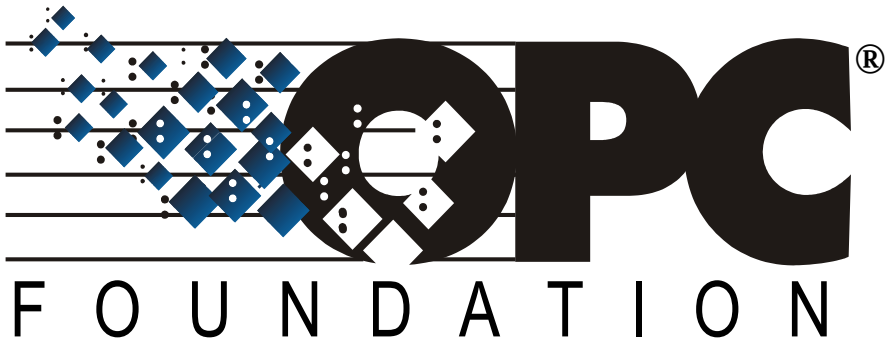


OPC 10000-9

OPC Unified Architecture

Part 9: Alarms & Conditions

Release 1.05.03

2023-12-31

OPC UA Specification

Specification Type:	Industry Standard Specification	Comments:	
Document Number	**OPC 10000-9**		
Title:	OPC Unified Architecture Part 9: Alarms & Conditions	Date:	2023-12-31
Version:	Release 1.05.03	Software:	MS-Word
		Source:	OPC 10000-9 - UA Specification Part 9 - Alarms and Conditions 1.05.03.docx
Author:	OPC FOUNDATION	Status:	Release

CONTENTS

1 Scope 1
2 Normative references 1
3 Terms, definitions, and abbreviations 2
3.1 Terms and definitions 2
3.2 Abbreviations and symbols 4
3.3 Used data types 4
4 Concepts 4
4.1 General 4
4.2 Conditions 4
4.3 Acknowledgeable Conditions 6
4.4 Previous states of Conditions 8
4.5 Condition state synchronization 8
4.6 Severity, quality, and comment 9
4.7 Dialogs 9
4.8 Alarms 9
4.9 Multiple active states 11
4.10 Condition instances in the AddressSpace 12
4.11 Alarm and Condition auditing 13
4.12 Alarms in a system 13
5 Model 13
5.1 General 13
5.2 Two-state state machines 14
5.3 ConditionVariable 16
5.4 ReferenceTypes 17
5.4.1 General 17
5.4.2 HasTrueSubState ReferenceType 17
5.4.3 HasFalseSubState ReferenceType 17
5.4.4 HasAlarmSuppressionGroup ReferenceType 18
5.4.5 AlarmGroupMember ReferenceType 18
5.4.6 AlarmSuppressionGroupMember ReferenceType 18
5.5 Condition Model 19
5.5.1 General 19
5.5.2 ConditionType 20
5.5.3 Condition and branch instances 24
5.5.4 Disable Method 24
5.5.5 Enable Method 25
5.5.6 AddComment Method 25
5.5.7 ConditionRefresh Method 26
5.5.8 ConditionRefresh2 Method 28
5.6 Dialog Model 30
5.6.1 General 30
5.6.2 DialogConditionType 30
5.6.3 Respond Method 31
5.6.4 Respond2 Method 32
5.7 Acknowledgeable Condition Model 33

5.7.1 General ... 33
5.7.2 AcknowledgeableConditionType ... 33
5.7.3 Acknowledge Method ... 34
5.7.4 Confirm Method ... 35
5.8 Alarm model ... 36
5.8.1 General ... 36
5.8.2 AlarmConditionType ... 37
5.8.3 AlarmGroupType ... 42
5.8.4 AlarmSuppressionGroupType ... 42
5.8.5 Reset Method ... 42
5.8.6 Reset2 Method ... 43
5.8.7 Silence Method ... 44
5.8.8 Suppress Method ... 45
5.8.9 Suppress2 Method ... 46
5.8.10 Unsuppress Method ... 46
5.8.11 Unsuppress2 Method ... 47
5.8.12 RemoveFromService Method ... 48
5.8.13 RemoveFromService2 Method ... 48
5.8.14 PlaceInService Method ... 49
5.8.15 PlaceInService2 Method ... 50
5.8.16 GetGroupMemberships Method ... 51
5.8.17 ShelvedStateMachineType ... 51
5.8.18 LimitAlarmType ... 59
5.8.19 Exclusive Limit Types ... 62
5.8.20 NonExclusiveLimitAlarmType ... 65
5.8.21 Level Alarm ... 67
5.8.22 Deviation Alarm ... 68
5.8.23 Rate of change Alarms ... 69
5.8.24 Discrete Alarms ... 70
5.8.25 DiscrepancyAlarmType ... 73
5.9 ConditionClasses ... 74
5.9.1 Overview ... 74
5.9.2 BaseConditionClassType ... 74
5.9.3 ProcessConditionClassType ... 75
5.9.4 MaintenanceConditionClassType ... 75
5.9.5 SystemConditionClassType ... 75
5.9.6 SafetyConditionClassType ... 76
5.9.7 HighlyManagedAlarmConditionClassType ... 76
5.9.8 TrainingConditionClassType ... 76
5.9.9 StatisticalConditionClassType ... 77
5.9.10 TestingConditionClassType ... 77
5.10 Audit Events ... 77
5.10.1 Overview ... 77
5.10.2 AuditConditionEventType ... 78
5.10.3 AuditConditionEnableEventType ... 79
5.10.4 AuditConditionCommentEventType ... 79
5.10.5 AuditConditionRespondEventType ... 79
5.10.6 AuditConditionAcknowledgeEventType ... 79

5.10.7 AuditConditionConfirmEventType 80
5.10.8 AuditConditionShelvingEventType 80
5.10.9 AuditConditionSuppressionEventType 80
5.10.10 AuditConditionSilenceEventType 81
5.10.11 AuditConditionResetEventType 81
5.10.12 AuditConditionOutOfServiceEventType 81
5.11 Condition Refresh related Events 82
5.11.1 Overview 82
5.11.2 RefreshStartEventType 82
5.11.3 RefreshEndEventType 82
5.11.4 RefreshRequiredEventType 83
5.12 HasCondition Reference type 83
5.13 Alarm & Condition status codes 83
5.14 Expected A & C server behaviours 84
5.14.1 General 84
5.14.2 Communication problems 84
5.14.3 Redundant A & C servers 84
6 AddressSpace organisation 85
6.1 General 85
6.2 EventNotifier and source hierarchy 85
6.3 Adding Conditions to the hierarchy 85
6.4 Conditions in InstanceDeclarations 86
6.5 Conditions in a VariableType 86
7 System State & Alarms 88
7.1 Overview 88
7.2 HasEffectDisable 88
7.3 HasEffectEnable 88
7.4 HasEffectSuppressed 89
7.5 HasEffectUnsuppressed 89
8 Alarm Summary and Objects 90
8.1 Overview 90
8.2 AlarmState Variable 91
8.3 AlarmMask 92
9 Alarm Metrics 92
9.1 Overview 92
9.2 AlarmMetricsType 93
9.3 AlarmRateVariableType 94
9.4 Reset Method 94
Annex A (informative) Recommended localized names 95
A.1 Recommended state names for TwoState Variables 95
A.1.1 LocaleId “en” 95
A.1.2 LocaleId “de” 95
A.1.3 LocaleId “fr” 96
A.2 Recommended dialog response options 96
Annex B (informative) Examples 98
B.1 Examples for Event sequences from Condition instances 98
B.1.1 Overview 98

B.1.2 Server maintains current state only 98
B.1.3 Server maintains previous states 98
B.1.4 Server current-State Model with Suppression 100
B.1.5 Example for On-Delay, Off Delay and ReAlarmTime 101
B.2 AddressSpace examples 102
Annex C (informative) Mapping to EEMUA 105
Annex D (informative) Mapping from OPC A&E to OPC UA A & C 106
D.1 Overview 106
D.2 Alarms and Events COM UA wrapper 106
D.2.1 Event areas 106
D.2.2 Event sources 106
D.2.3 Event categories 107
D.2.4 Event attributes 108
D.2.5 Event subscriptions 108
D.2.6 Condition instances 110
D.2.7 Condition Refresh 111
D.3 Alarms and Events COM UA proxy 111
D.3.1 General 111
D.3.2 Server status mapping 111
D.3.3 Event Type mapping 111
D.3.4 Event category mapping 112
D.3.5 Event Category attribute mapping 113
D.3.6 Event Condition mapping 116
D.3.7 Browse mapping 116
D.3.8 Qualified names 117
D.3.9 Subscription filters 118
Annex E – IEC 62682 Mapping 120
E.1 Overview 120
E.2 Terms 120
E.3 Alarm records & State Indications 124
Annex F System State (Informative) 125
F.1 Overview 125
F.2 SystemStateStateMachineType 126

Figures

Figure 1 – Base Condition state model 5
Figure 2 – AcknowledgeableConditions state model 6
Figure 5 – Alarm state machine model 10
Figure 6 – Typical Alarm Timeline example 11
Figure 7 – Multiple active states example 12
Figure 8 – ConditionType hierarchy 14
Figure 10 – Condition model 20
Figure 12 – DialogConditionType Overview 30
Figure 13 – AcknowledgeableConditionType overview 33

Figure 14 – AlarmConditionType Hierarchy Model 37
Figure 15 – Alarm Model 38
Figure 16 – Shelve state transitions 52
Figure 17 – ShelvedStateMachineType model 53
Figure 18 – LimitAlarmType 60
Figure 19 – ExclusiveLimitStateMachineType 63
Figure 20 – ExclusiveLimitAlarmType 65
Figure 21 – NonExclusiveLimitAlarmType 66
Figure 22 – DiscreteAlarmType Hierarchy 71
Figure 23 – ConditionClass type hierarchy 74
Figure 24 – AuditEvent hierarchy 78
Figure 25 – Refresh Related Event Hierarchy 82
Figure 26 – Typical HasNotifier Hierarchy 85
Figure 27 – Use of HasCondition in a HasNotifier hierarchy 86
Figure 28 – Use of HasCondition in an InstanceDeclaration 86
Figure 29 – Use of HasCondition in a VariableType 87
Figure B.1 – Single state example 98
Figure B.2 – Previous state example 99
Figure B.3 – SuppressedState and OutOfServiceState example 100
Figure B.5 – HasCondition used with Condition instances 103
Figure B.6 – HasCondition reference to a Condition type 104
Figure B.7 – HasCondition used with an instance declaration 104
Figure D.1 – The type model of a wrapped COM AE server 108
Figure D.2 – Mapping UA Event Types to COM A&E Event Types 112
Figure D.3 – Example mapping of UA Event Types to COM A&E categories 113
Figure D.4 – Example mapping of UA Event Types to A&E categories with attributes 116
Figure F.1 – SystemState transitions 125
Figure F.2 – SystemStateStateMachineType Model 126

TABLES

Table 1 – Parameter types defined in 10000-3 4
Table 2 – Parameter types defined in 10000-4 4
Table 3 – TwoStateVariableType definition 14
Table 4 – ConditionVariableType definition 16
Table 5 – HasTrueSubState ReferenceType 17
Table 6 – HasFalseSubState ReferenceType 18
Table 7 – HasAlarmSuppressionGroup ReferenceType 18
Table 8 – AlarmGroupMember ReferenceType 18
Table 9 – AlarmSuppressionGroupMember ReferenceType 19
Table 10 – ConditionType definition 21
Table 11 – ConditionType Additional Subcomponents 21

Table 12 – ConditionId SimpleAttributeOperand Illustration 24
Table 13 – Disable result codes 24
Table 14 – Disable Method AddressSpace definition 25
Table 15 – Enable result codes 25
Table 16 – Enable Method AddressSpace definition 25
Table 17 – AddComment arguments 26
Table 18 – AddComment result codes 26
Table 19 – AddComment Method AddressSpace definition 26
Table 20 – ConditionRefresh parameters 27
Table 21 – ConditionRefresh result codes 27
Table 22 – ConditionRefresh Method AddressSpace definition 28
Table 23 – ConditionRefresh2 parameters 28
Table 24 – ConditionRefresh2 result codes 29
Table 25 – ConditionRefresh2 Method AddressSpace definition 29
Table 26 – DialogConditionType definition 30
Table 27 – DialogConditionType Additional Subcomponents 30
Table 28 – Respond parameters 31
Table 29 – Respond Result Codes 31
Table 30 – Respond Method AddressSpace definition 32
Table 31 – Respond2 parameters 32
Table 32 – Respond2 Result Codes 32
Table 33 – Respond2 Method AddressSpace definition 32
Table 34 – AcknowledgeableConditionType definition 33
Table 35 – AcknowledgeableConditionType Additional Subcomponents 33
Table 36 – Acknowledge parameters 34
Table 37 – Acknowledge result codes 34
Table 38 – Acknowledge Method AddressSpace definition 35
Table 39 – Confirm Method parameters 35
Table 40 – Confirm result codes 35
Table 41 – Confirm Method AddressSpace definition 36
Table 42 – AlarmConditionType definition 38
Table 43 – AlarmConditionType Additional Subcomponents 39
Table 44 – AlarmGroupType definition 42
Table 45 – AlarmSuppressionGroupType definition 42
Table 46 – Reset result codes 43
Table 47 – Reset Method AddressSpace definition 43
Table 48 – Reset2 Method parameters 43
Table 49 – Reset2 result codes 44
Table 50 – Reset2 Method AddressSpace definition 44
Table 51 – Silence result codes 44
Table 52 – Silence Method AddressSpace definition 45
Table 53 – Suppress result codes 45

