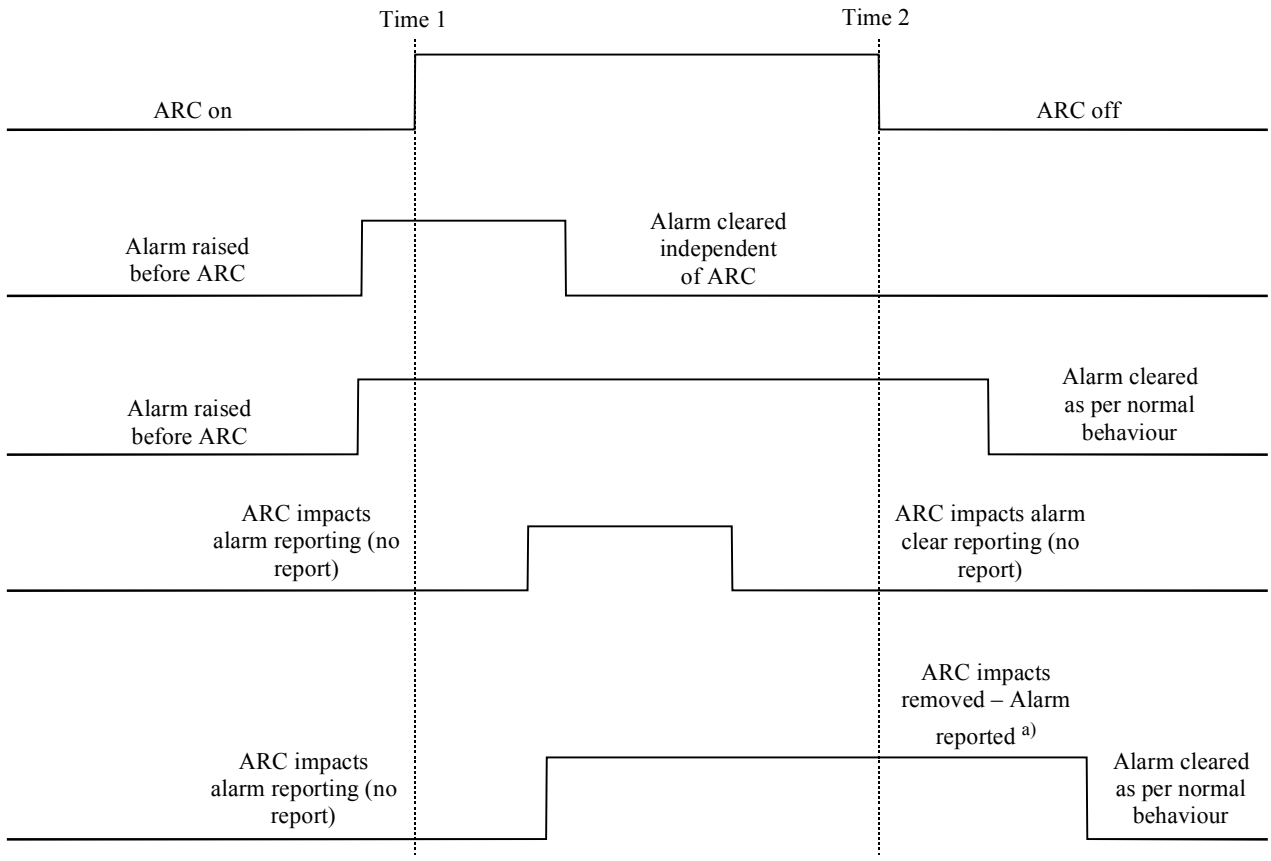
This use case describes the case of the operability of the resource determining and controlling when resource alarm reporting is to be turned on after having been set to a qualified inhibit. The criteria used to determine the operability of a given resource is technology specific.

2.1.6 Timer-controlled ARC

This use case describes the case of an internal timer determining and controlling when resource alarm reporting is to be turned on after having been set to a timed inhibit.

2.1.7 Transition to reporting

This high-level use case contains all of the transition to reporting scenarios for ARC. Possible transition behaviours for a transition to reporting are illustrated in Figure 2.



a) In the case of QOS alarms, the alarm may not be reported.

Figure 2/M.3100 – Alarm notification reference trace

2.2 Business requirements list

1) The Alarm Reporting Control feature shall support the following use cases:
   - alarm-free setup (and modification, breakdown) of lines, sections, and paths;
   - alarm-free modification of payload structures;
   - alarm-free intervals for some installation and maintenance activities.
2) A managed entity shall support the ability to turn on/off alarm reporting over its management interfaces.
3) When alarm reporting is turned off for any managed resource that reports alarms, performance monitoring threshold crossing alerts for the managed resource shall be inhibited. This requirement applies to counters. Gauges are for further study. One example of sending threshold crossing alerts is via the Quality of Service alarm.
4) When alarm reporting is turned off for any managed resource that reports alarms, performance measurement shall continue to be updated normally.
5) When alarm reporting is turned on for any managed resource that reports alarms after having been turned off, all associated performance monitoring threshold crossing alerts shall be allowed if inhibited by alarm report control. This requirement applies to counters. Gauges are for further study.
6) When a managed system/managed application has alarm reporting turned off for a managed resource, current alarm information and performance monitoring data shall be available over management interfaces by management request. Current alarm information shall identify, at minimum, the probable cause.

7) When alarm reporting is turned off, actions triggered based on alarm monitoring information shall continue to occur with the obvious exception of alarm reporting itself. For example, protection switching, operational state transitions, forward defect indication, backward defect indication, etc., shall continue to behave in the same manner as when alarm reporting is turned on.

2.3 Reference trace for ARC impact on alarm notifications

Figure 2 first illustrates alarm reporting being inhibited for a period of time beginning with Time 1 and ending with Time 2. Then it illustrates what would happen in the event that an alarm existed prior to Time 1 and cleared before Time 2. It can be seen here that the alarm clear would be reported for this case when the clear occurred. The next event trace shows an alarm being raised before Time 1 and clearing after Time 2. The raise and clear for this alarm will be reported normally as these events are occurring outside of the Alarm Reporting Control window. The fourth trace illustrates the case where an alarm occurs and clears within the Alarm Reporting Control window. In this case, neither the raising nor the clearing of the alarm will be reported. The final trace shows the case of an alarm occurring during after Time 1 but before Time 2 and clearing after Time 2. In this case, the alarm will be reported at Time 2 and will have a timestamp indicating the actual time the event occurred. The clear will reported as it is normally as it is outside of the Alarm Reporting Control window.

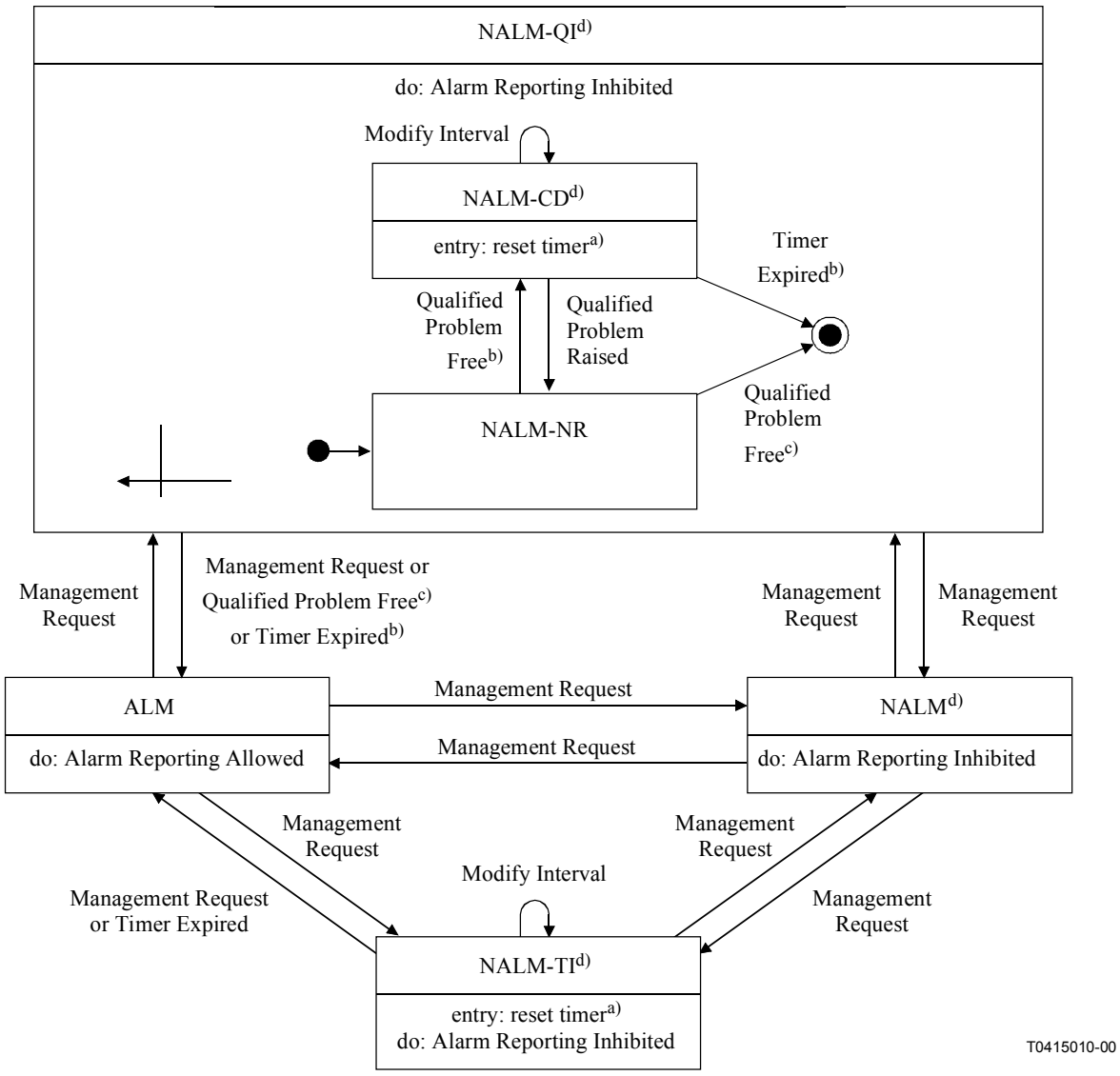
In summary, the following points can be noted with regard to the provided traces:

1) Alarm clears for alarm that were reported prior to entering an Alarm Reporting Control mode shall not be inhibited.
2) Alarm indications and associated clears that occur within an Alarm Reporting Control window shall be inhibited.
3) Alarms that occur in an Alarm Reporting Control window and still existing when no longer in an Alarm Reporting Control mode shall be reported in the transition to the normal reporting mode. These reports shall correctly identify the time the alarm was raised. In the case of quality of service alarms, the alarm may not be reported.

3 Analysis

3.1 ARC state diagram

This clause provides an illustration of the possible alarm reporting states for each managed resource providing the Alarm Reporting Control feature.



ALM Alarm Reporting Allowed/Turned On
CD Count Down
NALM Alarm Reporting Inhibited/Turned Off (i.e. No Alarm Reporting)
NR Not Ready
QI Qualified Inhibit
TI Timed Inhibit

a) The interval may be set to zero.
b) If NALM-CD is supported.
c) If NALM-CD is NOT supported.
d) Support for this state is optional at the generic level.

Figure 3/M.3100 – Alarm Reporting Control state transition diagram

3.2 ARC state requirements list

This clause describes the generic Alarm Reporting Control requirements. Further details such as the default state and the list of states required to be supported is considered technology specific and will need to be addressed by technology specific information model definitions.

1) Upon management requested creation of a managed resource, the ability to specify the state shall be provided.

2) The "ALM" state is required and at least one of the "NALM-T1", "NALM-QI" or "NALM" states.

3) If "NALM-QI" is supported, then the support of "NALM-NR" is required and "NALM-CD" is optional.

4) If the "NALM" state is supported, then a management request is required to change the resource to another state.

5) If the "NALM-QI" state is supported, then upon creation of a management representation of a managed resource, unless otherwise specified in a creation request, the managed system/managed application shall place the managed resource in the "NALM-QI" state and shall not report alarms for the managed resource over its management interfaces until the managed resource is in the "ALM" state.

6) The managed system/managed application shall not autonomously transition a managed resource from the "ALM" state. A management requested change from this state is required.

7) If the "NALM-CD" state is supported, a persistence interval should be provided to facilitate transitioning to the "ALM" state from the "NALM-QI" state.

8) If the "NALM-CD" state is supported, when the ARC interval timer expires in the "NALM-CD" state, the managed resource shall transition from the "NALM-QI" state to the "ALM" state.

9) If the "NALM-CD" state is not supported but the "NALM-QI" state is supported, when the managed entity becomes qualified problem-free, the managed resource shall transition from the "NALM-QI" state to the "ALM" state.

10) The time remaining for the persistence interval in the "NALM-QI" state shall be retrievable.

11) The default persistence interval should be programmable on a per managed system/managed application basis at minimum. If the persistence interval is programmable, the default persistence interval default value shall be documented in system management interface specifications.

12) When the ARC interval timer expires in the "NALM-TI" state, the managed resource shall transition from the "NALM-TI" state to the "ALM" state.

13) The time remaining for the timed interval in the "NALM-TI" state shall be retrievable.

14) The default timed interval for the "NALM-TI" state should be programmable on a per managed system/managed application basis at minimum. If the timed interval is programmable, the default timed interval default value shall be documented in system management interface specifications.

15) There shall be separate defaults for the "NALM-CD" and "NALM-TI" ARC intervals.

16) If the "NALM-QI" state is supported, in the management request to turn reporting off (i.e. when transitioning to the "NALM-QI" state), the manager shall be able to specify a persistence interval. This value is in effect until changed by another management request or until the state is exited. If a persistence interval is not specified in the management request, the default persistence interval shall be used.

17) If the "NALM-TI" state is supported, in the management request to turn reporting off (i.e. when transitioning to the "NALM-TI" state), the manager shall be able to specify a timed interval. This value is in effect until changed by another management request or until the state is exited. If a timed interval is not specified in the management request, the default timed interval shall be used.

18) If the "NALM-QI" state is supported, the persistence interval for a single managed entity shall be able to be modified via a management request while it is in the "NALM-QI" state. This value is in effect until changed by another management request or until the state is exited.

19) If the "NALM-TI" state is supported, the timed interval for a single managed entity shall be able to be modified via a management request while it is in the "NALM-TI" state. This value is in effect until changed by another management request or until the state is exited.

20) Upon auto creation of a managed resource and when the default state is either "NALM-QI" or "NALM-TI" and the ARC interval is programmable, the default interval (timed or persistence accordingly) shall be used.

21) The timed and persistence intervals shall be programmable between 0 and 99 hours with a one-minute granularity.

22) Queries of the time remaining shall be rounded up to the nearest minute.

23) The ARC interval timer(s) shall be accurate within ±10 seconds.

24) The managed resource shall support transitions directly to the "ALM" state from any other state via management request.

25) If the "NALM-TI" state is supported, the ability to place a managed resource that is in "ALM" state into "NALM-TI" state via management request shall be provided.

26) A managed resource shall not automatically transit into the "NALM-TI" state.

27) A timed interval shall be able to be specified with the management request to place a managed resource in the "NALM-TI" state.

28) Unless otherwise requested via management request, the managed resource that is placed in the "NALM-TI" state shall remain in that state, until the ARC interval timer expires, at which time it shall transit into the "ALM" state.

29) When a managed resource is manually placed in the "NALM", "NALM-QI" or "NALM-TI" state, the managed resource shall emit an autonomous message indicating that the alarm reporting of the managed resource is turned off. There shall be a different message for each ARC state (i.e. "NALM", "NALM-QI" and "NALM-TI").

30) When the managed resource transits into "ALM" state, an autonomous message shall be sent indicating that the managed resource's alarm reporting is turned on.

31) The managed entity shall support the ability to configure the list of probable causes (i.e. off-normal condition types) that will be inhibited by the Alarm Reporting Control. The default value for this list shall be all probable causes applicable for the managed entity.

32) If the "NALM-CD" state is supported and the managed entity is in the "NALM-NR" state and the managed entity becomes qualified problem-free, the managed entity shall transition to the "NALM-CD" state.

33) If the managed entity is in the "NALM-CD" state and a qualified problem occurs, the managed entity shall transition back to the "NALM-NR" state.

34) In the transition from the "ALM" state to any Alarm Reporting Control state, the controlled probable causes for the managed entity will be removed from the list of inputs for aggregate audibles/visuals.