Table 54 – Suppress Method AddressSpace definition 45
Table 55 – Suppress2 Method parameters 46
Table 56 – Suppress2 Method AddressSpace definition 46
Table 57 – Unsuppress result codes 47
Table 58 – Unsuppress Method AddressSpace definition 47
Table 59 – Unsuppress2 Method parameters 47
Table 60 – Unsuppress2 Method AddressSpace definition 48
Table 61 – RemoveFromService result codes 48
Table 62 – RemoveFromService Method AddressSpace definition 48
Table 63 – RemoveFromService2 Method parameters 49
Table 64 – RemoveFromService2 result codes 49
Table 65 – RemoveFromService2 Method AddressSpace definition 49
Table 66 – PlaceInService result codes 50
Table 67 – PlaceInService Method AddressSpace definition 50
Table 68 – PlaceInService2 Method parameters 50
Table 69 – PlaceInService2 result codes 50
Table 70 – PlaceInService2 Method AddressSpace definition 51
Table 71 – GetGroupMemberships result codes 51
Table 72 – GetGroupMemberships Method AddressSpace definition 51
Table 73 – ShelvedStateMachineType definition 53
Table 74 – ShelvedStateMachineType Additional References 54
Table 76 – Unshelve result codes 55
Table 77 – Unshelve Method AddressSpace definition 55
Table 78 – Unshelve2 Method parameters 55
Table 79 – Unshelve2 result codes 56
Table 80 – Unshelve2 Method AddressSpace definition 56
Table 81 – TimedShelve parameters 56
Table 82 – TimedShelve result codes 56
Table 83 – TimedShelve Method AddressSpace definition 57
Table 84 – TimedShelve2 parameters 57
Table 85 – TimedShelve2 result codes 57
Table 86 – TimedShelve2 Method AddressSpace definition 58
Table 87 – OneShotShelve result codes 58
Table 88 – OneShotShelve Method AddressSpace definition 58
Table 89 – OneShotShelve2 Method parameters 59
Table 90 – OneShotShelve2 result codes 59
Table 91 – OneShotShelve2 Method AddressSpace definition 59
Table 92 – LimitAlarmType definition 61
Table 93 – ExclusiveLimitStateMachineType definition 63
Table 94 – ExclusiveLimitStateMachineType Additional References 64
Table 96 – ExclusiveLimitAlarmType definition 65
Table 97 – NonExclusiveLimitAlarmType definition 66

Table 98 – NonExclusiveLimitAlarmType Additional Subcomponents 67
Table 99 – NonExclusiveLevelAlarmType definition 67
Table 100 – ExclusiveLevelAlarmType definition 68
Table 101 – NonExclusiveDeviationAlarmType definition 68
Table 102 – ExclusiveDeviationAlarmType definition 69
Table 103 – NonExclusiveRateOfChangeAlarmType definition 70
Table 104 – ExclusiveRateOfChangeAlarmType definition 70
Table 105 – DiscreteAlarmType definition 71
Table 106 – OffNormalAlarmType definition 71
Table 107 – SystemOffNormalAlarmType definition 72
Table 108 – TripAlarmType definition 72
Table 109 – InstrumentDiagnosticAlarmType definition 72
Table 110 – SystemDiagnosticAlarmType definition 73
Table 111 – CertificateExpirationAlarmType definition 73
Table 112 – DiscrepancyAlarmType definition 73
Table 113 – BaseConditionClassType definition 75
Table 114 – ProcessConditionClassType definition 75
Table 115 – MaintenanceConditionClassType definition 75
Table 116 – SystemConditionClassType definition 76
Table 117 – SafetyConditionClassType definition 76
Table 118 – HighlyManagedAlarmConditionClassType definition 76
Table 119 – TrainingConditionClassType definition 77
Table 120 – StatisticalConditionClassType definition 77
Table 121 – TestingConditionClassType definition 77
Table 122 – AuditConditionEventType definition 78
Table 123 – AuditConditionEnableEventType definition 79
Table 124 – AuditConditionCommentEventType definition 79
Table 125 – AuditConditionRespondEventType definition 79
Table 126 – AuditConditionAcknowledgeEventType definition 80
Table 127 – AuditConditionConfirmEventType definition 80
Table 128 – AuditConditionShelvingEventType definition 80
Table 129 – AuditConditionSuppressionEventType definition 81
Table 130 – AuditConditionSilenceEventType definition 81
Table 131 – AuditConditionResetEventType definition 81
Table 132 – AuditConditionOutOfServiceEventType definition 81
Table 133 – RefreshStartEventType definition 82
Table 134 – RefreshEndEventType definition 82
Table 135 – RefreshRequiredEventType definition 83
Table 136 – HasCondition *ReferenceType* Definition 83
Table 137 – Alarm & Condition result codes 84
Table 138 – HasEffectDisable ReferenceType 88
Table 139 – HasEffectEnable ReferenceType 89

Table 140 – HasEffectSuppressed ReferenceType 89
Table 141 – HasEffectUnsuppressed ReferenceType 90
Table 142 – AlarmStateVariableType definition 92
Table 143 – AlarmMask values 92
Table 144 – AlarmMask definition 92
Table 145 – AlarmMetricsType Definition 93
Table 146 – AlarmRateVariableType Definition 94
Table 147 – Suppress result codes 94
Table 148 – Reset Method AddressSpace Definition 94
Table A.1 – Recommended state names for LocaleId “en” 95
Table A.2 – Recommended DisplayNames for LocaleId “en” 95
Table A.3 – Recommended state names for LocaleId “de” 96
Table A.4 – Recommended DisplayNames for LocaleId “de” 96
Table A.5 – Recommended state names for LocaleId “fr” 96
Table A.6 – Recommended DisplayNames for LocaleId “fr” 96
Table A.7 – Recommended dialog response options 97
Table B.1 – Example of a Condition that only keeps the latest state 98
Table B.2 – Example of a *Condition* that maintains previous states via branches 99
Table B.3 – Example of a Condition that is Suppressed / OutOfService 101
Table C.1 – EEMUA Terms 105
Table D.1 – Mapping from standard Event categories to OPC UA Event types 107
Table D.2 – Mapping from ONEVENTSTRUCT fields to UA BaseEventType Variables 109
Table D.3 – Mapping from ONEVENTSTRUCT fields to UA AuditEventType Variables 109
Table D.4 – Mapping from ONEVENTSTRUCT fields to UA AlarmType Variables 110
Table D.5 – Event category attribute mapping table 113
Table F.1 – SystemStateStateMachineType definition 127
Table F.2 – SystemStateStateMachineType additional references 128

OPC FOUNDATION

UNIFIED ARCHITECTURE –

FOREWORD

This specification is the specification for developers of OPC UA applications. The specification is a result of an analysis and design process to develop a standard interface to facilitate the development of applications by multiple vendors that shall inter-operate seamlessly together.

AGREEMENT OF USE

GENERAL PROVISIONS

Should any provision of this Agreement be held to be void, invalid, unenforceable or illegal by a court, the validity and enforceability of the other provisions shall not be affected thereby.

This Agreement shall be governed by and construed under the laws of the State of Minnesota, excluding its choice or law rules.

This Agreement embodies the entire understanding between the parties with respect to, and supersedes any prior understanding or agreement (oral or written) relating to, this specification.

ISSUE REPORTING

The OPC Foundation strives to maintain the highest quality standards for its published specifications, hence they undergo constant review and refinement. Readers are encouraged to report any issues and view any existing errata here: http://www.opcfoundation.org/errata

Revision 1.05.03 Highlights

The following table includes the Mantis issues resolved with this revision.

Mantis ID	Scope	Summary	Resolution
8421	Errata	For the AcknowledgeableConditionType the text in an error description references ConditionType	Change ConditionType to AcknowledgeableConditionTypeA
9022	Errata	ConditionId needs further clarification	Added text to explain that ConditionId have to remain constant

OPC Unified Architecture Specification

Part 9: Alarms & Conditions

1 Scope

This document specifies the representation of *Alarms* and *Conditions* in the OPC Unified Architecture. Included is the *Information Model* representation of *Alarms* and *Conditions* in the OPC UA address space. Other aspects of alarm systems like alarm philosophy, life cycle, alarm response times, alarm types and many other details are captured in standards such as IEC 62682 and ISA 18.2. The *Alarms* and *Conditions Information Model* in this specification, is designed in accordance with IEC 62682 and ISA 18.2. Annex C specifies how the model described in this document maps to EEMUA. Annex D specifies a recommended mapping between OPC Classic Alarm & Events (A&E) servers to the model described in this document.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application.

10000-1: OPC UA Specification: Part 1 – Concepts

https://www.opcfoundation.org/UA/Part1/

10000-3: OPC UA Specification: Part 3 – Address Space Model

https://www.opcfoundation.org/UA/Part3/

10000-4: OPC UA Specification: Part 4 – Services

https://www.opcfoundation.org/UA/Part4/

10000-5: OPC UA Specification: Part 5 – Information Model

https://www.opcfoundation.org/UA/Part5/

10000-6: OPC UA Specification: Part 6 – Mappings

https://www.opcfoundation.org/UA/Part6/

10000-7: OPC UA Specification: Part 7 – Profiles

https://www.opcfoundation.org/UA/Part7/

10000-8: OPC UA Specification: Part 8 – Data Access

https://www.opcfoundation.org/UA/Part8/

10000-11: OPC UA Specification: Part 11 – Historical Access

https://www.opcfoundation.org/UA/Part11/

10000-16: OPC UA Specification: Part 16 – State Machines

https://www.opcfoundation.org/UA/Part16/

EEMUA: 2nd Edition EEMUA 191 – Alarm System – A guide to design, management and procurement (Appendixes 6, 7, 8, 9)

https://www.eemua.org/Products/Publications/Print/EEMUA-Publication-191.aspx

IEC 62682: Management of alarm systems for the process industries (Edition 1.0 2014-10)

https://webstore.iec.ch/publication/7363

ISA 18.2: Management of Alarm Systems for the Process Industries

https://webstore.ansi.org/Standards/ISA/ansiisa182016

IETF RFC 2045: Multipurpose Internet Mail Extensions (MIME) Part One

https://www.ietf.org/rfc/rfc2045.txt

IETF RFC 2046: Multipurpose Internet Mail Extensions (MIME) Part Two

https://www.ietf.org/rfc/rfc2046.txt

IETF RFC 2047: Multipurpose Internet Mail Extensions (MIME) Part Three

https://www.ietf.org/rfc/rfc2047.txt

3 Terms, definitions, and abbreviations

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in 10000-1, 10000-3, 10000-4, and 10000-5 as well as the following apply.

3.1.1
Acknowledge
Operator action that indicates recognition of an *Alarm*

Note 1 to entry: This definition is copied from EEMUA. The term “Accept” is another common term used to describe *Acknowledge*. They can be used interchangeably. This document will use *Acknowledge.*

3.1.2
Active
state for an *Alarm* that indicates that the situation the *Alarm* is representing currently exists

Note 1 to entry: Other common terms defined by EEMUA are “Standing” for an *Active Alarm* and “Cleared” when the *Condition* has returned to normal and is no longer *Active*.

3.1.3
AdaptiveAlarm
Alarm for which the set point or limits are changed by an algorithm.

Note 1 to entry: *AdaptiveAlarms* are alarms that are adjusted automatically by algorithms. These algorithms might detect conditions in a plant and change setpoints or limits to keep alarms from occurring. These changes occur, in many cases, without *Operator* interactions.

3.1.4
AlarmFlood
condition during which the alarm rate is greater than the *Operator* can effectively manage

Note 1 to entry: OPC UA does not define the conditions that would be considered alarm flooding, these conditions are defined in other specification such as IEC 62682 or ISA 18.2

3.1.5
AlarmManager
application that manages alarms in a system

Note 1 An *AlarmManager* usually includes higher level functionality like intelligent alarm suppression or dynamic adjustment of limits or other alarm management functionality. It will still act on the alarm model associated with the actual alarm source.

3.1.6
AlarmSuppressionGroup
group of *Alarms* that is used to suppress other *Alarms*.

Note 1 to entry: An *AlarmSuppressionGroup* is an instance of an *AlarmGroupType* that is used to suppress other *Alarms*. If any *Alarm* in the group is active, then the *AlarmSuppressionGroup* is active. If all *Alarms* in the *AlarmSuppressionGroup* are inactive then the *AlarmSuppressionGroup* is inactive.

Note 2 to entry: The *Alarm* to be affected references *AlarmSuppressionGroups* with a *HasAlarmSuppressionGroup ReferenceType*.

3.1.7
ConditionClass
Condition grouping that indicates in which domain or for what purpose a certain *Condition* is used

Note 1 to entry: Some top-level *ConditionClasses* are defined in this specification. Vendors or organisations may derive more concrete classes or define different top-level classes.

3.1.8
ConditionBranch
specific state of a *Condition*

Note 1 to entry: The *Server* can maintain *ConditionBranches* for the current state as well as for previous states.

3.1.9
ConditionSource
element which a specific *Condition* is based upon or related to

Note 1 to entry: Typically, it will be a *Variable* representing a process tag (e.g. FIC101) or an *Object* representing a device or subsystem.

In *Events* generated for *Conditions*, the *SourceNode Property* (inherited from the *BaseEventType*) will contain the *NodeId* of the *ConditionSource*.

3.1.10
Confirm
Operator action informing the *Server* that a corrective action has been taken to address the cause of the *Alarm*

3.1.11
Disable
system is configured such that the *Alarm* will not be generated even though the base *Alarm Condition* is present

Note 1 to entry: This definition is copied from EEMUA and is further defined in EEMUA.

In IEC 62682 disable has been replaced with “Out of Service”.

3.1.12
LatchingAlarm
alarm that remains in alarm state after the process condition has returned to normal and requires an *Operator* reset before the alarm returns to normal

Note 1 to entry: Latching alarms are typically discrepancy alarms, where an action does not occur within a specific time. Once the action occurs the alarm stays active until it is reset.

3.1.13
Operator
special user who is assigned to monitor and control a portion of a process

Note 1 to entry: “A Member of the operations team who is assigned to monitor and control a portion of the process and is working at the control system’s Console” as defined in EEMUA. In this standard an Operator is a special user. All descriptions that apply to general users also apply to Operators.

3.1.14
Refresh
act of providing an update to an *Event Subscription* that provides all *Alarms* which are considered to be *Retained*

Note 1 to entry: This concept is further defined in EEMUA.

3.1.15
Retain
Alarm in a state that is interesting for a *Client* wishing to synchronize its state of *Conditions* with the *Server*’s state

3.1.16
Shelving
facility where the *Operator* is able to temporarily prevent an *Alarm* from being displayed to the *Operator* when it is causing the *Operator* a nuisance

Note 1 to entry "A Shelved *Alarm* will be removed from the list and will not re-annunciate until un-shelved." as defined in EEMUA.

3.1.17
Suppress
act of determining whether an *Alarm* should not occur

Note 1 to entry: "An Alarm is suppressed when logical criteria are applied to determine that the Alarm should not occur, even though the base Alarm Condition (e.g. Alarm setting exceeded) is present" as defined in EEMUA. In IEC 62682 Suppressed Alarms are also described as being "Suppressed by Design", in that the system is designed with logic to Suppress an Alarm when certain criteria exist. For example, if a process unit is taken off line then low level alarms are Suppressed for all equipment in the off-line unit.

3.2 Abbreviations and symbols

A&E Alarm & Event (as used for OPC COM)

COM (Microsoft Windows) Component Object Model

DA Data Access

MIME Multipurpose Internet Mail Extensions

UA Unified Architecture

3.3 Used data types

The following tables describe the data types that are used throughout this document. These types are separated into two tables. Base data types defined in 10000-3 are given in Table 1. The base types and data types defined in 10000-4 are given in Table 2.