35) In the transition to the "ALM" state from any Alarm Reporting Control state, alarms that had not been reported due to ARC but still present shall be reported. In addition, these previously controlled probable causes for the managed entity will be added to the list of inputs for aggregate audibles/visuals.

36) If timestamps are supported for alarm reports, the timestamp on any alarm report shall be the time the alarm event occurred. This means the timestamp when the alarm is sent on entry into the "ALM" state is the same as the timestamp would have been if the resource had been in the "ALM" state when the event occurred.

3.3 ARC state table

Table 1/M.3100 – Alarm reporting control state event matrix

Event\State	ALM	NALM	NALM-TI	NALM-NR	NALM-CD
Managed resource becomes qualified problem-free	Clear alarm(s) as normal, Remain in ALM	Remain in NALM	Remain in NALM-TI	Transition to NALM-CD if NALM-CD supported; otherwise transition to ALM	
Qualified problem raised	Raise alarm(s) as normal, Remain in ALM	Remain in NALM	Remain in NALM-TI	Remain in NALM-NR	Transition to NALM-NR
Manager request to transition to ALM	Reject Request, Remain in ALM	Report existing alarms raised during ARC, Transition to ALM	Report existing alarms raised during ARC, Transition to ALM	Report existing alarms raised during ARC, Transition to ALM	Report existing alarms raised during ARC, Transition to ALM
Manager request to transition to NALM	Transition to NALM	Reject Request NALM	Transition to NALM	Transition to NALM	Transition to NALM
Manager request to transition to NALM-TI, interval not provided in request	if NALM-TI supported set timed interval to default timed interval and Transition to NALM-TI; otherwise Reject Request and Remain in ALM	if NALM-TI supported set timed interval to default timed interval and Transition to NALM-TI; otherwise Reject Request and Remain in NALM	Reject Request, Remain in NALM-TI	Reject Request, Remain in NALM-NR	Reject Request, Remain in NALM-CD
Manager request to transition to NALM-QI, interval not provided in request	if NALM-QI supported set persistence interval to default persistence interval and Transition to NALM-QI; otherwise Reject Request and Remain in ALM	if NALM-QI supported set persistence interval to default persistence interval and Transition to NALM-QI; otherwise Reject Request and Remain in NALM	Reject Request, Remain in NALM-TI	Reject Request, Remain in NALM-NR	Reject Request, Remain in NALM-CD

Table 1/M.3100 – Alarm reporting control state event matrix *(continued)*

Event\State	ALM	NALM	NALM-TI	NALM-NR	NALM-CD
Manager request to transition to NALM-TI, interval provided in request	if NALM-TI supported set timed interval and Transition to NALM-TI; otherwise Reject Request and Remain in ALM	if NALM-TI supported set timed interval and Transition to NALM-TI; otherwise Reject Request and Remain in NALM	Reject Request, Remain in NALM-TI	Reject Request, Remain in NALM-NR	Reject Request, Remain in NALM-CD
Manager request to transition to NALM-QI, interval provided in request	if NALM-QI supported set persistence interval, Transition to NALM-NR; otherwise Reject Request and Remain in ALM	if NALM-QI supported set persistence interval, Transition to NALM-NR; otherwise Reject Request and Remain in NALM	Reject Request, Remain in NALM-TI	Reject Request, Remain in NALM-NR	Reject Request, Remain in NALM-CD
Timer expires			Report existing alarms raised during ARC, Transition to ALM		Report existing alarms raised during ARC, Transition to ALM
Manager request to modify persistence interval default	If current value specifies no adjustment, Reject Request; otherwise Change default, 1st potential use is next transition to NALM-QI	If current value specifies no adjustment, Reject Request; otherwise Change default, 1st potential use is next transition to NALM-QI	If current value specifies no adjustment, Reject Request; otherwise Change default, 1st potential use is next transition to NALM-QI	If current value specifies no adjustment, Reject Request; otherwise Change default, 1st potential use is next transition to NALM-QI	If current value specifies no adjustment, Reject Request; otherwise Change default, 1st potential use is next transition to NALM-QI
Manager request to modify timed interval default	If current value specifies no adjustment, Reject Request; otherwise Change default, 1st potential use is next transition to NALM-TI	If current value specifies no adjustment, Reject Request; otherwise Change default, 1st potential use is next transition to NALM-TI	If current value specifies no adjustment, Reject Request; otherwise Change default, 1st potential use is next transition to NALM-TI	If current value specifies no adjustment, Reject Request; otherwise Change default, 1st potential use is next transition to NALM-TI	If current value specifies no adjustment, Reject Request; otherwise Change default, 1st potential use is next transition to NALM-TI

Table 1/M.3100 – Alarm reporting control state event matrix *(concluded)*

Event\State	ALM	NALM	NALM-TI	NALM-NR	NALM-CD
Manager request to change ARC interval	Reject Request, Remain in ALM	Reject Request, Remain in NALM	Change Timed Interval, re-enter NALM-TI	Change Persistence Interval if NALM-CD supported; otherwise Reject Request, Remain in NALM-NR	Change Persistence Interval, re-enter NALM-CD
Manager request to modify ARC probable cause list	Modify list, Remain in ALM	Modify list, send alarms for existing alarms no longer inhibited, Remain in NALM	Modify list, send alarms for existing alarms no longer inhibited, Remain in NALM-TI	Modify list, send alarms for existing alarms no longer inhibited, re-determine if qualified problem-free, Remain in NALM-NR	Modify list, send alarms for existing alarms no longer inhibited, re-determine if qualified problem-free, Remain in NALM-CD

3.4 ARC object model

3.4.1 ARC class

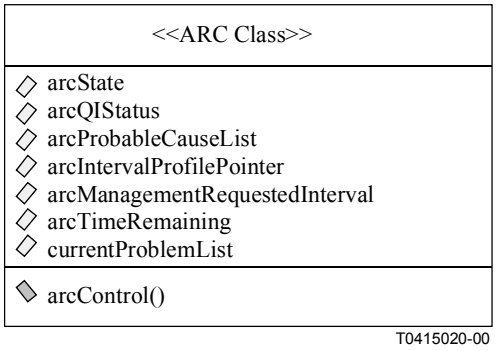


Figure 4/M.3100 – ARC class

3.4.2 ARC interval profile class

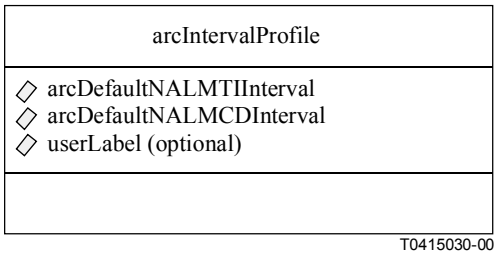


Figure 5/M.3100 – ARC interval profile class

3.4.3 ARC retrieve alarm detail class

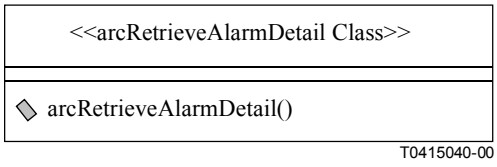


Figure 6/M.3100 – ARC retrieve alarm detail class

3.5 ARC functional model description

This functional model description (in Figure 7) has been included to show, within a typical managed system, the flow of information relating to a detected failure or probable cause. It has also been included to illustrate ARC impacts to the functional model. ARC causes certain probable causes to be marked as "not reported".