Table 1 – Parameter types defined in 10000-3

Parameter Type
Argument
BaseDataType
NodeId
LocalizedText
Boolean
ByteString
Double
Duration
String
UInt16
Int32
UtcTime

Table 2 – Parameter types defined in 10000-4

Parameter Type
IntegerId
StatusCode

4 Concepts

4.1 General

This standard defines an *Information Model* for *Conditions*, Dialog *Conditions*, and *Alarms* including acknowledgement capabilities. It is built upon and extends base Event handling which is defined in 10000-3, 10000-4 and 10000-5. This *Information Model* can also be extended to support the additional needs of specific domains. The details of what aspects of the Information Model are supported are defined via Profiles (see 10000-7 for Profile definitions). Some systems may expose historical Events and Conditions via the standard Historical Access framework (see 10000-11 for Historical Event definitions).

4.2 Conditions

Conditions are used to represent the state of a system or one of its components. Some common examples are:

- a temperature exceeding a configured limit
- a device needing maintenance
- a batch process that requires a user to confirm some step in the process before proceeding

Each *Condition* instance is of a specific *ConditionType*. The *ConditionType* and derived types are sub-types of the *BaseEventType* (see 10000-3 and 10000-5). This part defines types that are common across many industries. It is expected that vendors or other standardisation groups will define additional *ConditionTypes* deriving from the common base types defined in this part. The *ConditionTypes* supported by a *Server* are exposed in the *AddressSpace* of the *Server*.

Condition instances are specific implementations of a *ConditionType*. It is up to the *Server* whether such instances are also exposed in the *Server's AddressSpace*. Clause 4.10 provides additional background about *Condition* instances. *Condition* instances shall have a unique identifier to differentiate them from other instances. This is independent of whether they are exposed in the *AddressSpace*.

As mentioned above, *Conditions* represent the state of a system or one of its components. In certain cases, however, previous states that still need attention also have to be maintained. *ConditionBranches* are introduced to deal with this requirement and distinguish current state and previous states. Each *ConditionBranch* has a BranchId that differentiates it from other branches of the same *Condition* instance. The *ConditionBranch* which represents the current state of the *Condition* (the trunk) has a NULL BranchId. *Server*s can generate separate *Event Notifications* for each branch. When the state represented by a *ConditionBranch* does not need further attention, a final *Event Notification* for this branch will have the *Retain Property* set to False. Clause 5.5 provides more information and use cases. Maintaining previous states and therefore the support of multiple branches is optional for *Servers*.

Conceptually, the lifetime of the *Condition* instance is independent of its state. However, *Servers* may provide access to *Condition* instances only while *ConditionBranches* exist.

The base *Condition* state model is illustrated in Figure 1. It is extended by the various *Condition* subtypes defined in this standard and may be further extended by vendors or other standardisation groups. The primary states of a *Condition* are disabled and enabled. The *Disabled* state is intended to allow *Conditions* to be turned off at the *Server* or below the *Server* (in a device or some underlying system). The *Enabled* state is normally extended with the addition of sub-states.

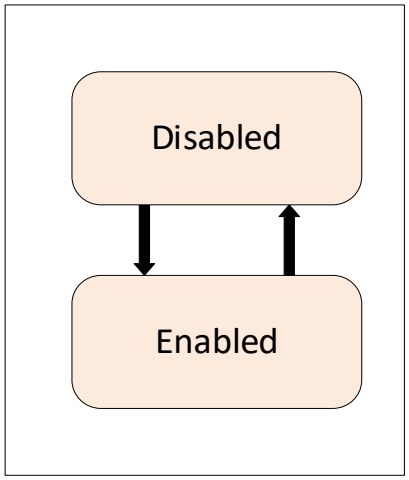


Figure 1 – Base Condition state model

A transition into the *Disabled* state results in a *Condition Event* however no subsequent *Event Notifications* are generated until the *Condition* returns to the Enabled state.

ISA 18.2 and IEC 62682, which are the basis for this information model, no longer support enabling and disabling of alarms. As a result, even though this feature is still supported for backward compatibility it is recommended that alarms never be disabled.

When a *Condition* enters the Enabled state, that transition and all subsequent transitions result in *Condition Events* being generated by the *Server*.

If *Auditing* is supported by a *Server*, the following *Auditing* related action shall be performed. The *Server* will generate *AuditEvents* for *Enable* and *Disable* operations (either through a *Method* call or some *Server* / vendor – specific means), rather than generating an *AuditEvent Notification* for each *Condition* instance being enabled or disabled. For more information, see the definition of *AuditConditionEnableEventType* in 5.10.2. *AuditEvents* are also generated for any other *Operator* action that results in changes to the *Conditions*.

4.3 Acknowledgeable Conditions

AcknowledgeableConditions are sub-types of the base *ConditionType*. *AcknowledgeableConditions* expose states to indicate whether a *Condition* has to be acknowledged or confirmed.

An *AckedState* and a *ConfirmedState* extend the *EnabledState* defined by the *Condition*. The state model is illustrated in Figure 2. The enabled state is extended by adding the *AckedState* and (optionally) the *ConfirmedState*.

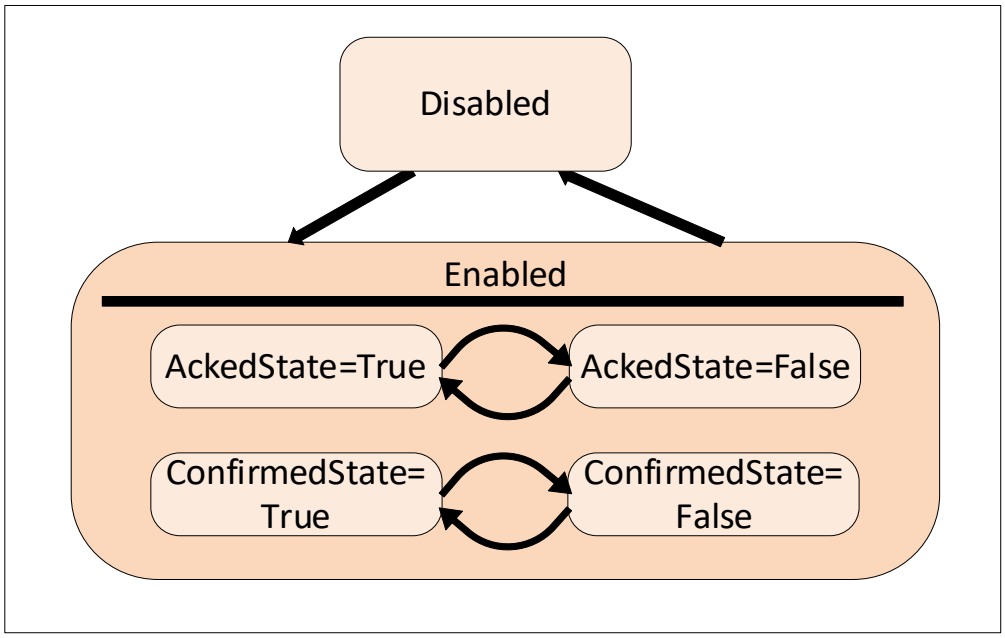


Figure 2 – AcknowledgeableConditions state model

Acknowledgment of the transition may come from the *Client* or may be due to some logic internal to the *Server*. For example, acknowledgment of a related *Condition* may result in this *Condition* becoming acknowledged, or the *Condition* may be set up to automatically *Acknowledge* itself when the acknowledgeable situation disappears.

Two *Acknowledge* state models are supported by this standard. Either of these state models can be extended to support more complex acknowledgement situations.

The basic *Acknowledge* state model is illustrated in Figure 3. This model defines an AckedState. The specific state changes that result in a change to the state depend on a Server's implementation. For example, in typical *Alarm* models the change is limited to a transition to the *Active* state or transitions within the *Active* state. More complex models however can also allow for changes to the AckedState when the *Condition* transitions to an inactive state.

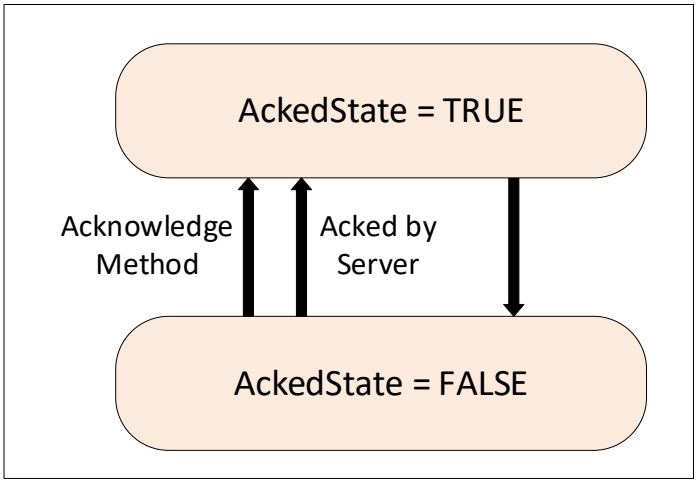


Figure 3 - Acknowledge State Model

A more complex state model which adds a confirmation to the basic *Acknowledge* is illustrated in Figure 4. The *Confirmed Acknowledge* model is typically used to differentiate between acknowledging the presence of a *Condition* and having done something to address the *Condition*. For example, an *Operator* receiving a motor high temperature *Notification* calls the *Acknowledge Method* to inform the *Server* that the high temperature has been observed. The *Operator* then takes some action such as lowering the load on the motor in order to reduce the temperature. The *Operator* then calls the *Confirm Method* to inform the *Server* that a corrective action has been taken.

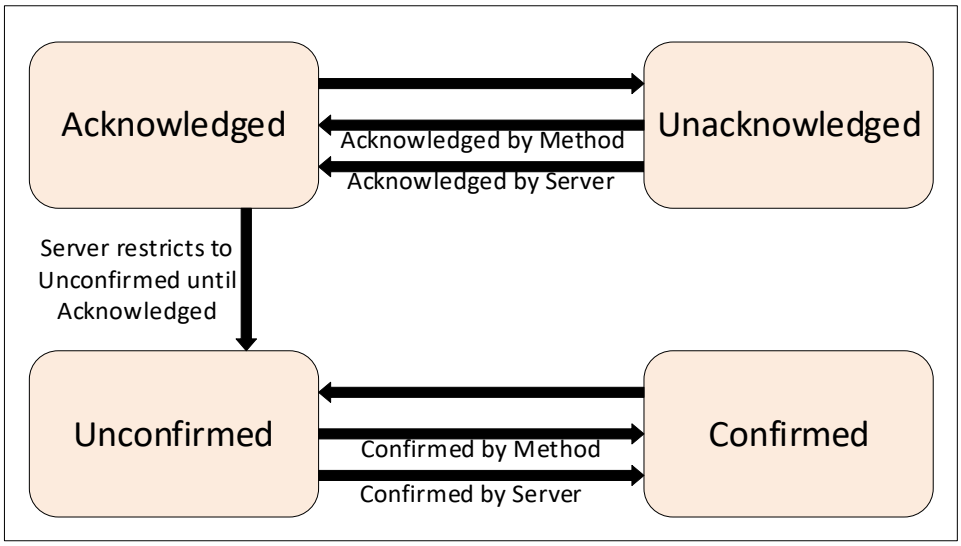


Figure 4 - Confirm acknowledge State model

The *AcknowledgeableConditions* model can also be used for a simple *Condition* that requires a confirmation. For example, a motor start event might need to be acknowledged by an operator, this event is not an alarm, just an action that needs to be acknowledged by the operator. It could also be an event that is generated for an operator change of a process input (grade of paper being made) that needs to be acknowledged. It is not something that requires an anwser like a question, for this there are *DialogCondition*. It is just an acknowledge that the operator observed the change.

4.4 Previous states of Conditions

Some systems require that previous states of a *Condition* are preserved for some time. A common use case is the acknowledgement process. In certain environments, it is required to acknowledge both the transition into *Active* state and the transition into an inactive state. Systems with strict safety rules sometimes require that every transition into *Active* state has to be acknowledged. In situations where state changes occur in short succession there can be multiple unacknowledged states and the *Server* maintains *ConditionBranches* for all previous unacknowledged states. These branches will be deleted after they have been acknowledged or if they reached their final state.

Multiple ConditionBranches can also be used for other use cases where snapshots of previous states of a *Condition* require additional actions.

4.5 Condition state synchronization

When a *Client* subscribes for *Events*, the *Notification* of transitions will begin at the time of the *Subscription*. The currently existing state will not be reported. This means for example that *Clients* are not informed of currently *Active Alarms* until a new state change occurs.

Clients can obtain the current state of all *Condition* instances that are in an interesting state, by requesting a *Refresh* for a *Subscription*. It should be noted that *Refresh* is not a general replay capability since the *Server* is not required to maintain an *Event* history.

Clients request a *Refresh* by calling the ConditionRefresh *Method*. The *Server* will respond with a *RefreshStartEventType Event*. This *Event* is followed by the *Retained Conditions*. The *Server* may also send new *Event Notifications* interspersed with the *Refresh* related *Event Notifications*. After the *Server* is done with the *Refresh*, a *RefreshEndEvent* is issued marking the completion of the Refresh. *Clients* shall check for multiple *Event Notifications* for a *ConditionBranch* to avoid overwriting a new state delivered together with an older state from the *Refresh* process. If a *ConditionBranch* exists, then the current *Condition* shall be reported. This is True even if the only interesting item regarding the *Condition* is that *ConditionBranches* exist. This allows a *Client* to accurately represent the current *Condition* state.

A *Client* that wishes to display the current status of *Alarms* and *Conditions* (known as a “current *Alarm* display”) would use the following logic to process *Refresh Event Notifications*. The *Client* flags all *Retained Conditions* as suspect on reception of the *Event* of the *RefreshStartEventType*. The *Client* adds any new *Events* that are received during the Refresh without flagging them as suspect. The *Client* also removes the suspect flag from any *Retained Conditions* that are returned as part of the Refresh. When the *Client* receives a *RefreshEndEvent*, the *Client* removes any remaining suspect *Events*, since they no longer apply.

The following items should be noted with regard to ConditionRefresh:

- As described in 4.4 some systems require that previous states of a *Condition* are preserved for some time. Some *Servers* – in particular if they require acknowledgement of previous states – will maintain separate *ConditionBranches* for prior states that still need attention.

  ConditionRefresh shall issue *Event Notifications* for all interesting states (current and previous) of a *Condition* instance and *Clients* can therefore receive more than one *Event* for a *Condition* instance with different BranchIds.

- Under some circumstances a *Server* may not be capable of ensuring the *Client* is fully in sync with the current state of *Condition* instances. For example, if the underlying system represented by the *Server* is reset or communications are lost for some period of time the *Server* may need to resynchronize itself with the underlying system. In these cases, the *Server* shall send an *Event* of the *RefreshRequiredEventType* to advise the *Client* that a *Refresh* may be necessary. A *Client* receiving this special *Event* should initiate a *ConditionRefresh* as noted in this clause.
- To ensure a *Client* is always informed, the three special *EventTypes* (*RefreshEndEventType*, *RefreshStartEventType* and *RefreshRequiredEventType*)

ignore the *Event* content filtering associated with a *Subscription* and will always be delivered to the *Client*.

- ConditionRefresh applies to a *Subscription*. If multiple Event Notifiers are included in the same *Subscription*, all *Event Notifiers* are refreshed.

4.6 Severity, quality, and comment

Comment, severity and quality are important elements of *Conditions* and any change to them will cause *Event Notification*s.

The Severity of a *Condition* is inherited from the base *Event* model defined in 10000-5. It indicates the urgency of the *Condition* and is also commonly called ‘priority’, especially in relation to *Alarms* in the *ProcessConditionClassType*.

A Comment is a user generated string that is to be associated with a certain state of a *Condition*.

Quality refers to the quality of the data value(s) upon which this *Condition* is based. Since a *Condition* is usually based on one or more *Variables*, the *Condition* inherits the quality of these *Variables*. E.g., if the process value is “Uncertain”, the “Level Alarm” *Condition* is also questionable. If more than one variable is represented by a given condition or if the condition is from an underlining system and no direct mapping to a variable is available, it is up to the application to determine what quality is displayed as part of the condition.

4.7 Dialogs

Dialogs are *ConditionTypes* used by a *Server* to request user input. They are typically used when a *Server* has entered some state that requires intervention by a *Client*. For example, a *Server* monitoring a paper machine indicates that a roll of paper has been wound and is ready for inspection. The *Server* would activate a Dialog *Condition* indicating to the user that an inspection is required. Once the inspection has taken place the user responds by informing the *Server* of an accepted or unaccepted inspection allowing the process to continue.

4.8 Alarms

Alarms are specializations of *AcknowledgeableConditions* that add the concepts of an *Active* state and other states like *Shelving* state and *Suppressed* state to a *Condition*. The state model is illustrated in Figure 5. The complete model with all states is defined in 5.8.

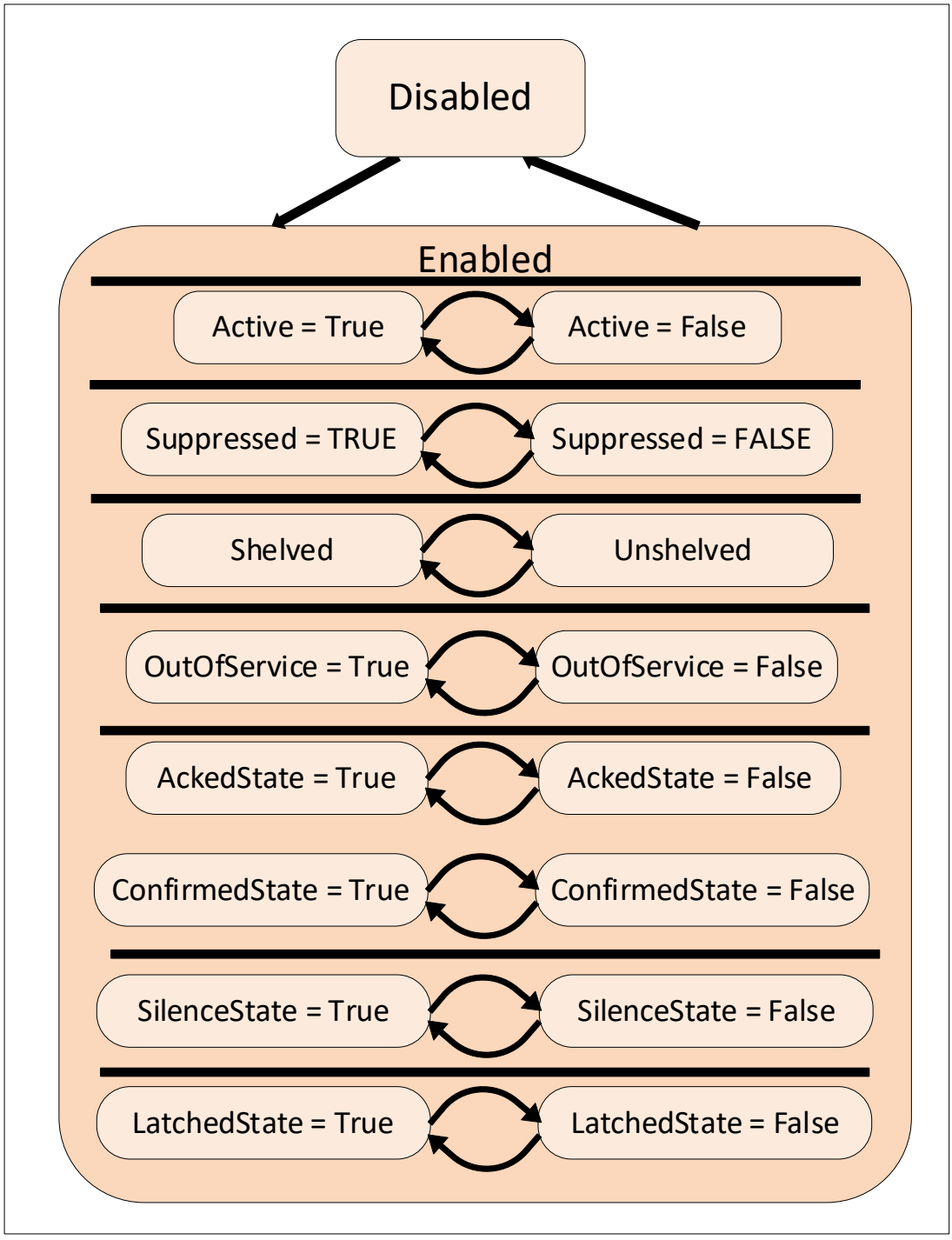


Figure 5 – Alarm state machine model

An *Alarm* in the *Active* state indicates that the situation the *Condition* is representing currently exists. When an *Alarm* is an inactive state it is representing a situation that has returned to a normal state.

Some *Alarm* subtypes introduce sub-states of the *Active* state. For example, an *Alarm* representing a temperature may provide a high level state as well as a critically high state (see following Clause).

The shelving state can be set by an *Operator* via OPC UA *Methods*. The suppressed state is set internally by the *Server* due to system specific reasons. *Alarm* systems typically implement

the suppress, out of service and shelve features to help keep *Operators* from being overwhelmed during *Alarm* "storms" by limiting the number of *Alarms* an *Operator* sees on a current *Alarm* display. This is accomplished by setting the *SuppressedOrShelved* flag on second order dependent *Alarms* and/or *Alarms* of less severity, leading the *Operator* to concentrate on the most critical issues.

The LatchedState is a state that is added to any alarm that requires additional processing, once it goes active it does not clear until it is explicitly reset, even if the value that triggered the alarm returns to normal. This might be an alarm that requires a physical inspection once it has occurred to ensure it is no longer in alarm, or a series of tests that might be required to ensure the alarm is no longer active or some other actions. Any AlarmType can become a latched alarm by the addition of this optional sub-state.

The shelved, out of service and suppressed states differ from the *Disabled* state in that *Alarms* are still fully functional and can be included in *Subscription Notifications* to a *Client*. A disabled Alarm is not processed in any manner, and is not supported as part of the active Alarm model defined in ISA 18.2.

Alarms follow a typical timeline that is illustrated in Figure 6. They have a number of delay times associated with them and a number of states that they might occupy. The goal of an alarming system is to inform *Operator*s about conditions in a timely manner and allow the *Operator* to take some action before some consequences occur. The consequences may be economic (product is not usable and must be discard), may be physical (tank overflows), may safety (fire or explosion could occur) or any of a number of other possibilities. Typically, if no action is taken related to an alarm for some period of time the process will cross some threshold at which point consequences will start to occur. The OPC UA *Alarm* model describes these states, delays and actions.

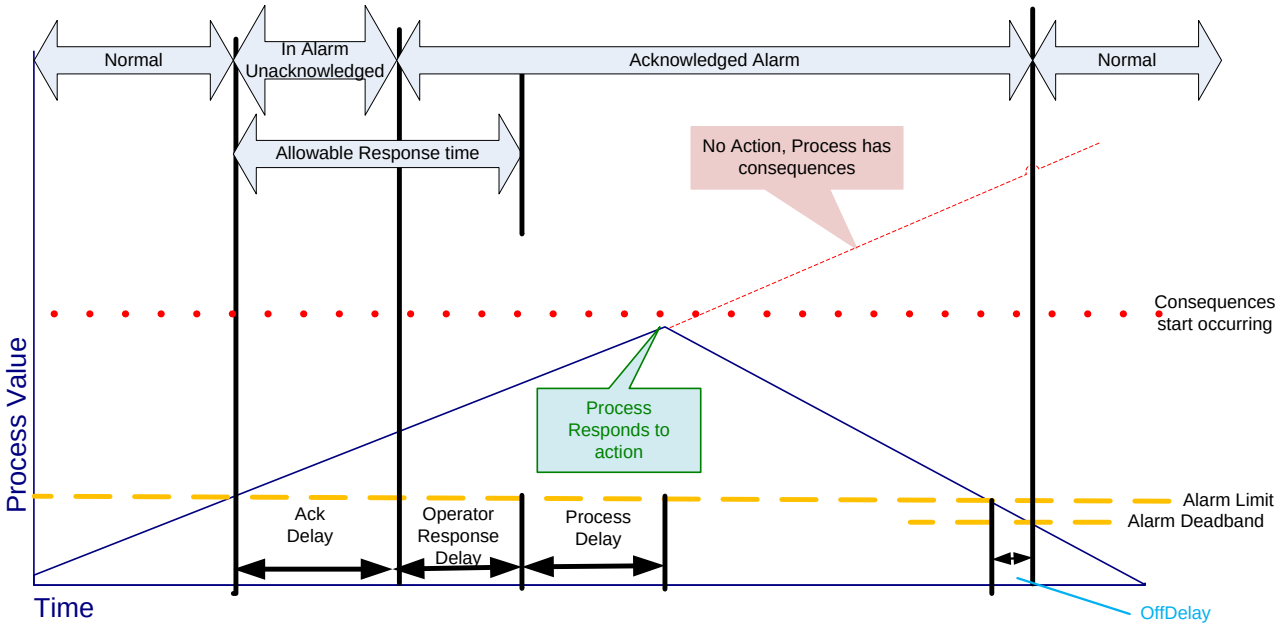


Figure 6 – Typical Alarm Timeline example

4.9 Multiple active states

In some cases, it is desirable to further define the *Active* state of an *Alarm* by providing a sub-state machine for the *Active* State. For example, a multi-state level *Alarm* when in the *Active* state may be in one of the following sub-states: LowLow, Low, High or HighHigh. The state model is illustrated in Figure 7.

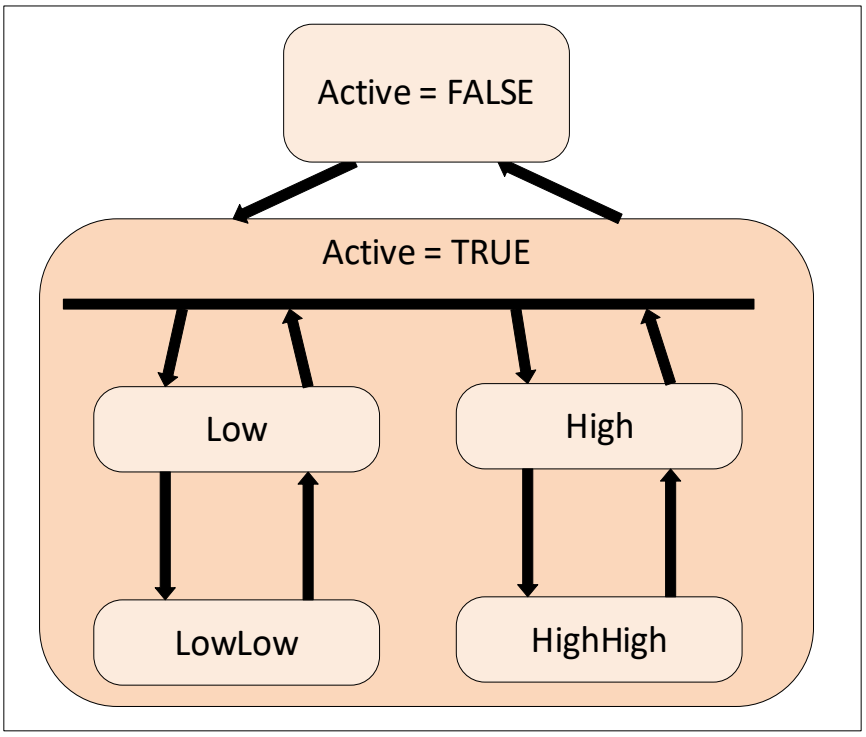


Figure 7 – Multiple active states example

With the multi-state *Alarm* model, state transitions among the sub-states of *Active* are allowed without causing a transition out of the *Active* state.

To accommodate different use cases both a (mutually) exclusive and a non-exclusive model are supported.

Exclusive means that the *Alarm* can only be in one sub-state at a time. If for example a temperature exceeds the HighHigh limit the associated exclusive level *Alarm* will be in the HighHigh sub-state and not in the High sub-state.

Some *Alarm* systems, however, allow multiple sub-states to exist in parallel. This is called non-exclusive. In the previous example where the temperature exceeds the HighHigh limit a non-exclusive level *Alarm* will be both in the High and the HighHigh sub-state.

4.10 Condition instances in the AddressSpace

Because *Conditions* always have a state (*Enabled* or *Disabled*) and possibly many sub-states it makes sense to have instances of *Conditions* present in the *AddressSpace*. If the *Server* exposes *Condition* instances they usually will appear in the *AddressSpace* as components of the *Objects* that “own” them. For example, a temperature transmitter that has a built-in high temperature *Alarm* would appear in the *AddressSpace* as an instance of some temperature transmitter *Object* with a *HasComponent Reference* to an instance of a *LimitAlarmType*.

The availability of instances allows Data Access *Clients* to monitor the current *Condition* state by subscribing to the *Attribute* values of *Variable Nodes*. The values of the nodes may not always correspond with the value that appear in *Events*, they may be more recent than what was in the *Event*.

While exposing *Condition* instances in the *AddressSpace* is not always possible, doing so allows for direct interaction (read, write and *Method* invocation) with a specific *Condition* instance. For example, if a *Condition* instance is not exposed, there is no way to invoke the *Enable* or *Disable Method* for the specific *Condition* instance.