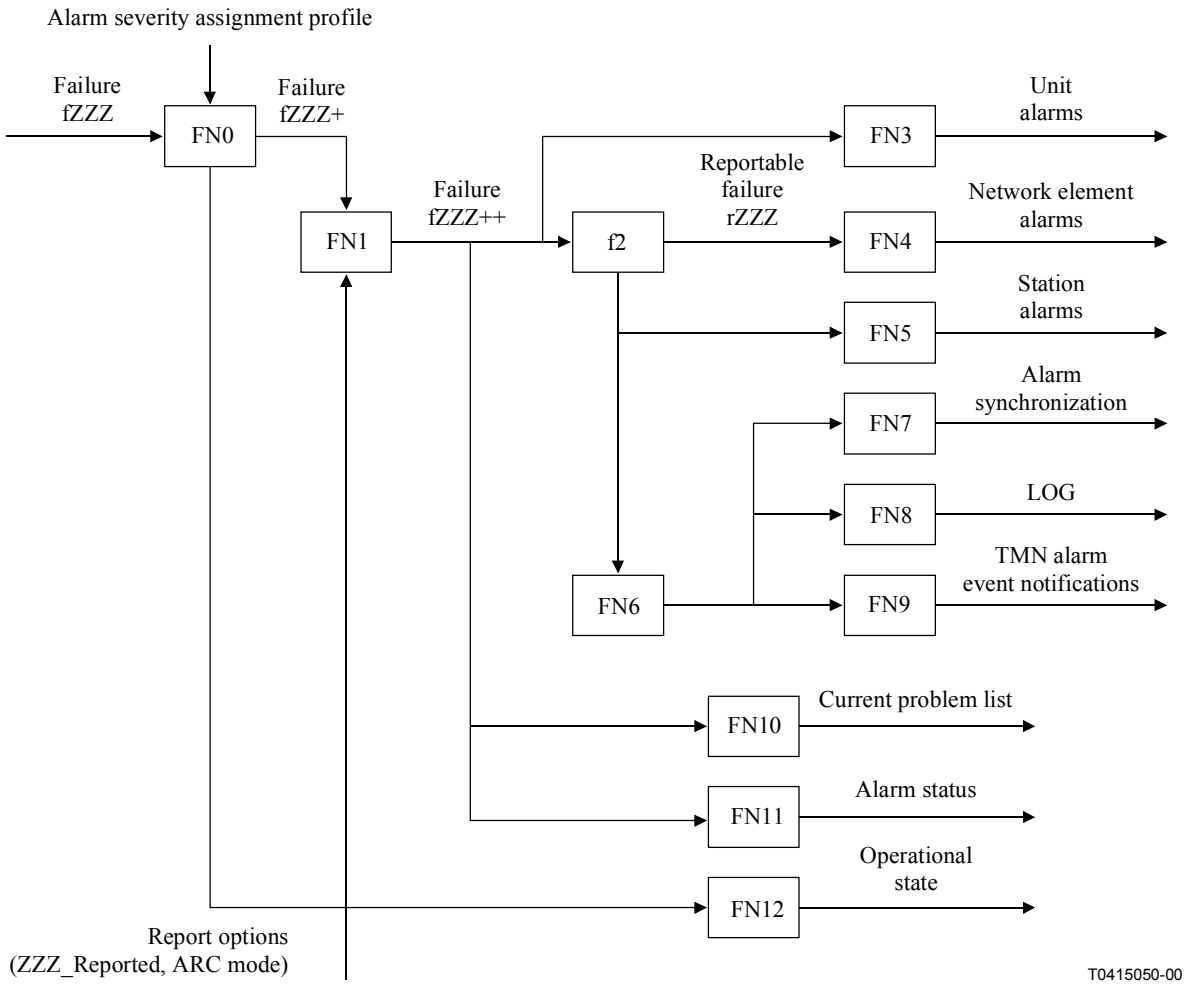


Figure 7/M.3100 – Alarm flow functional model

- Function FN0 is responsible for assigning a severity for a given probable cause. The probable cause and its marked severity and other alarm information (including specific problem, backup status, trend indication, threshold info, event time, additional text, additional information, state change information, proposed repair action, monitored attributes, event type, managed object class, and managed object instance) are forwarded to function FN1. This alarm information is recorded at the time the alarm occurs.
- Function FN1 is responsible for marking a probable cause as "reported" or "not reported" for ARC. A probable cause is marked as "not reported" when the ARC information specified the probable cause to be "not reported". The "Failure fZZZ++" indicates the alarm status of the probable cause in addition to all object centric alarm information received from the FN0 function including: severity, specific problem, backup status, trend indication, threshold info, event time, additional text, additional information, state change information, proposed repair action, monitored attributes, event type, managed object class, and managed object instance. The output of the FN1 function is broadcast to FN3, f2, FN10, FN11 and FN12.
- Function f2 is a filter that forwards only probable cause indications that have been identified as reportable alarms by FN1. The output of the f2 filter is broadcast to functions FN4, FN5 and FN6.
- Function FN3 is responsible for determining whether or not unit audible/visual indicators need to be updated. The effect of ARC upon audible/visual indicators is left undefined in this Recommendation. It is only illustrated here to show that alarm information is forwarded to this function for application-specific processing.

- Function FN4 is responsible for determining whether or not aggregate audible/visual indicators need to be updated.
- Function FN5 is responsible for determining whether or not aggregate station audible/visual indicators need to be updated.
- Function FN6 is the TMN event pre-processing function. The output of the FN6 function is broadcast to functions FN7, FN8 and FN9.
- Function FN7 is responsible for storing all current reportable alarm information.
- Function FN8 is responsible for determining whether or not the event notification needs to be logged.
- Function FN9 is responsible for forwarding event notifications over the TMN.
- Function FN10 is responsible for updating the current problem list.
- Function FN11 is responsible for updating the alarm status.
- Function FN12 is responsible for updating operational state.

3.6 Alarm reporting parameters

Upon a transition from ARC, all alarm notification parameters in an alarm notification that need to be reported and that had occurred during ARC (other than notification identifier and correlated notifications) should reflect the values as defined in Table 2.

Table 2/M.3100 – Alarm reporting parameters table

Data in alarm notification	Set upon alarm occurrence/notification
Perceived severity	Occurrence
Probable cause	Occurrence
Specific problems	Occurrence
Backup status	Occurrence
Back up object	Occurrence
Trend indication	Occurrence
Threshold info	Occurrence
Event time	Occurrence
Additional text	Occurrence
Additional info	Occurrence
Notification identifier	Notification
Correlated notifications	Notification
State change information	Occurrence
Proposed repair action	Occurrence
Monitored attributes	Occurrence
Event type	Occurrence
Managed object class	Occurrence
Managed object instance	Occurrence

3.7 Relationship between ASAP, alarm status, and perceived severity

This clause discusses the relationship between alarm severity assignment specified in the alarm severity assignment profile and the perceived severity and alarm status values that are assigned to a probable cause both when in ARC (alarm reporting is turned off) and when not in ARC (alarm reporting is turned on).

Both when in ARC and not in ARC, the perceived severity for a probable cause is assigned the same way. In addition, in the case that the alarm severity assignment profile is supported, this assignment is done based on the assignments made in the alarm severity assignment profile as indicated in Table 3. However, when a probable cause is under ARC, the alarm status for that probable cause is always set to Pending.

Table 3/M.3100 – Alarm severity and status table

Alarm Severity Assignment Profile	Perceived severity	Alarm status	Alarm status in ARC
NA (Not Alarmed)	<unassigned>	Pending	Pending
WN (Warning)	WN	WN	Pending
MN (Minor)	MN	MN	Pending
MJ (Major)	MJ	MJ	Pending
CR (Critical)	CR	CR	Pending
<unassigned>	Indeterminate	Indeterminate	Pending
<any>	<unassigned>	Pending	Pending

3.8 ARC relationship to ITU-T Q.821

In the context of ARC, a current alarm is an outstanding problem (i.e. probableCause) and current alarm summary control returns current **reportable** (i.e. non-pending) alarms only. Alarms under alarm reporting control are not considered reportable alarms, and therefore will not be included in alarm synchronization.

4 Design

4.1 CMIP/CMIS/CMISE

4.1.1 ARC management information model overview

The Alarm Reporting Control management information model is defined to overcome limitations in the ITU-T X.721 [20] and ITU-T X.734 [26] definition of EFD and limitations in the ITU-T M.3100 [3] definition of audibleVisualLocalAlarmPackage and resetAudibleAlarmPackage when temporary alarm reporting control is needed such as during some cases of controlled maintenance and provisioning.

Reasons why these mechanisms are considered inadequate include the following:

1) This feature requires temporary inhibition of reports for all managers. While EFD can do this, it is somewhat awkward for a manager to do this on another manager's behalf without an understanding of the other manager's EFD(s).

2) This feature requires that not only should alarms for a resource not be forwarded to a manager, but they should also not be included in aggregate audible/visual indicators. The EFD does not control audible/visual indicators. While there are controls for audible/visual indicators in the managedElement class and subclasses, these are controls for the behavior of the aggregate itself and do not control the information being fed into the aggregate.

3) This feature introduces methods to allow a resource to automatically transition from a non-reporting mode to a reporting mode. The EFD and the audible/visual functions do not support this capability.

This information model introduces several new definitions including:

– a new managed object class;

– a new package that may be included in the definition of any object class that supports alarms;

– a new parameter for clarifying the discrepancy between the time of the alarm and the time of the alarm notification when alarm reporting is resumed. This required a revision to all of the alarm reporting packages.

4.1.2 ARC managed object class

4.1.2.1 arcIntervalProfile

The Alarm Reporting Control interval profile managed object class provides the ability to configure default persistence and timed intervals for the "NALM-QI" and the "NALM-TI" states respectively. Association with this class implies that timing for both the "NALM-QI" and the "NALM-TI" states are supported by the resource. A class figure, using UML, has been provided in Figure 8.

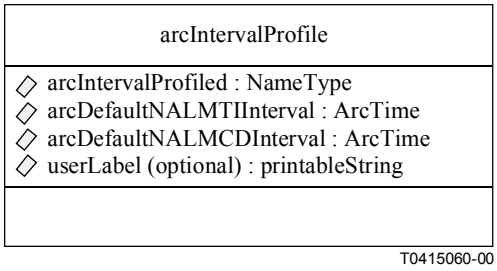


Figure 8/M.3100 – Alarm reporting control interval profile object class

The Alarm reporting control interval profile managed object class, as shown in Figure 8 has four attributes defined. Even though Figure 8 does not show it, this class also supports some notifications.

4.1.2.2 Alarm reporting control interval profile inheritance hierarchy

Figure 9 contains the inheritance hierarchy for the managed object class. Alarm reporting control interval profile is a concrete class (i.e. one that is expected to be used to instantiate managed objects). This class is a subclass of "top".

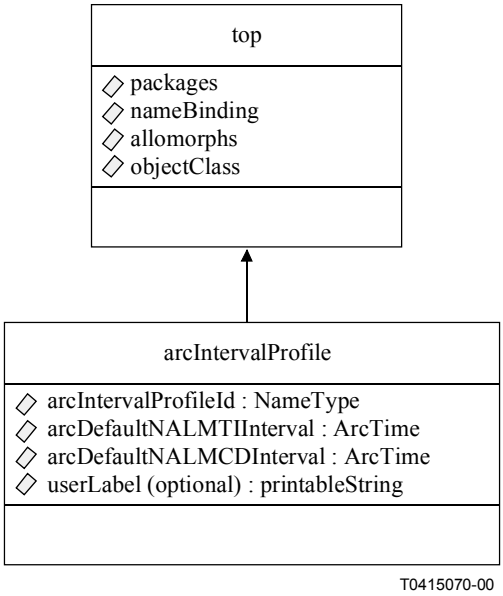


Figure 9/M.3100 – Inheritance hierarchy

4.1.2.3 Name bindings

Multiple name bindings have been defined for this class to support the use of ARC in various types of systems (see Figure 10).

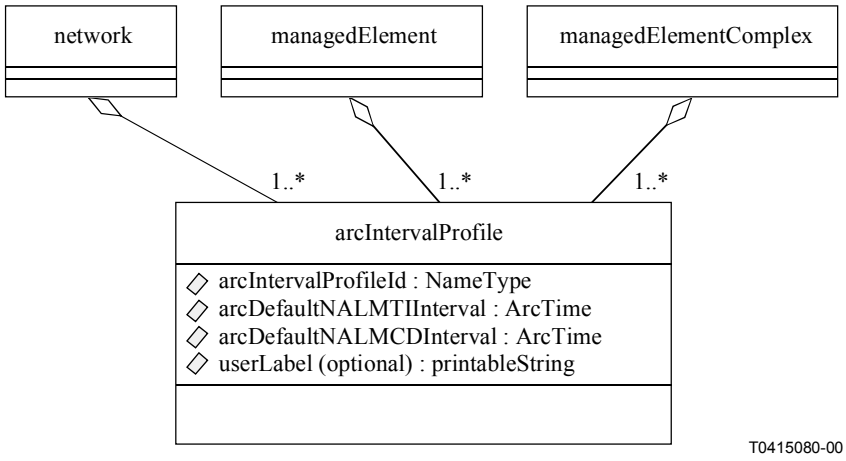


Figure 10/M.3100 – Naming tree hierarchy

The following namebindings will be provided: arcIntervalProfile-managedElement, arcIntervalProfile-managedElementComplex, arcIntervalProfile-network.

4.1.3 ARC package

This package has been defined to be included in object class definitions for objects that support alarm reporting. The characteristics illustrated (see Figure 11) are in addition to the other characteristics defined for an object class.

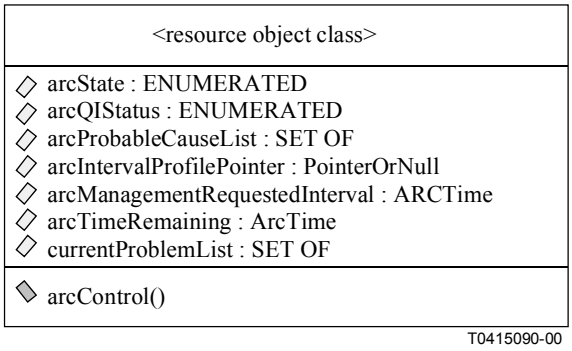


Figure 11/M.3100 – Alarm reporting control package

4.1.4 ARC retrieve alarm detail package

This package has been defined to be included in object class definitions for objects that support alarm reporting. The characteristics illustrated (see Figure 12) are in addition to the other characteristics defined for an object class.

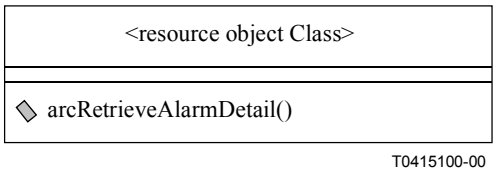


Figure 12/M.3100 – ARC retrieve alarm detail package

4.1.5 Example application

This clause provides an example scenario of a given application of this information model.

Application Scenario 1

The default state is "NALM-QI" for all objects, the default persistence interval is 5 minutes, the default value for arcProbableCauseList is empty for all objects, the arcIntervalProfilePointer is not NULL and points to the object that defined the default persistence interval for all objects. All object classes support the currentProblemList and alarmStatus attributes. All object classes use the operationalState to determine operability for the managed resource.

1) A circuit pack is plugged-in.
2) The circuitPack object is auto created in the "NALM-QI" state. The arcTimeRemaining and arcManagementRequestedInterval are set to 5 minutes.
3) The circuitPack object creation causes the auto creation of the supported termination point(s). The termination point(s) are created in the "NALM-QI" state. The arcTimeRemaining and arcManagementRequestedInterval are set to 5 minutes.
4) The circuitPack is determined to be failed, the probableCause is added to the currentProblemList as pending and the alarmStatus is updated accordingly. In addition, the circuitPack waits to be qualified problem-free. Because the supported termination point(s) are also inoperable due to their dependency on the circuitPack, they are also waiting to be qualified problem-free. The failed circuit pack is replaced.

5) It is determined that the failure has cleared and the circuitPack is now operationally enabled (i.e. operationalState = enabled). The circuitPack object begins counting down the persistence interval.

6) The supported Line termination points are detected to all have LOS failures. The LOS is added to the currentProblemList as pending and the alarmStatus is updated accordingly. The termination points wait to be qualified problem-free.

7) The persistence interval expires for the circuitPack, so it transitions to the "ALM" state.

Application Scenario 2

The default state is "NALM" for all objects, the default value for arcProbableCauseList is empty for all objects, the arcIntervalProfilePointer is NULL for all objects. All object classes support the currentProblemList and alarmStatus attributes. All object classes use the operationalState to determine operability for the managed resource. The path termination point (trail termination sink function) does not receive a signal (no signal, or unequipped signal). In this case, the path termination point is considered inoperable.

1) A multi-termination point circuit pack is plugged in and the termination points for that circuit pack are automatically created as a result in the NALM state. The transmitted trace identifiers are provisioned during the creation of the termination points.

2) A bidirectional connection is set up in the network and terminated at a termination point on that circuit pack; the expected trace identifier is provisioned at both termination points of the bidirectional connection.

3) When the connection is set up, both termination endpoints are queried for their fTIM status or for their received trace identifier values. If both fTIMs are cleared or both received trace identifiers match the expected values, the termination point ARC state will be changed from NALM into ALM by means of a management request.