4.11 Alarm and Condition auditing

The OPC UA Standards include provisions for auditing. Auditing is an important security and tracking concept. Audit records provide the “Who”, “When” and “What” information regarding user interactions with a system. These audit records are especially important when *Alarm* management is considered. *Alarms* are the typical instrument for providing information to a user that something needs the user’s attention. A record of how the user reacts to this information is required in many cases. Audit records are generated for all *Method* calls that affect the state of the system, for example, an *Acknowledge Method* call would generate an *AuditConditionAcknowledgeEventType Event*.

The standard *AuditEventTypes* defined in 10000-5 already include the fields required for *Condition* related audit records. To allow for filtering and grouping, this standard defines a number of sub-types of the *AuditEventTypes* but without adding new fields to them.

This standard describes the *AuditEventType* that each *Method* shall generate if Audit Events are supported by the *Server*. For example, the *Disable Method* has an *AlwaysGeneratesEvent Reference* to an *AuditConditionEnableEventType*. An *Event* of this type shall be generated for every invocation of the *Method* if audit events are supported. The audit *Event* describes the user interaction with the system, in some cases this interaction may affect more than one *Condition* or be related to more than one state.

4.12 Alarms in a system

In a system, alarms might be managed at different levels and by different applications. An alarm might be detected in an instrument, but the full alarm model for that alarm instance might be maintained in a higher level *Server*. This can cause issues in cases where the instrument is restarted or the UA Server that is acting as an alarm server is restarted. It is desirable that the state of alarms is maintained and that after any restart of either application all alarms recover their same state as before the restart. But it is acceptable if an alarm might require some management actions again following a restart. It is not acceptable that a device that is in alarm is no longer reported as being in alarm. For example, if the *AlarmManager* is restarted when it recovers it is able to detect that the device has an alarm, but it might not be able to recover that the alarm has a comment that had been entered as part of an alarm acknowledgement or even that is was acknowledged. The details of what states are expected to be recovered are provided in the individual object models.

5 Model

5.1 General

The *Alarm* and *Condition* model extends the OPC UA base *Event* model by defining various *Event Types* based on the *BaseEventType*. All of the *Event Types* defined in this standard can be further extended to form domain or *Server* specific *Alarm* and *Condition Types*.

Instances of *Alarm* and *Condition Types* may be optionally exposed in the *AddressSpace* in order to allow direct access to the state of an *Alarm* or *Condition*. Instances not exposed in the *AddressSpace* still have a *ConditionId* (*NodeId*). This *NodeId* can be the target of references in the *AddressSpace* even though the target node does not exist in the AddressSpace. For example, an *AlarmGroup* might reference a number of *Conditions* that do not exist in the *AddressSpace.*

The following sub clauses define the OPC UA *Alarm* and *Condition Types*. Figure 8 informally describes the hierarchy of these *Types*. Subtypes of the *LimitAlarmType* and the *DiscreteAlarmType* are not shown.

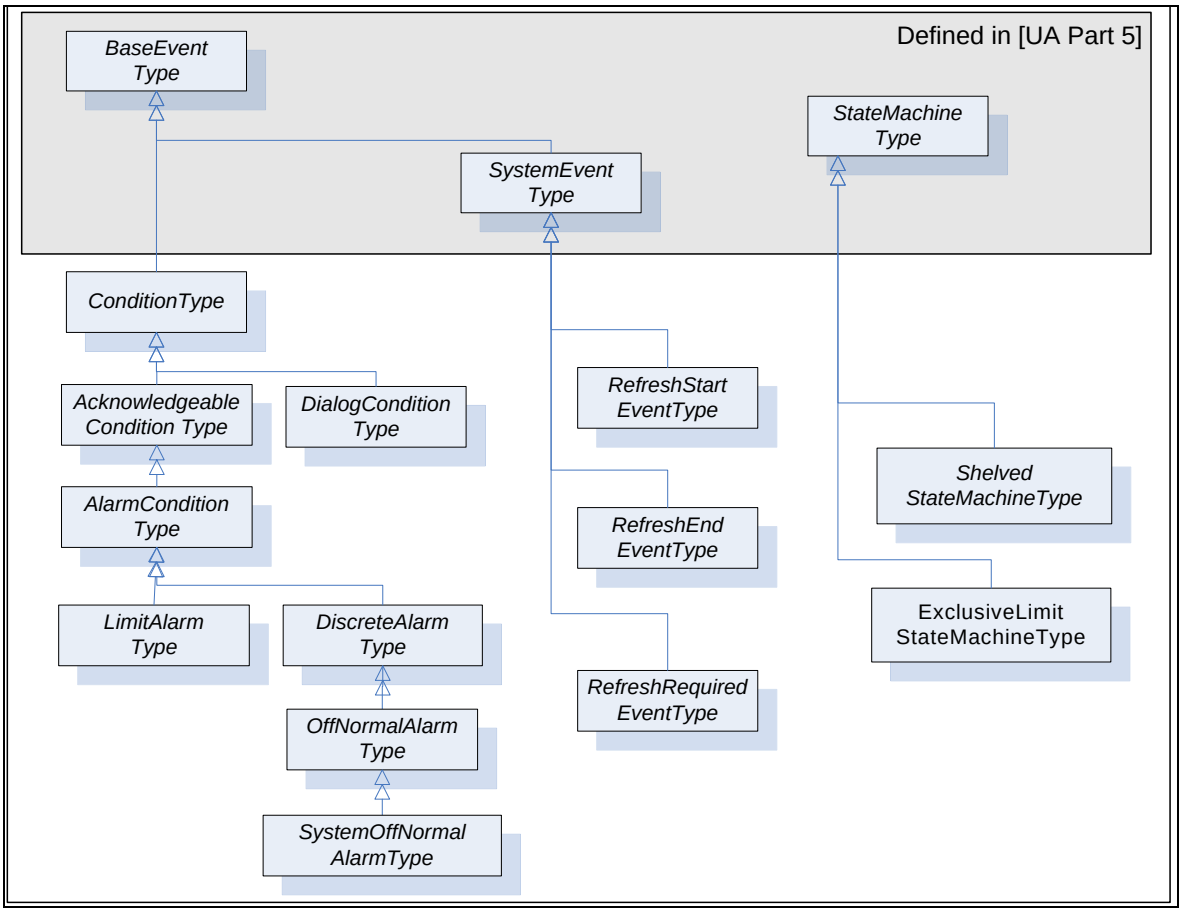


Figure 8 – ConditionType hierarchy

5.2 Two-state state machines

Most states defined in this standard are simple – i.e. they are either True or False. The *TwoStateVariableType* is introduced specifically for this use case. More complex states are modelled by using a *StateMachineType* defined in 10000-16.

The *TwoStateVariableType* is derived from the *StateVariableType* defined in 10000-16. and formally defined in Table 3.

Table 3 – TwoStateVariableType definition

Attribute	**Value**				
BrowseName	TwoStateVariableType				
DataType	LocalizedText				
ValueRank	-1 (-1 = Scalar)				
IsAbstract	False				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**Modelling Rule**
Subtype of the *StateVariableType* defined in 10000-16. Note that a *Reference* to this subtype is not shown in the definition of the *StateVariableType*					
HasProperty	Variable	Id	Boolean	PropertyType	Mandatory
HasProperty	Variable	TransitionTime	UtcTime	PropertyType	Optional
HasProperty	Variable	EffectiveTransitionTime	UtcTime	PropertyType	Optional
HasProperty	Variable	TrueState	LocalizedText	PropertyType	Optional
HasProperty	Variable	FalseState	LocalizedText	PropertyType	Optional
ConformanceUnits					
A & C Basic					

The *Value Attribute* of an instance of *TwoStateVariableType* contains the current state as a human readable name. The *EnabledState* for example, might contain the name “Enabled” when True and “Disabled” when False.

Id is inherited from the *StateVariableType* and overridden to reflect the required *DataType* (Boolean). The value shall be the current state, i.e. either True or False.

TransitionTime specifies the time when the current state was entered.

EffectiveTransitionTime specifies the time when the current state or one of its sub states was entered. If, for example, a LevelAlarm is active and – while active – switches several times between High and HighHigh, then the *TransitionTime* stays at the point in time where the *Alarm* became active whereas the *EffectiveTransitionTime* changes with each shift of a sub state.

The optional *Property EffectiveDisplayName* from the *StateVariableType* is used if a state has sub states. It contains a human readable name for the current state after taking the state of any *SubStateMachines* in account. As an example, the *EffectiveDisplayName* of the *EnabledState* could contain “Active/HighHigh” to specify that the *Condition* is active and has exceeded the HighHigh limit.

Other optional *Properties* of the *StateVariableType* have no defined meaning for *TwoStateVariableType*.

TrueState and *FalseState* contain the localized string for the *TwoStateVariableType* value when its *Id Property* has the value True or False, respectively. Since the two *Properties* provide meta-data for the *Type*, *Servers* shall not allow these *Properties* to be selected in the *Event* filter for a MonitoredItem. The *TrueState Property* and *FalseState Property* shall only exist on *InstanceDeclarations*. See Figure 9 for an illustration. *Clients* can use the Read *Service* to get the values of the *TrueState* and *FalseState Property*.

A *HasTrueSubState Reference* is used to indicate that the True state has sub states.

A *HasFalseSubState Reference* is used to indicate that the False state has sub states.

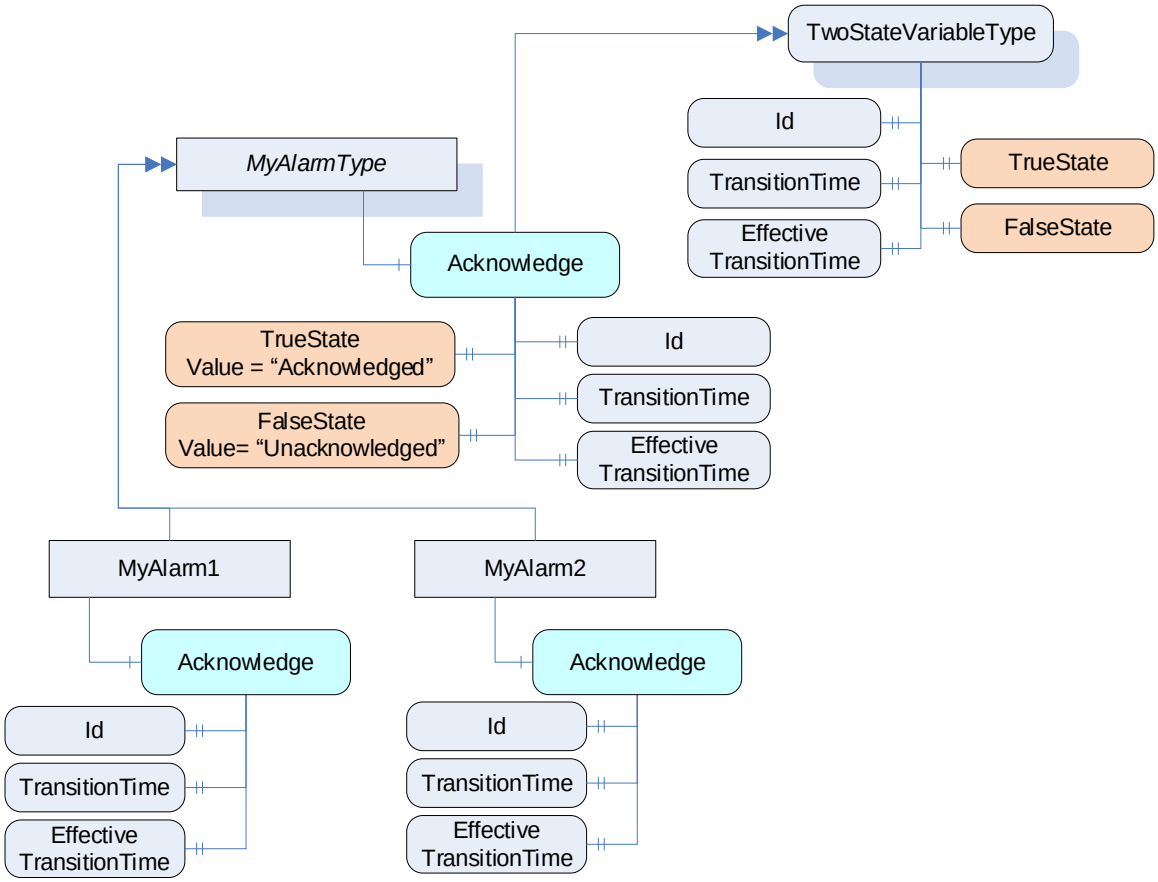


Figure 9 - TwoStateVariable Illustration

5.3 ConditionVariable

Various information elements of a *Condition* are not considered to be states. However, a change in their value is considered important and supposed to trigger an *Event Notification*. These information elements are called *ConditionVariable*.

ConditionVariables are represented by a *ConditionVariableType,* formally defined in Table 4.

Table 4 – ConditionVariableType definition

Attribute	**Value**				
BrowseName	ConditionVariableType				
DataType	BaseDataType				
ValueRank	-2 (-2 = Any)				
IsAbstract	False				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**Modelling Rule**
Subtype of the *BaseDataVariableType* defined in 10000-5.					
HasProperty	Variable	SourceTimestamp	UtcTime	PropertyType	Mandatory
ConformanceUnits					
A & C Basic					

SourceTimestamp indicates the time of the last change of the *Value* of this *ConditionVariable*. It shall be the same time that would be returned from the *Read Service* inside the *DataValue* structure for the *ConditionVariable Value Attribute*.

5.4 ReferenceTypes

5.4.1 General

This Clause defines *ReferenceTypes* that are needed beyond those already specified as part of 10000-3 and 10000-5. This includes extending *TwoStateVariableType* state machines with sub states and the addition of *Alarm* grouping.

The *TwoStateVariableType References* will only exist when sub states are available. For example, if a *TwoStateVariableType* machine is in a False State, then any sub states referenced from the True state will not be available. If an Event is generated while in the False state and information from the True state sub state is part of the data that is to be reported than this data would be reported as a NULL. With this approach, *TwoStateVariableTypes* can be extended with subordinate state machines in a similar fashion to the *StateMachineType* defined in 10000-16.

5.4.2 HasTrueSubState ReferenceType

The *HasTrueSubState ReferenceType* is a concrete *ReferenceType* that can be used directly. It is a subtype of the *NonHierarchicalReferences ReferenceType*.

The semantics indicate that the sub state (the target *Node*) is a subordinate state of the True super state. If more than one state within a *Condition* is a sub state of the same super state (i.e. several *HasTrueSubState References* exist for the same super state) they are all treated as independent sub states. The representation in the *AddressSpace* is specified in Table 5.

The *SourceNode* of the *Reference* shall be an instance of a *TwoStateVariableType* and the *TargetNode* shall be either an instance of a *TwoStateVariableType* or an instance of a subtype of a *StateMachineType*.