4.1.6 GDMO/ASN.1

The model defines a new package in this Recommendation and can be used by any object class that supports alarm reporting and the control of alarm reporting. In addition it defines a profile object for the configuration of alarm reporting control time intervals. Finally, this model introduces a new parameter that is to be included in alarm reports upon the resumption of alarm reporting after a period of alarm reporting inhibition.

```
arcIntervalProfile MANAGED OBJECT CLASS
    DERIVED FROM "Recommendation X.721: 1992":top;
    CHARACTERIZED BY
    arcIntervalProfilePackage PACKAGE
    BEHAVIOUR arcIntervalProfilePackageBehaviour BEHAVIOUR
        DEFINED AS
        "This object defines the default ARC intervals for the Alarm Reporting Control (ARC) states that
        support time-based transitions. An interval profile is only applicable for ARC states that
        automatically transition within an agent with time being a factor (but not necessarily the only factor)
        in the transition criteria from a mode of inhibited alarm reporting to a mode of allowed alarm
        reporting. Automatic agent state transitions from a mode of allowed alarm reporting to a mode of
        inhibited alarm reporting is prohibited. Support for this object is required only when settable
        intervals for the related ARC states are required."
    ;;
    ATTRIBUTES
        arcIntervalProfileId GET SET-BY-CREATE,
        arcDefaultNALMTIInterval GET-REPLACE, -- interval for the "nalm-ti" state
        arcDefaultNALMCDInterval GET-REPLACE -- interval for the "nalm-qi" state
        ;;;
```

```
        CONDITIONAL PACKAGES
                attributeValueChangeNotificationPackage PRESENT IF
"the attributeValueChange notification defined in Recommendation X.721 is supported by an instance of this
managed object class",
                createDeleteNotificationsPackage PRESENT IF
                "the objectCreation and objectDeletion notifications defined in Recommendation X.721 are
supported by an instance of this managed object class",
                userLabelPackage PRESENT IF "an instance supports it"
        ;
REGISTERED AS { m3100ObjectClass 66};

arcPackage PACKAGE
BEHAVIOUR arcPackageBehaviour BEHAVIOUR
        DEFINED AS
        "This package defines the characteristics required for an object supporting Alarm Reporting Control
        (ARC). The ARC feature shall be supported by any object that supports alarm reporting. Changes to
        arcProbableCauseList take effect immediately. The behaviour of the changes for each probable cause is
        similar to the behaviour exhibited when transitioning to and from the ALM state. The reporting for a
        probable cause stops when the probable cause is added and starts when removed from the list. When
        arcProbableCauseList is modified, changes will be made according to best effort. Only non-supported
        probableCauses shall return errors and not added to list; valid probable causes shall be accepted and
        added to list. Changes in the default timed intervals (the two in the ARC profile) takes effect only when
        entering into QI or TI states from any other state as long as an override value is not specified in the
        arcControl action. Changes in the arcManagementRequestedInterval are allowed only when it has a time
        value (as opposed to being set to noAdjustment) and then takes effect immediately. Attribute value change
        notifications shall be sent for changes to arcState, arcProbableCauseList, arcIntervalProfilePointer, and
        arcManagementRequestedInterval"
        ;;
        ATTRIBUTES
                arcState GET, -- SCNs shall be used
        arcQIStatus GET, -- No AVCs or SCNs shall be sent for changes in value
        arcProbableCauseList GET-REPLACE ADD-REMOVE notSupportedProbableCause,
                arcIntervalProfilePointer GET-REPLACE,
                arcManagementRequestedInterval GET-REPLACE,
                arcTimeRemaining GET, -- No AVCs shall be sent for changes in value of this attribute
                currentProblemList GET
                ;
        ACTIONS
                -- need to add error parameters definitions for arcControl action
                arcControl
                ;
        NOTIFICATIONS
                "Recommendation X.721:1992": attributeValueChange,
                "Recommendation X.721:1992":stateChange
                ;
REGISTERED AS { m3100Package 94};

arcRetrieveAlarmDetailPackage PACKAGE
BEHAVIOUR arcRetrieveAlarmDetailPackageBehaviour BEHAVIOUR
        DEFINED AS
        "This package defines an ability to query useful alarm information beyond alarmStatus and
        probableCause when alarm notifcations are not sent for a given probableCause (e.g. when the alarm is
        under Alarm Reporting Conrol (ARC))."
        ;;
        ACTIONS
                arcRetrieveAlarmDetail
                ;
REGISTERED AS { m3100Package 95};

environmentalAlarmR2Package PACKAGE
        ATTRIBUTES
                alarmStatus  GET,
                currentProblemList          GET
        ;
```

```
        NOTIFICATIONS
                "Recommendation X.721:1992":environmentalAlarm
                        "Recommendation Q.821:1992":logRecordIdParameter
                        "Recommendation Q.821:1992":correlatedRecordNameParameter
                        "Recommendation Q.821:1992":suspectObjectListParameter
                        alarmingResumedParameter
                        affectedObjectListParameter
        ;
REGISTERED AS {m3100Package 96};

equipmentsEquipmentAlarmR2Package PACKAGE
        ATTRIBUTES
                alarmStatus  GET,
                currentProblemList          GET
        ;
        NOTIFICATIONS
                "Recommendation X.721:1992":equipmentAlarm
                        "Recommendation Q.821:1992":logRecordIdParameter
                        "Recommendation Q.821:1992":correlatedRecordNameParameter
                        "Recommendation Q.821:1992":suspectObjectListParameter
                                alarmingResumedParameter
                            affectedObjectListParameter
        ;
REGISTERED AS {m3100Package 97 };

processingErrorAlarmR2Package PACKAGE
        ATTRIBUTES
                alarmStatus  GET,
                currentProblemList          GET
        ;
        NOTIFICATIONS
                "Recommendation X.721:1992":processingErrorAlarm
                        "Recommendation Q.821:1992":logRecordIdParameter
                        "Recommendation Q.821:1992":correlatedRecordNameParameter
                        "Recommendation Q.821:1992":suspectObjectListParameter
                        alarmingResumedParameter
                        affectedObjectListParameter
        ;
REGISTERED AS {m3100Package 98 };

softwareProcessingErrorAlarmR2Package PACKAGE
        ATTRIBUTES
                alarmStatus  GET,
                currentProblemList          GET
        ;
        NOTIFICATIONS
                "Recommendation X.721:1992":processingErrorAlarm
                        "Recommendation Q.821:1992":logRecordIdParameter
                        "Recommendation Q.821:1992":correlatedRecordNameParameter
                        "Recommendation Q.821:1992":suspectObjectListParameter
                                alarmingResumedParameter
                        affectedObjectListParameter
        ;

REGISTERED AS {m3100Package 99 };

tmnCommunicationsAlarmInformationR1Package   PACKAGE
        BEHAVIOUR
                tmnCommunicationsAlarmInformationBehaviour;
        ATTRIBUTES
                alarmStatus  GET,
                currentProblemList          GET
        ;
```

```
        NOTIFICATIONS
                "Recommendation X.721:1992":communicationsAlarm
                        "Recommendation Q.821:1992":logRecordIdParameter
                        "Recommendation Q.821:1992":correlatedRecordNameParameter
                        "Recommendation Q.821:1992":suspectObjectListParameter
                        alarmingResumedParameter
                        affectedObjectListParameter
        ;
REGISTERED AS {m3100Package 100 };

arcDefaultNALMTIInterval ATTRIBUTE
        WITH ATTRIBUTE SYNTAX M3100ASN1TypeModule4.ArcDefaultNALMTIInterval;
        MATCHES FOR EQUALITY, ORDERING;
        BEHAVIOUR arcDefaultNALMTIIntervalBehaviour BEHAVIOUR
        DEFINED AS
        "This attribute defines the default/initial value for the ARC interval timer of the ARC nalm-ti state if
        another interval is not specified in the management request to transition to the state.";;
        REGISTERED AS { m3100Attribute 148};

arcDefaultNALMCDInterval ATTRIBUTE
        WITH ATTRIBUTE SYNTAX M3100ASN1TypeModule4. ArcDefaultNALMCDInterval;
        MATCHES FOR EQUALITY, ORDERING;
        BEHAVIOUR arcDefaultNALMCDIntervalBehaviour BEHAVIOUR
        DEFINED AS
        "This attribute defines the default/initial value for the ARC interval timer of the ARC nalm-qi state if
        another interval is not specified in the management request to transition to the state.";;
REGISTERED AS { m3100Attribute 149 };

arcIntervalProfileId ATTRIBUTE
        WITH ATTRIBUTE SYNTAX ASN1DefinedTypesModule.NameType;
        MATCHES FOR EQUALITY, ORDERING, SUBSTRINGS;
        BEHAVIOUR arcIntervalProfileIdBehaviour BEHAVIOUR
        DEFINED AS
        "The arcIntervalProfileId is an attribute type whose distinguished value can be used as a RDN when
        naming an instance of the arcIntervalProfile object class.";;
REGISTERED AS { m3100Attribute 150};

arcIntervalProfilePointer ATTRIBUTE
        WITH ATTRIBUTE SYNTAX ASN1DefinedTypesModule.PointerOrNull;
        MATCHES FOR EQUALITY;
        BEHAVIOUR arcIntervalProfilePointerBehaviour BEHAVIOUR
        DEFINED AS
        "This attribute identifies the associated arc interval profile object. The value of this attribute is NULL
        when settable persistence and timed intervals are not used (i.e. for nalm-qi and nalm-ti states).";;
REGISTERED AS { m3100Attribute 151 };

arcManagementRequestedInterval ATTRIBUTE
        WITH ATTRIBUTE SYNTAX M3100ASN1TypeModule4.ArcTime;
        MATCHES FOR EQUALITY;
        BEHAVIOUR arcManagementRequestedIntervaBehaviour BEHAVIOUR
        DEFINED AS
        "This identifies the management requested time for an ARC interval. This attribute changes value only
        upon management request or when a resource automatically transitions to the ALM state. Management
        requests to change the value of this attribute are denied when it is invalid to do so. For example, when the
        managed resource is in the ALM or NALM state. The value of this attribute reflects whether or not the
        ARC interval can be adjusted via management request at a given moment.";;
REGISTERED AS {m3100Attribute 152};
```