It is not required to provide the *HasTrueSubState Reference* from super state to sub state, but it is required that the sub state provides the inverse *Reference* (*IsTrueSubStateOf*) to its super state.

Table 5 – HasTrueSubState ReferenceType

Attributes	**Value**		
BrowseName	HasTrueSubState		
InverseName	IsTrueSubStateOf		
Symmetric	False		
IsAbstract	False		
References	**NodeClass**	**BrowseName**	**Comment**
ConformanceUnits			
A & C Basic			

5.4.3 HasFalseSubState ReferenceType

The *HasFalseSubState ReferenceType* is a concrete *ReferenceType* that can be used directly. It is a subtype of the *NonHierarchicalReferences ReferenceType*.

The semantics indicate that the sub state (the target *Node*) is a subordinate state of the False super state. If more than one state within a *Condition* is a sub state of the same super state (i.e. several *HasFalseSubState References* exist for the same super state) they are all treated as independent sub states. The representation in the *AddressSpace* is specified in Table 6.

The *SourceNode* of the *Reference* shall be an instance of a *TwoStateVariableType* and the *TargetNode* shall be either an instance of a *TwoStateVariableType* or an instance of a subtype of a *StateMachineType*.

It is not required to provide the *HasFalseSubState Reference* from super state to sub state, but it is required that the sub state provides the inverse *Reference* (IsFalseSubStateOf) to its super state.

Table 6 – HasFalseSubState ReferenceType

Attributes	**Value**		
BrowseName	HasFalseSubState		
InverseName	IsFalseSubStateOf		
Symmetric	False		
IsAbstract	False		
References	**NodeClass**	**BrowseName**	**Comment**
ConformanceUnits			
A & C Basic			

5.4.4 HasAlarmSuppressionGroup ReferenceType

The *HasAlarmSuppressionGroup ReferenceType* is a concrete *ReferenceType* that can be used directly. It is a subtype of the *HasComponent ReferenceType*. The representation in the *AddressSpace* is specified in Table 7

This *ReferenceType* binds an AlarmSuppressionGroup to an *Alarm*.

The *SourceNode* of the *Reference* shall be an instance of an *AlarmConditionType* or sub type. The *TargetNode* shall be an instance of an *AlarmGroupType*.

Table 7 – HasAlarmSuppressionGroup ReferenceType

Attributes	**Value**		
BrowseName	HasAlarmSuppressionGroup		
InverseName	IsAlarmSuppressionGroupOf		
Symmetric	False		
IsAbstract	False		
References	**NodeClass**	**BrowseName**	**Comment**
ConformanceUnits			
A & C Suppression Group			

5.4.5 AlarmGroupMember ReferenceType

The *AlarmGroupMember ReferenceType* is a concrete *ReferenceType* that can be used directly. It is a subtype of the *Organizes* Reference Type.

This *ReferenceType* is used to indicate the *Alarm* instances that are part of an *Alarm Group*. The representation in the *AddressSpace* is specified in Table 8

The *SourceNode* of the *Reference* shall be an instance of an *AlarmGroupType* or sub type of it. The *TargetNode* shall be an instance of an *AlarmConditionType* or a subtype of it.

Table 8 – AlarmGroupMember ReferenceType

Attributes	**Value**		
BrowseName	AlarmGroupMember		
InverseName	MemberOfAlarmGroup		
Symmetric	False		
IsAbstract	False		
References	**NodeClass**	**BrowseName**	**Comment**
ConformanceUnits			
A & C Suppression Group			
A & C First in Group Alarm			

5.4.6 AlarmSuppressionGroupMember ReferenceType

The *Alarm*Suppression*GroupMember ReferenceType* is a concrete *ReferenceType* that can be used directly. It is a subtype of the *AlarmGroupMember ReferenceType*.

This *ReferenceType* is used to indicate the *Alarm* instances or *Boolean Variables* that are part of an *Alarm Group*. The representation in the *AddressSpace* is specified in Table 9

The *SourceNode* of the *Reference* shall be an instance of an *AlarmGroupType* or sub type of it. The *TargetNode* shall be an instance of an *AlarmConditionType* or a subtype of it, or an instance of *BaseDataVariableType* that has a *DataType* of *Boolean*.

Table 9 – AlarmSuppressionGroupMember ReferenceType

Attributes	**Value**		
BrowseName	AlarmSuppressionGroupMember		
InverseName	MemberOfAlarmSuppressionGroup		
Symmetric	False		
IsAbstract	False		
References	**NodeClass**	**BrowseName**	**Comment**
ConformanceUnits			
A & C Suppression Group			

5.5 Condition Model

5.5.1 General

The *Condition* model extends the *Event* model by defining the *ConditionType*. The *ConditionType* introduces the concept of states differentiating it from the base *Event* model. Unlike the *BaseEventType*, *Conditions* are not transient. The *ConditionType* is further extended into Dialog and *AcknowledgeableConditionType*, each of which has their own sub-types.

The *Condition* model is illustrated in Figure 10 and formally defined in the subsequent tables. It is worth noting that this figure, like all figures in this document, is not intended to be complete. Rather, the figures only illustrate information provided by the formal definitions.

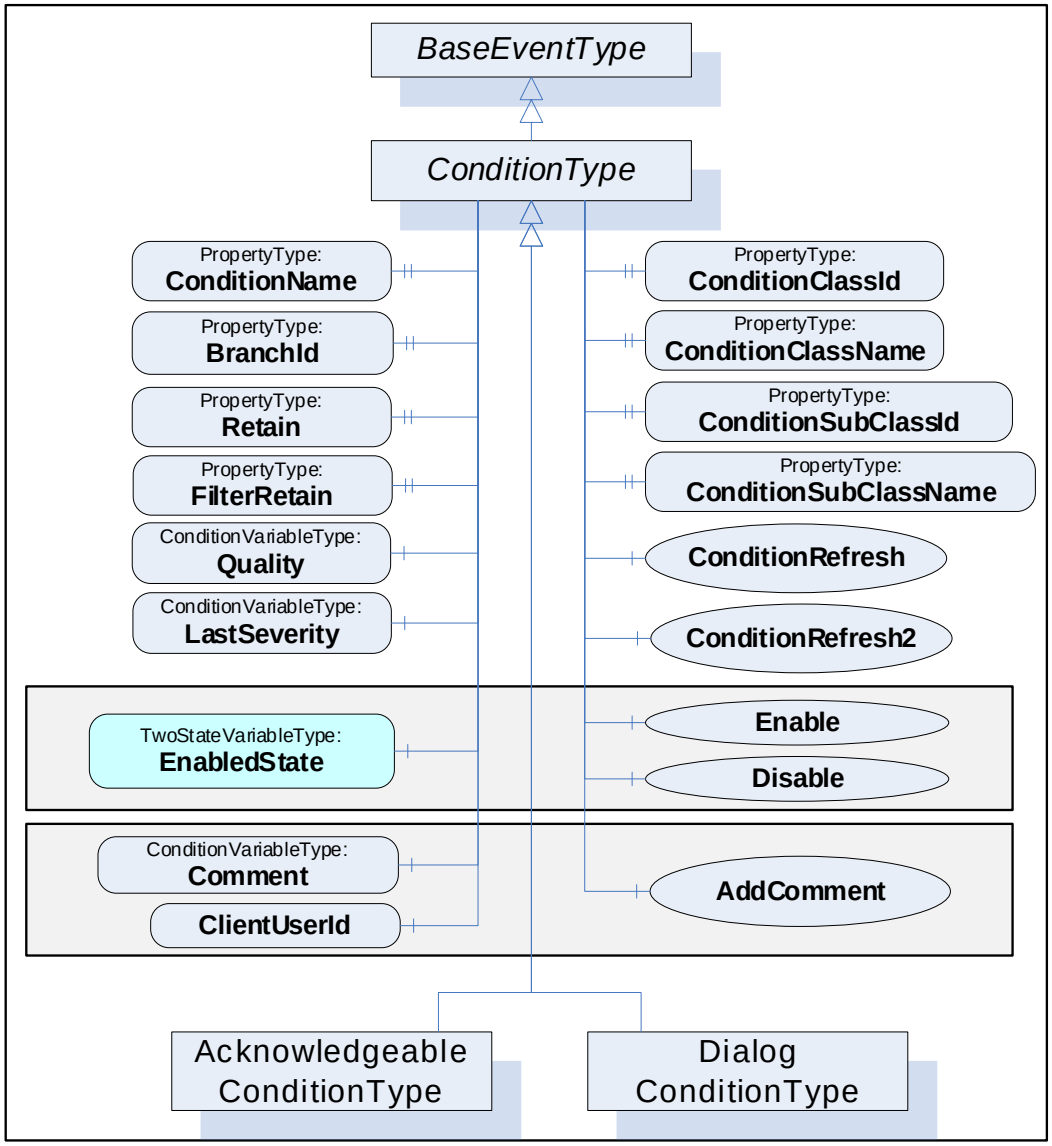


Figure 10 – Condition model

5.5.2 ConditionType

The *ConditionType* defines all general characteristics of a *Condition*. All other *ConditionTypes* derive from it. It is formally defined in Table 10 and Table 11. The False state of the *EnabledState* shall not be extended with a sub state machine.

Table 10 – ConditionType definition

Attribute	Value				
BrowseName	ConditionType				
IsAbstract	True				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**Modelling Rule**
Subtype of the *BaseEventType* defined in 10000-5					
HasSubtype	ObjectType	DialogConditionType	Defined in Clause 5.6.2		
HasSubtype	ObjectType	AcknowledgeableConditionType	Defined in Clause 5.7.2		
HasProperty	Variable	ConditionClassId	NodeId	PropertyType	Mandatory
HasProperty	Variable	ConditionClassName	LocalizedText	PropertyType	Mandatory
HasProperty	Variable	ConditionName	String	PropertyType	Mandatory
HasProperty	Variable	BranchId	NodeId	PropertyType	Mandatory
HasProperty	Variable	Retain	Boolean	PropertyType	Mandatory
HasProperty	Variable	SupportsFilteredRetain	Boolean	PropertyType	
HasComponent	Variable	EnabledState	LocalizedText	TwoStateVariableType	Mandatory
HasComponent	Variable	Quality	StatusCode	ConditionVariableType	Mandatory
HasComponent	Variable	LastSeverity	UInt16	ConditionVariableType	Mandatory
HasComponent	Variable	Comment	LocalizedText	ConditionVariableType	Mandatory
HasProperty	Variable	ClientUserId	String	PropertyType	Mandatory
HasComponent	Method	Disable	Defined in Clause 5.5.4		Mandatory
HasComponent	Method	Enable	Defined in Clause 5.5.5		Mandatory
HasComponent	Method	AddComment	Defined in Clause 5.5.6		Mandatory
HasComponent	Method	ConditionRefresh	Defined in Clause 5.5.7		
HasComponent	Method	ConditionRefresh2	Defined in Clause 5.5.8		
ConformanceUnits					
A & C Basic					

Table 11 – ConditionType Additional Subcomponents

BrowsePath	References	NodeClass	BrowseName	DataType	TypeDefinition	Others
EnabledState	HasProperty	Variable	TrueState	LocalizedText	PropertyType	
EnabledState	HasProperty	Variable	FalseState	LocalizedText	PropertyType	

The empty “Others” column indicates that no *ModellingRule* applies.

The *ConditionType* inherits all *Properties* of the *BaseEventType*. Their semantic is defined in 10000-5. *SourceNode Property* identifies the *ConditionSource*. See 5.12 for more details. If the *ConditionSource* is not a *Node* in the *AddressSpace,* the *NodeId* is set to NULL. The *SourceNode* Property is the *Node,* which the *Condition* is associated with, it may be the same as the *InputNode* for an *Alarm*, but it may be a separate node. For example, a motor, which is a *Variable* with a *Value* that is an RPM, may be the *ConditionSource* for *Conditions* that are related to the motor as well as a temperature sensor associated with the motor. In the former the *InputNode* for the High RPM *Alarm* is the value of the Motor RPM, while in the later the *InputNode* of the High Alarm would be the value of the temperature sensor that is associated with the motor.

ConditionClassId, ConditionClassName, ConditionSubClassId and *ConditionSubClassName* originally defined in *ConditionType* are now defined in the *BaseEventType* (from which this type is derived). They are optional in the *BaseEventType*, but *ConditionClassId,* and *ConditionClassName* are *Mandatory* in *ConditionType* and thus listed (to update the modelling rule).

ConditionName identifies the *Condition* instance that the *Event* originated from. It can be used together with the *SourceName* in a user display to distinguish between different *Condition* instances. If a *ConditionSource* has only one instance of a *ConditionType*, and the *Server* has no instance name, the *Server* shall supply the name element of the BrowseName of the *ConditionType*.

BranchId is NULL for all *Event Notifications* that relate to the current state of the *Condition* instance. If *BranchId* is not NULL, it identifies a previous state of this *Condition* instance that

still needs attention by an *Operator*. If the current *ConditionBranch* is transformed into a previous *ConditionBranch* then the Server needs to assign a non-NULL *BranchId*. An initial *Event* for the branch will generated with the values of the *ConditionBranch* and the new *BranchId*. The *ConditionBranch* can be updated many times before it is no longer needed. When the *ConditionBranch* no longer requires *Operator* input the final *Event* will have *Retain* set to False. The retain bit on the current Event is True, as long as any ConditionBranches require Operator input. See 4.2 for more information about the need for creating and maintaining previous *ConditionBranches* and Clause B.1 for an example using branches. The *BranchId DataType* is *NodeId* although the *Server* is not required to have *ConditionBranches* in the *AddressSpace*. The use of a *NodeId* allows the *Server* to use simple numeric identifiers, strings or arrays of bytes.

Retain when True describes a *Condition* (or *ConditionBranch*) as being in a state that is interesting for a *Client* wishing to synchronize its state with the *Server*'s state. The logic to determine how this flag is set is *Server* specific. Typically, all *Active Alarms* would have the *Retain* flag set; however, it is also possible for inactive *Alarms* to have their *Retain* flag set to True.

In normal processing when a *Client* receives an *Event* with the *Retain* flag set to False, the *Client* should consider this as a *ConditionBranch* that is no longer of interest, in the case of a "current *Alarm* display" the *ConditionBranch* would be removed from the display.