arcProbableCauseList ATTRIBUTE
WITH ATTRIBUTE SYNTAX M3100ASN1TypeModule4.ArcProbableCauseList;
MATCHES FOR EQUALITY;
BEHAVIOUR arcProbableCauseListBehaviour BEHAVIOUR
DEFINED AS
"The probable causes in this list are inhibited when alarm reporting is turned off. An empty list indicates all probable causes the resource supports are inhibited. Should one of these probable cause indications be raised when alarm reporting is inhibited, the currentProblemList shall be updated with the probable cause as normal but the alarm status for the probable cause shall be 'activePending'.";;
REGISTERED AS {m3100Attribute 153};

arcState ATTRIBUTE
WITH ATTRIBUTE SYNTAX M3100ASN1TypeModule4.ArcState;
MATCHES FOR EQUALITY;
BEHAVIOUR arcStateBehaviour BEHAVIOUR
DEFINED AS
"This attribute defines the Alarm Reporting Control (ARC) state of the object. The initial state and the set of ARC states required to be supported for a given object shall be defined in the object class behaviour. State change notifications shall be used to indicate value changes for this attribute.";;
REGISTERED AS {m3100Attribute 154};

arcQIStatus ATTRIBUTE
WITH ATTRIBUTE SYNTAX M3100ASN1TypeModule4.ArcQIStatus;
MATCHES FOR EQUALITY;
BEHAVIOUR arcQIStatusBehaviour BEHAVIOUR
DEFINED AS
"This attribute defines the Alarm Reporting Control (ARC) status of the object. Neither state change notifications nor attribute value change notifications shall be used to indicate value changes for this attribute.";;
REGISTERED AS {m3100Attribute 155};

arcTimeRemaining ATTRIBUTE
WITH ATTRIBUTE SYNTAX M3100ASN1TypeModule4.ArcTime;
MATCHES FOR EQUALITY;
BEHAVIOUR arcTimeRemainingBehaviour BEHAVIOUR
DEFINED AS
"This identifies the time remaining for an ARC interval (i.e. persistence interval for the nalm-qi state and timed interval for the nalm-ti state). Note that it does not necessarily indicate the time remaining in the state. For example, the arcTimeRemaining could be 30 minutes in the nalm-qi state and if a qualified problem is raised for the managed resource before the ARC interval timer expires it will exit the timer and wait indefinately until it once again becomes qualified problem-free, restarts the timer, and begins to decrement the time remaining again. When a resource transitions to the nalm-ti, nalm, or nalm-qi state, the value of this attribute is initialized to the management requested interval. When there is no timer running, the value will indicate that the timer is not running (i.e. no adjustments in time taking place).";;
REGISTERED AS {m3100Attribute 156};

arcControl ACTION
BEHAVIOUR arcControlBeh BEHAVIOUR
DEFINED AS
"The arcControl action provides management control for alarm reporting. This control is to be used either to turn reporting on or to turn reporting off. This is achieved by identifying the desired ARC state. In some cases the action will be denied because a state is not supported for a given resource type. In addition to specifying the state, the manager may request an arcInterval other than the default for a one time use. Such an override is only applicable in transitions to the nalm-qi and naml-ti states.";;
MODE CONFIRMED;
WITH INFORMATION SYNTAX M3100ASN1TypeModule4.ArcControlRequest;
REGISTERED AS { m3100Action 20 };

```
arcRetrieveAlarmDetail ACTION
        BEHAVIOUR arcRetrieveAlarmDetailBeh BEHAVIOUR
        DEFINED AS
        "The arcRetrieveAlarmDetail action provides a mechanism for querying a subset of the information
        relating to all current problems (i.e. probable cause, alarm status, perceived severity, and event time) and
        may be executed at any time, even when the the current problem is under management control for alarm
        reporting.";;
        MODE CONFIRMED;
        WITH REPLY SYNTAX M3100ASN1TypeModule4.ArcAlarmDetailSet;
REGISTERED AS { m3100Action 21 };

affectedObjectListParameter PARAMETER
        CONTEXT EVENT-INFO;
        WITH SYNTAX M3100ASN1TypeModule4.ArcAffectedObjectList;
        BEHAVIOUR affectedObjectListParameterBeh BEHAVIOUR
        DEFINED AS
        "The affectedObjectListParameter may be attached to alarm notifications. The purpose of this parameter
        is to identify the list of resources that are affected by the problem.";;
REGISTERED AS { m3100Parameter 66 };

alarmingResumedParameter PARAMETER
        CONTEXT EVENT-INFO;
        WITH SYNTAX M3100ASN1TypeModule4.AlarmingResumed;
        BEHAVIOUR alarmingResumedBeh BEHAVIOUR
        DEFINED AS
        "The alarmingResumedParameter shall be attached to alarm notifications emitted as a result of the
        resumption of alarming on a resource. The purpose of this parameter is to clarify the reason for any
        discrepancy between the time the event is received and the timestamp in the alarm notification. The
        timestamp of the alarm notification shall be the time that the problem was declared.";;
REGISTERED AS { m3100Parameter 67};

notSupportedProbableCause PARAMETER
CONTEXT SPECIFIC-ERROR;
WITH SYNTAX M3100ASN1TypeModule4.NotSupportedProbableCause;
BEHAVIOUR notSupportedProbableCauseBeh BEHAVIOUR
        DEFINED AS
        "The probable cause values that are not supported by the object due to the fact that the object does not
        declare the probable cause.";;
REGISTERED AS { m3100Parameter 68};

arcIntervalProfile-managedElement NAME BINDING
        SUBORDINATE OBJECT CLASS arcIntervalProfile AND SUBCLASSES;
        NAMED BY SUPERIOR OBJECT CLASS managedElement AND SUBCLASSES;
        WITH ATTRIBUTE arcIntervalProfileId;
        BEHAVIOUR arcIntervalProfile-managedElementBeh BEHAVIOUR
        DEFINED AS
        "This name binding is used to name an instance of an arcIntervalProfile relative to a managedElement
        instance. The creation of a single instance of the arcIntervalProfile object is the result of the creation of the
        containing managedElement instance." ;;
REGISTERED AS { m3100NameBinding 90};

arcIntervalProfile-managedElementComplex NAME BINDING
        SUBORDINATE OBJECT CLASS arcIntervalProfile AND SUBCLASSES;
        NAMED BY SUPERIOR OBJECT CLASS managedElementComplex AND SUBCLASSES;
        WITH ATTRIBUTE arcIntervalProfileId;
        BEHAVIOUR arcIntervalProfile-managedElementComplexBeh BEHAVIOUR
        DEFINED AS
        "This name binding is used to name an instance of an arcIntervalProfile relative to a
        managedElementComplex instance. The creation of a single instance of the arcIntervalProfile object is the
        result of the creation of the containing managedElementComplex instance." ;;
REGISTERED AS { m3100NameBinding 91};
```

```
arcIntervalProfile-network NAME BINDING
        SUBORDINATE OBJECT CLASS arcIntervalProfile AND SUBCLASSES;
        NAMED BY SUPERIOR OBJECT CLASS network AND SUBCLASSES;
        WITH ATTRIBUTE arcIntervalProfileId;
        BEHAVIOUR arcIntervalProfile-networkBeh BEHAVIOUR
        DEFINED AS
        "This name binding is used to name an instance of an arcIntervalProfile relative to a network instance. The
        creation of a single instance of the arcIntervalProfile object is the result of the creation of the containing
        network instance." ;;
REGISTERED AS { m3100NameBinding 92};

M3100ASN1TypeModule4 {itu-t recommendation m gnm(3100) informationModel(0) asn1Modules(2)
asn1Module4(3) }
DEFINITIONS IMPLICIT TAGS ::=
BEGIN
-- EXPORTS everything
IMPORTS

ObjectInstance
        FROM CMIP-1 {joint-iso-ccitt ms(9) cmip(1) modules(0) protocol(3)}

EventTime
        FROM Attribute-ASN1Module {joint-iso-ccitt ms(9) smi(3) part2(2) asn1Module(2) 1}

AdditionalInformation, AlarmStatus, PerceivedSeverity, ProbableCause
        FROM Attribute-ASN1Module{joint-iso-ccitt ms(9) smi (3) part2 (2) asn1Module(2) 1};

AlarmingResumed ::= BOOLEAN -- TRUE implies alarm reporting is resumed
ArcAffectedObjectList ::= SET OF ObjectInstance

ArcAlarmDetail ::= SEQUENCE {
problem ProbableCause,
alarmStatus AlarmStatus,
perceivedSeverity PerceivedSeverity OPTIONAL, -- must be present unless <unassigned> (i.e. not an alarm)
eventTime EventTime OPTIONAL
}

ArcAlarmDetailSet ::= SEQUENCE {
ArcAlarmDetail
}

ArcControlRequest ::= SEQUENCE {
time ArcTime DEFAULT noAdjustment : NULL,
newState ArcState,
additionalInfo AdditionalInformation OPTIONAL
}
ArcDefaultNALMCDInterval ::= ArcTime
ArcDefaultNALMTIInterval ::= ArcTime
ArcInterval ::= INTEGER (0..5940) -- minutes (max of 99 hours)
ArcProbableCauseList ::= SET OF ProbableCause -- empty set means all object probable causes
ArcState ::= ENUMERATED{ alm(0), nalm(1), nalmQualifiedInhibit(2), nalmTimedInhibit(4) }
ArcQIStatus ::= ENUMERATED { notApplicable(0), nalmNotReported(1), nalmCountDown(2)}

ArcTime ::= CHOICE {
                noAdjustment [0] NULL,
                time [1] ArcInterval -- minutes
                }

NotSupportedProbableCause ::= SET OF ProbableCause

END
```