SupportsFilteredRetain Property is only provided on the *ConditionType*. When this *Property* is set to True on the Type, then the *Server* provides a *Client* specific *Retain* flag value taking into account any *Client* provided filter. When the property is False on the *ConditionType* then the *Server* does not provide a *Client* specific the value of the *Retain* flag. For example, if a *Client* applies a filter to exclude *Alarms* that are shelved, and the *SupportsFilteredRetain* is set to True, the *Client* receives an *Alarm* (it is not shelved, *Retain* is true). The *Client* (or another *Client*) shelves the *Alarm*. At this point the *Alarm* no longer passes the filter, but since the previous event was sent, this event is transmitted with Retain = False. For an example see B.1.4

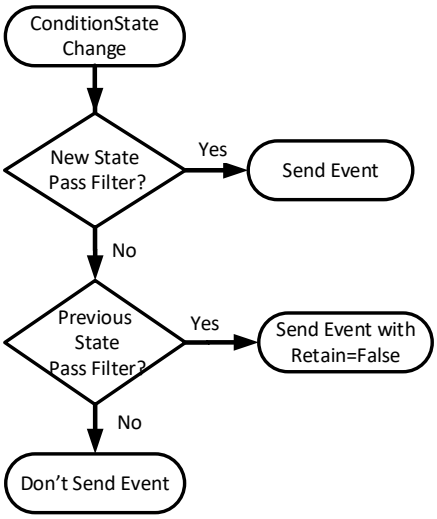


Figure 11 - SupportsFilteredRetain process

Figure 11 provides an illustration of the processing a *Server* shall follow for processing *Retain* flag when *SupportsFilteredRetain* flag is set to True.

EnabledState indicates whether the *Condition* is enabled. *EnabledState/Id* is True if enabled, False otherwise. *EnabledState/TransitionTime* defines when the *EnabledState* last changed. Recommended state names are described in A.1.

A *Condition*'s *EnabledState* effects the generation of *Event Notifications* and as such results in the following specific behaviour:

- When the *Condition* instance enters the *Disabled* state, the *Retain Property* of this *Condition* shall be set to False by the *Server* to indicate to the *Client* that the *Condition* instance is currently not of interest to *Client*s. This includes all *ConditionBranches* if any branches exist.
- When the *Condition* instance enters the enabled state, the *Condition* shall be evaluated and all of its *Properties* updated to reflect the current values. If this evaluation causes the *Retain Property* to transition to True for any *ConditionBranch*, then an *Event Notification* shall be generated for that *ConditionBranch*.
- The *Server* may choose to continue to test for a *Condition* instance while it is *Disable*d. However, no *Event Notifications* will be generated while the *Condition* instance is disabled.
- For any *Condition* that exists in the *AddressSpace* the *Attributes* and the following *Variables* will continue to have valid values even in the *Disable*d state; EventId, *Event* Type, Source *Node*, Source Name, Time, and EnabledState. Other *Properties* may no longer provide current valid values. All *Variables* that are no longer provided shall return a status of Bad_ConditionDisabled. The Event that reports the Disabled state should report the *Properties* as NULL or with a status of Bad_ConditionDisabled.

When enabled, changes to the following *Variables* shall cause a *ConditionType Event Notification*:

- Quality
- Severity (inherited from *BaseEventType*)
- Comment

This may not be the complete list. Subtypes of *ConditionType* may define additional *Variables* that trigger *Event Notifications*. In general, changes to *Variables* of the types *TwoStateVariableType, ConditionVariableType, StateMachineType* or any of their subtypes trigger *Event Notifications* and are not explicitly described in subtypes.

In the event of a restart of an *AlarmManager*, the *AlarmManager* shall recover the *Enabled*/*Disabled* states of all current conditions. If the system can not determine if the *Condition* is *Enabled* or *Disabled*, it shall be *Enabled*.

Quality reveals the status of process values or other resources that this *Condition* instance is based upon. If, for example, a process value is “Uncertain”, the associated “LevelAlarm” *Condition* is also questionable. Values for the *Quality* can be any of the OPC *StatusCodes* defined in 10000-8 as well as *Good*, *Uncertain* and *Bad* as defined in 10000-4. These *StatusCodes* are similar to but slightly more generic than the description of data quality in the various field bus specifications. It is the responsibility of the *Server* to map internal status information to these codes. A *Server* that supports no quality information shall return *Good*. This quality can also reflect the communication status associated with the system that this value or resource is based on and from which this *Alarm* was received. For communication errors to the underlying system, especially those that result in some unavailable *Event* fields, the quality shall be Bad_NoCommunication error.

Events are only generated for *Conditions* that have their *Retain* field set to True and for the initial transition of the *Retain* field from True to False.

LastSeverity provides the previous severity of the *ConditionBranch*. Initially this *Variable* contains a zero value; it will return a value only after a severity change. The new severity is supplied via the *Severity Property,* which is inherited from the *BaseEventType*.

Comment contains the last comment provided for a certain state (*ConditionBranch*) of a *Condition*. It may have been provided by an *AddComment Method,* some other *Method* or in some other manner. Any change in this field, shall trigger a new event to be generated. The initial value of this *Variable* is NULL, unless it is provided in some other manner.

ClientUserId is related to the *Comment* field and contains the identity of the user who inserted the most recent *Comment.* The logic to obtain the *ClientUserId* is defined in 10000-5.

The *NodeId* of the *Condition* instance is used as *ConditionId*. It is not explicitly modelled as a component of the *ConditionType*. However, it can be requested with the following *SimpleAttributeOperand* (see Table 12) in the *SelectClause* of the *EventFilter*: See 10000-4 for a detailed definition of the *SelectClause* in an *Event Subscription*.

Table 12 – ConditionId SimpleAttributeOperand Illustration

Name	Type	Description
SimpleAttributeOperand		
typeId	NodeId	*NodeId* of the *ConditionType Node*
browsePath[]	QualifiedName	empty
attributeId	IntegerId	Id of the *NodeId Attribute*

5.5.3 Condition and branch instances

Conditions are *Objects* which have a state which changes over time. Each *Condition* instance has a *ConditionId* as an identifier which uniquely identifies it within the *Server*. This *Condition* (and it representative *ConditionId)* follows the same rules associated with *Nodes* (and their representative *NodeIds*) in the *AddressSpace* (see 10000-3). Therefore, once a *Condition* is created in a system that does not expose instances, any time that *Condition* is active it shall always have the same *ConditionId*. This allows higher level alarm management systems to operate on *Conditions* and to perform analysis of them.

A *Condition* instance may be an *Object* that appears in the *Server Address Space*. If this is the case the *ConditionId* shall be the *NodeId* for the *Object*.

The state of a *Condition* instance at any given time is the set values for the *Variable*s that belong to the *Condition* instance. If one or more *Variable* values change the *Server* generates an *Event* with a unique *EventId*.

If a *Client* calls *Refresh* the *Server* will report the current state of a *Condition* instance by re-sending the last *Event* (i.e. the same *EventId* and *Time* is sent).

A *ConditionBranch* is a copy of the *Condition* instance state that can change independently of the current *Condition* instance state. Each *Branch* has an identifier called a *BranchId* which is unique among all active *Branches* for a *Condition* instance. *Branches* are typically not visible in the *Address Space* and this standard does not define a standard way to make them visible.

5.5.4 Disable Method

The *Disable Method* is used to change a *Condition* instance to the *Disabled* state. Normally, the *NodeId* of the object instance as the *ObjectId* is passed to the Call *Service*. However, some *Servers* do not expose *Condition* instances in the *AddressSpace.* Therefore, all *Servers* shall allow *Clients* to call the *Disable Method* by specifying *ConditionId* as the *ObjectId.* The *Method* cannot be called with an *ObjectId* of the *ConditionType Node*. Since *Condition* instances may not be defined in the *AddressSpace*, the *MethodId* that is passed in the *Call Service* shall be the *NodeId* of the *Disable Method* on the *ConditionType*.

Signature

```
Disable();
```

Method Result Codes in Table 13 (defined in Call Service)

Table 13 – Disable result codes

Result Code	Description
Bad_ConditionAlreadyDisabled	See Table 137 for the description of this result code.

Table 14 specifies the *AddressSpace* representation for the *Disable Method*.

Table 14 – Disable Method AddressSpace definition

Attribute	Value				
BrowseName	Disable				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**Modelling Rule**
AlwaysGeneratesEvent	ObjectType	AuditConditionEnableEventType	Defined in 5.10.2		
ConformanceUnits					
A & C Enable					

If *Auditing* is supported, this *Method* shall generate an *Event* of *AuditConditionEnableEventType* for all invocations of the *Method*.

5.5.5 Enable Method

The *Enable Method* is used to change a *Condition* instance to the enabled state. Normally, the *NodeId* of the object instance as the *ObjectId* is passed to the Call *Service*. However, some *Servers* do not expose *Condition* instances in the *AddressSpace.* Therefore, all *Servers* shall allow *Clients* to call the *Enable Method* by specifying *ConditionId* as the *ObjectId.* The *Method* cannot be called with an *ObjectId* of the *ConditionType Node*. If the *Condition* instance is not exposed, then it may be difficult for a *Client* to determine the *ConditionId* for a disabled *Condition.* Since *Condition* instances may not be defined in the *AddressSpace*, the *MethodId* that is passed in the *Call Service* shall be the *NodeId* of the *Enable Method* on the *ConditionType*.

Signature

```
Enable();
```

Method result codes in Table 15 (defined in Call Service)

Table 15 – Enable result codes

Result Code	Description
Bad_ConditionAlreadyEnabled	See Table 137 for the description of this result code.

Table 16 specifies the *AddressSpace* representation for the *Enable Method*.

Table 16 – Enable Method AddressSpace definition

Attribute	Value				
BrowseName	Enable				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**Modelling Rule**
AlwaysGeneratesEvent	ObjectType	AuditConditionEnableEventType	Defined in 5.10.2		
ConformanceUnits					
A & C Enable					

If *Auditing* is supported, this *Method* shall generate an *Event* of *AuditConditionEnableEventType* for all invocations of the *Method*.

5.5.6 AddComment Method

The *AddComment Method* is used to apply a comment to a specific state of a *Condition* instance. Normally, the *NodeId* of the *Object* instance is passed as the *ObjectId* to the *Call Service*. However, some *Servers* do not expose *Condition* instances in the *AddressSpace.* Therefore, all *Servers* shall also allow *Clients* to call the *AddComment Method* by specifying *ConditionId* as the *ObjectId.* The *Method* cannot be called with an *ObjectId* of the *ConditionType Node*.

Signature

```
AddComment(
    [in] ByteString EventId
```

```
    [in] LocalizedText Comment
    );
```

The parameters are defined in Table 17

Table 17 – AddComment arguments

Argument	Description
EventId	EventId identifying a particular *Event Notification* where a state was reported for a *Condition*.
Comment	A localized text to be applied to the *Condition*.

Method result codes in Table 18 (defined in Call Service)

Table 18 – AddComment result codes

Result Code	Description
Bad_MethodInvalid	The *MethodId* provided does not correspond to the *ObjectId* provided. See 10000-4 for the general description of this result code.
Bad_EventIdUnknown	See Table 137 for the description of this result code.
Bad_NodeIdInvalid	Used to indicate that the specified *ObjectId* is not valid or that the *Method* was called on the ConditionType *Node*. See 10000-4 for the general description of this result code.

Comments

Comments are added to *Event* occurrences identified via an *EventId*. *EventIds* where the related *EventType* is not a ConditionType (or subtype of it) and thus does not support *Comments* are rejected.

A *ConditionEvent* – where the *Comment Variable* contains this text – will be sent for the identified state. If a comment is added to a previous state (i.e. a state for which the Server has created a branch), the *BranchId* and all *Condition* values of this branch will be reported. If the comment field is NULL (both locale and text are empty) it will be ignored and any existing comments will remain unchanged. If the comment is to be reset, an empty text with a locale shall be provided.

Table 19 specifies the *AddressSpace* representation for the *AddComment Method*.

Table 19 – AddComment Method AddressSpace definition

Attribute	**Value**				
BrowseName	AddComment				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**ModellingRule**
HasProperty	*Variable*	InputArguments	Argument[]	PropertyType	Mandatory
AlwaysGeneratesEvent	ObjectType	AuditConditionComment EventType	Defined in 5.10.4		
ConformanceUnits					
A & C Comment					

If *Auditing* is supported, this *Method* shall generate an *Event* of *AuditConditionCommentEventType* for all invocations of the *Method*.

5.5.7 ConditionRefresh Method

ConditionRefresh allows a *Client* to request a *Refresh* of all *Condition* instances that currently are in an interesting state (they have the *Retain* flag set). This includes previous states of a *Condition* instance for which the *Server* maintains *Branches*. A *Client* would typically invoke this *Method* when it initially connects to a *Server* and following any situations, such as communication disruptions, in which it would require resynchronization with the *Server*. This *Method* is only available on the *ConditionType*. To invoke this *Method*, the call shall pass the well-known *MethodId* of the *Method* on the *ConditionType* and the *ObjectId* shall be the well-known *NodeId* of the *ConditionType ObjectType*.

Signature

```
ConditionRefresh(
    [in] IntegerId SubscriptionId
    );
```

The parameters are defined in Table 20

Table 20 – ConditionRefresh parameters

Argument	Description
SubscriptionId	A valid *Subscription* Id of the *Subscription* to be refreshed. The *Server* shall verify that the *SubscriptionId* provided is part of the *Session* that is invoking the *Method*.

Method result codes in Table 21 (defined in Call Service)

Table 21 – ConditionRefresh result codes

Result Code	Description
Bad_SubscriptionIdInvalid	See 10000-4 for the description of this result code
Bad_NothingToDo	The *ConditionRefresh Method* was called on a *SubscriptionId* that has no event *MonitoredItems*.
Bad_RefreshInProgress	See Table 137 for the description of this result code
Bad_UserAccessDenied	The *Method* was not called in the context of the *Session* that owns the *Subscription* See 10000-4 for the general description of this result code.

Comments

Sub clause 4.5 describes the concept, use cases and information flow in more detail.

The input argument provides a *Subscription* identifier indicating which *Client Subscription* shall be refreshed. If the *Subscription* is accepted the *Server* will react as follows:

1) The *Server* issues an event of *RefreshStartEventType* (defined in 5.11.2) marking the start of *Refresh.* A copy of the instance of *RefreshStartEventType* is queued into the *Event* stream for every *Notifier MonitoredItem* in the *Subscription*. Each of the *Event* copies shall contain the same *EventId*.
2) The *Server* issues *Event Notifications* of any *Retained Conditions* and *Retained Branches* of *Conditions* that meet the *Subscriptions* content filter criteria. Note that the EventId for such a refreshed *Notification* shall be identical to the one for the original *Notification,* the values of the other *Properties* are *Server* specific, in that some *Servers* may be able to replay the exact *Events* with all *Properties*/*Variables* maintaining the same values as originally sent, but other *Servers* might only be able to regenerate the *Event*. The regenerated *Event* might contain some updated Property/*Variable* values. For example, if the *Alarm* limits associated with a *Variable* were changed after the generation of the *Event* without generating a change in the *Alarm* state, the new limit might be reported. In another example, if the HighLimit was 100 and the *Variable* is 120. If the limit were changed to 90 no new *Event* would be generated since no change to the *StateMachine*, but the limit on a *Refresh* would indicate 90, when the original *Event* had indicated 100.
3) The *Server* may intersperse new *Event Notifications* that have not been previously issued to the *Notifier* along with those being sent as part of the *Refresh* request. *Clients* shall check for multiple *Event Notifications* for a *ConditionBranch* to avoid overwriting a new state delivered together with an older state from the *Refresh* process.
4) The *Server* issues an instance of *RefreshEndEventType* (defined in 5.11.3) to signal the end of the *Refresh.* A copy of the instance of *RefreshEndEventType* is queued into the *Event* stream for every *Notifier MonitoredItem* in the *Subscription*. Each of the *Events* copies shall contain the same *EventId*.