4.1.7 Compliance

Managed object class definitions support the function of this Alarm Reporting Control (ARC) feature by incorporating the ARC package. Inclusion of the ARC package indicates that the managed object class supports the "ALM" state and at least one other state of the set "NALM", "NALM-TI", and "NALM-QI".

The definition of the managed object class including the ARC package shall specify in the behaviour clause which of the optional and conditional characteristics are to be utilized and any further restrictions on their use and their values. In particular, the behaviour of the managed object class shall clarify the following definitions:

1) The set of required ARC state values for the class.
2) The factors that determine operability for the class. For example, the definition for "qualified problem" may be augmented by the class definition by specifying a list of probable causes that affect operability.
3) The class shall specify whether or not existing quality of service alarms that were inhibited due to ARC must be reported when the resource transitions to the "ALM" state from any other ARC state.
4) If it is determined necessary to constrain the default ARC state value for the managed entity, the ARC state default value(s) allowed for the class shall be provided in the class definition.

4.1.8 Conformance

Managed Object Conformance Statements (MOCS) for the arcPackage and arcIntervalProfile are to be supplied to which conformance is claimed.

4.2 CORBA

The specifications for this design are provided in ITU-T M.3120 [4], *CORBA generic network and NE level information model*.

APPENDIX I

Application scenarios

Scenario 1: Turn-Up Scenario

There is no signal present for the termination point. The default persistence interval is set to 0. The default state for the termination point is "NALM-NR". The default state for the circuit pack is "ALM".

1) A single port circuit pack is plugged in and the termination point for that circuit pack is automatically created as a result in the "NALM-NR" state.
2) The termination point managed resource becomes free of qualified problems, so it transitions to the "NALM-CD" state.
3) Because the default persistence interval value is set to zero, the termination point managed resource transitions to the "ALM" state immediately.

Scenario 2: Turn Reporting Off Indefinitely

Reporting is turned on. The managed resource is free of qualified problems.

1) A management request to turn off reporting indefinitely (i.e. set state to "NALM"). As a result, the managed resource transitions from the "ALM" state to the "NALM" state.

Because there is no qualifying or strictly time-based criteria relevant for remaining in this state, the managed resource remains in this state indefinitely.

Scenario 3: Turning off reporting for 2 hours regardless of the failure state

An LOS is present on a termination point. The unavailable seconds (UAS) count is near threshold. UAS is a condition that does not persist and no clear is sent. The Craft is assigned 2 hours to repair trouble.

1) A management request is issued to place the termination point in "NALM-TI" state with a timed interval set to 2 hours.
2) An unavailable seconds (UAS) count exceeds its threshold; however the notification is suppressed.
3) The maintenance personnel proceeds to fix the problem that caused the LOS.
4) At the end of about 1.5 hours, the maintenance personnel determines that more time is needed, and then he/she contacts the manager to extend the timed interval for 2 more hours.
5) The manager issues a command to reset the timed interval to 2 hours.
6) The LOS clears and an alarm clear notification is sent.
7) Approximately 3.5 hours after the termination point was first placed in "NALM-TI" state, the managed resource automatically transitions to the "ALM" state.

Scenario 4: Using NALM For Alarm-Free Path Setup

The default state is "NALM" for all managed entities, the default value for the configurable list of probable causes is set to all probable causes, the default ARC intervals are not configurable. The path termination point (trail termination sink function) does not receive a signal (no signal, or unequipped signal). In this case, the path termination point is considered inoperable.

1) A multi-termination point circuit pack is plugged in and the termination points for that circuit pack are automatically created as a result in the "NALM" state. The transmitted trace identifiers are provisioned during the creation of the termination points.
2) A bidirectional connection is set up in the network and terminated at a termination point on that circuit pack; the expected trace identifier is provisioned at both termination points of the bidirectional connection.
3) When the connection is set up, both termination endpoints are queried for their fTIM status or for their received trace identifier values. If both fTIMs are cleared or both received trace identifiers match the expected values, the termination point ARC state will be changed from "NALM" into "ALM" by means of a management request.

APPENDIX II

Additional considerations

The following items have been noted for further study. Resolutions to these study points may be addressed in future revisions to this feature specification.

II.1 Business requirement considerations

1) There is no indication in the PM objects that its threshold crossing alerts are being suppressed.
2) It is not known whether or not this is a problem, but this model does not discriminate between security alarms and any other type of alarm. Additional restrictions with regards to security alarms may be applied at some future time.
3) Some further study is needed with regards to performance monitoring gauge behaviours during periods of Alarm Reporting Control.

II.2 GDMO/ASN.1 Design considerations

1) In order for this feature to become used widely, the core classes in ITU-T M.3100 (e.g. termination point objects, equipment objects) will need to be updated.

2) The arcManagementRequestedInterval, arcDefaultPersistenceInterval, and arcDefaultTimedInterval attributes have strange behavior in that this attribute can only be modified in certain ARC states. Similarly, the interval override in the arcControl action can only be specified with certain ARC states and is not allowed for others.

3) Additional parameter definitions for errors on actions need to be specified.

4) The current conformance reflects only the need to include MOCS. Whether one or more service definitions and functional units are required for the ARC feature needs further study.

5) The arcState behaviour may be overcomplicated by the fact that the manager is not allowed to change between the "NALM-QI" and the "NALM-TI" state. Of course, allowing these transitions is complicated also because of the semantic differences in meaning of the persistence and timed intervals.

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