It is important to note that if multiple *Event Notifiers* are in a *Subscription* all *Event Notifiers* are processed. If a *Client* does not want all *MonitoredItems* refreshed, then the *Client* should place

each *MonitoredItem* in a separate *Subscription* or call *ConditionRefresh2* if the *Server* supports it.

If more than one *Subscription* is to be refreshed, then the standard call *Service* array processing can be used.

As mentioned above, *ConditionRefresh* shall also issue *Event Notifications* for prior states if they still need attention. In particular, this is True for *Condition* instances where previous states still need acknowledgement or confirmation.

Table 22 specifies the *AddressSpace* representation for the *ConditionRefresh Method*.

Table 22 – ConditionRefresh Method AddressSpace definition

Attribute	**Value**				
BrowseName	ConditionRefresh				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**ModellingRule**
HasProperty	*Variable*	InputArguments	Argument[]	PropertyType	Mandatory
AlwaysGeneratesEvent	ObjectType	RefreshStartEventType	Defined in 5.11.2		
AlwaysGeneratesEvent	ObjectType	RefreshEndEventType	Defined in 5.11.3		
ConformanceUnits					
A & C Refresh					

5.5.8 ConditionRefresh2 Method

ConditionRefresh2 allows a *Client* to request a *Refresh* of all *Condition* instances that currently are in an interesting state (they have the *Retain* flag set) that are associated with the given Monitored item. In all other respects it functions as ConditionRefresh. A *Client* would typically invoke this *Method* when it initially connects to a *Server* and following any situations, such as communication disruptions where only a single *MonitoredItem* is to be resynchronized with the *Server*. This *Method* is only available on the *ConditionType*. To invoke this *Method*, the call shall pass the well-known *MethodId* of the *Method* on the *ConditionType* and the *ObjectId* shall be the well-known *NodeId* of the *ConditionType ObjectType*.

This *Method* is optional and as such *Clients* must be prepared to handle *Servers* which do not provide the *Method*. If the *Method* returns *Bad_MethodInvalid*, the *Client* shall revert to *ConditionRefresh*.

Signature

```
ConditionRefresh2(
    [in] IntegerId SubscriptionId
    [in] IntegerId MonitoredItemId
    );
```

The parameters are defined in Table 23

Table 23 – ConditionRefresh2 parameters

Argument	**Description**
SubscriptionId	The identifier of the *Subscription* containing the *MonitoredItem* to be refreshed. The *Server* shall verify that the *SubscriptionId* provided is part of the *Session* that is invoking the *Method*.
MonitoredItemId	The identifier of the *MonitoredItem* to be refreshed. The *MonitoredItemId* shall be in the provided *Subscription*.

Method result codes in Table 24(defined in Call Service)

Table 24 – ConditionRefresh2 result codes

Result Code	Description
Bad_SubscriptionIdInvalid	See 10000-4 for the description of this result code
Bad_MonitoredItemIdInvalid	See 10000-4 for the description of this result code
Bad_RefreshInProgress	See Table 137 for the description of this result code
Bad_UserAccessDenied	The *Method* was not called in the context of the Session that owns the *Subscription* See 10000-4 for the general description of this result code.
Bad_MethodInvalid	See 10000-4 for the description of this result code

Comments

Sub clause 4.5 describes the concept, use cases and information flow in more detail.

The input argument provides a *Subscription* identifier and *MonitoredItem* identifier indicating which *MonitoredItem* in the selected *Client Subscription* shall be refreshed. If the *Subscription* and *MonitoredItem* is accepted the *Server* will react as follows:

1) The *Server* issues a *RefreshStartEvent* (defined in 5.11.2) marking the start of *Refresh.* The *RefreshStartEvent* is queued into the *Event* stream for the *Notifier MonitoredItem* in the *Subscription*.
2) The *Server* issues *Event Notifications* of any *Retained Conditions* and *Retained Branches* of *Conditions* that meet the *Subscriptions* content filter criteria. Note that the EventId for such a refreshed *Notification* shall be identical to the one for the original *Notification,* the values of the other *Properties* are *Server* specific, in that some *Servers* may be able to replay the exact *Events* with all *Properties*/*Variables* maintaining the same values as originally sent, but other *Servers* might only be able to regenerate the *Event*. The regenerated *Event* might contain some updated Property/*Variable* values. For example, if the *Alarm* limits associated with a *Variable* were changed after the generation of the *Event* without generating a change in the *Alarm* state, the new limit might be reported. In another example, if the HighLimit was 100 and the *Variable* is 120. If the limit were changed to 90 no new *Event* would be generated since no change to the *StateMachine*, but the limit on a *Refresh* would indicate 90, when the original *Event* had indicated 100.
3) The *Server* may intersperse new *Event Notifications* that have not been previously issued to the notifier along with those being sent as part of the *Refresh* request. *Clients* shall check for multiple *Event Notifications* for a *ConditionBranch* to avoid overwriting a new state delivered together with an older state from the *Refresh* process.
4) The *Server* issues a *RefreshEndEvent* (defined in 5.11.3) to signal the end of the *Refresh.* The *RefreshEndEvent* is queued into the *Event* stream for the *Notifier MonitoredItem* in the *Subscription*.

If more than one *MonitoredItem* or *Subscription* is to be refreshed, then the standard call *Service* array processing can be used.

As mentioned above, *ConditionRefresh2* shall also issue *Event Notifications* for prior states if those states still need attention. In particular, this is True for *Condition* instances where previous states still need acknowledgement or confirmation.

Table 25 specifies the *AddressSpace* representation for the *ConditionRefresh2 Method*.

Table 25 – ConditionRefresh2 Method AddressSpace definition

Attribute	**Value**				
BrowseName	ConditionRefresh2				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**ModellingRule**
HasProperty	*Variable*	InputArguments	Argument[]	PropertyType	Mandatory
AlwaysGeneratesEvent	ObjectType	RefreshStartEventType	Defined in 5.11.2		
AlwaysGeneratesEvent	ObjectType	RefreshEndEventType	Defined in 5.11.3		
ConformanceUnits					
A & C Refresh2					

5.6 Dialog Model

5.6.1 General

The Dialog Model is an extension of the *Condition* model used by a *Server* to request user input. It provides functionality similar to the standard *Message* dialogs found in most operating systems. The model can easily be customized by providing *Server* specific response options in the *ResponseOptionSet* and by adding additional functionality to derived *Condition Types*.

5.6.2 DialogConditionType

The *DialogConditionType* is used to represent *Conditions* as dialogs. It is illustrated in Figure 12 and formally defined in Table 26 and Table 27.

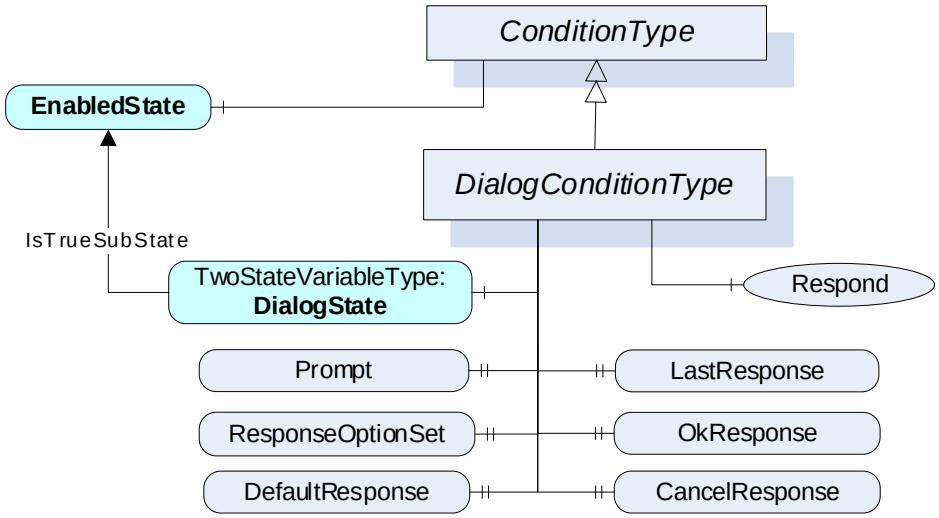


Figure 12 – DialogConditionType Overview

Table 26 – DialogConditionType definition

Attribute	**Value**				
BrowseName	DialogConditionType				
IsAbstract	False				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**Modelling Rule**
Subtype of the ConditionType defined in clause 5.5.2					
HasComponent	Variable	DialogState	LocalizedText	TwoStateVariableType	Mandatory
HasProperty	Variable	Prompt	LocalizedText	PropertyType	Mandatory
HasProperty	Variable	ResponseOptionSet	LocalizedText [ ]	PropertyType	Mandatory
HasProperty	Variable	DefaultResponse	Int32	PropertyType	Mandatory
HasProperty	Variable	LastResponse	Int32	PropertyType	Mandatory
HasProperty	Variable	OkResponse	Int32	PropertyType	Mandatory
HasProperty	Variable	CancelResponse	Int32	PropertyType	Mandatory
HasComponent	Method	Respond	Defined in Clause 5.6.3.		Mandatory
HasComponent	Method	Respond2	Defined in Clause 5.6.4.		Optional
ConformanceUnits					
A & C Dialog					

Table 27 – DialogConditionType Additional Subcomponents

BrowsePath	**References**	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**Others**
DialogState	HasProperty	Variable	TrueState	LocalizedText	PropertyType	
DialogState	HasProperty	Variable	FalseState	LocalizedText	PropertyType	

The empty "Others" column indicates that no *ModellingRule* applies.

The *DialogConditionType* inherits all *Properties* of the *ConditionType*.

DialogState/Id when set to True indicates that the *Dialog* is active and waiting for a response. Recommended state names are described in A.2.

Prompt is a dialog prompt to be shown to the user.

ResponseOptionSet specifies the desired set of responses as array of *LocalizedText*. The index in this array is used for the corresponding fields like *DefaultResponse*, *LastResponse* and *SelectedOption* in the *Respond Method*. The recommended localized names for the common options are described in A.1.

Typical combinations of response options are

- OK
- OK, Cancel
- Yes, No, Cancel
- Abort, Retry, Ignore
- Retry, Cancel
- Yes, No

DefaultResponse identifies the response option that should be shown as default to the user. It is the index in the *ResponseOptionSet* array. If no response option is the default, the value of the *Property* is -1.

LastResponse contains the last response provided by a *Client* in the *Respond Method*. If no previous response exists, then the value of the *Property* is -1.

OkResponse provides the index of the OK option in the *ResponseOptionSet* array. This choice is the response that will allow the system to proceed with the operation described by the prompt. This allows a *Client* to identify the OK option if a special handling for this option is available. If no OK option is available, the value of this *Property* is -1.

CancelResponse provides the index of the response in the *ResponseOptionSet* array that will cause the Dialog to go into the inactive state without proceeding with the operation described by the prompt. This allows a *Client* to identify the Cancel option if a special handling for this option is available. If no Cancel option is available, the value of this *Property* is -1.

5.6.3 Respond Method

Respond is used to pass the selected response option and end the dialog. *DialogState/Id* will return to False.

Signature

```
Respond(
    [in] Int32 SelectedResponse
    );
```

The parameters are defined in Table 28

Table 28 – Respond parameters

Argument	Description
SelectedResponse	Selected index of the *ResponseOptionSet* array.

Method result codes in Table 29 (defined in Call Service)

Table 29 – Respond Result Codes

Result Code	Description
Bad_DialogNotActive	See Table 137 for the description of this result code.
Bad_DialogResponseInvalid	See Table 137 for the description of this result code.

Table 30 specifies the *AddressSpace* representation for the *Respond Method*.

Table 30 – Respond Method AddressSpace definition

Attribute	**Value**				
BrowseName	Respond				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**ModellingRule**
HasProperty	*Variable*	InputArguments	Argument[]	PropertyType	Mandatory
AlwaysGeneratesEvent	ObjectType	AuditConditionRespondEventType	Defined in 5.10.5		
ConformanceUnits					
A & C Dialog					

If *Auditing* is supported, this *Method* shall generate an *Event* of *AuditConditionRespondEventType* for all invocations of the *Method*.

5.6.4 Respond2 Method

Respond2 Method extends the respond method by adding a comment field. For other functionality see the *Respond Method* definition.

Signature

```
Respond2(
    [in] Int32             SelectedResponse
    [in] LocalizedText     Comment
    );
```

The parameters are defined in Table 31

Table 31 – Respond2 parameters

Argument	**Description**
SelectedResponse	Selected index of the *ResponseOptionSet* array.
Comment	A localized text to be applied to the *Dialog*.

If the *Comment* argument is NULL (both locale and text are empty) it will be ignored and any existing comments will remain unchanged. If the comment is to be reset, an empty text with a locale shall be provided.

Method result codes in **Table 32** (defined in Call Service)

Table 32 – Respond2 Result Codes

Result Code	**Description**
Bad_DialogNotActive	See Table 137 for the description of this result code.
Bad_DialogResponseInvalid	See Table 137 for the description of this result code.

Table 33 specifies the *AddressSpace* representation for the *Respond2 Method*.

Table 33 – Respond2 Method AddressSpace definition

Attribute	**Value**				
BrowseName	Respond2				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**ModellingRule**
HasProperty	*Variable*	InputArguments	Argument[]	PropertyType	Mandatory
AlwaysGeneratesEvent	ObjectType	AuditConditionRespondEventType	Defined in 5.10.5		
ConformanceUnits					
A & C Dialog2					

If *Auditing* is supported, this *Method* shall generate an *Event* of *AuditConditionRespondEventType* for all invocations of the *Method*.

5.7 Acknowledgeable Condition Model

5.7.1 General

The Acknowledgeable *Condition* Model extends the *Condition* model. States for acknowledgement and confirmation are added to the *Condition* model.

AcknowledgeableConditions are represented by the *AcknowledgeableConditionType* which is a subtype of the *ConditionType*. The model is formally defined in the following sub clauses.

5.7.2 AcknowledgeableConditionType

The *AcknowledgeableConditionType* extends the *ConditionType* by defining acknowledgement characteristics. The *AcknowledgeableConditionType* is illustrated in Figure 13 and formally defined in Table 34 and Table 35.

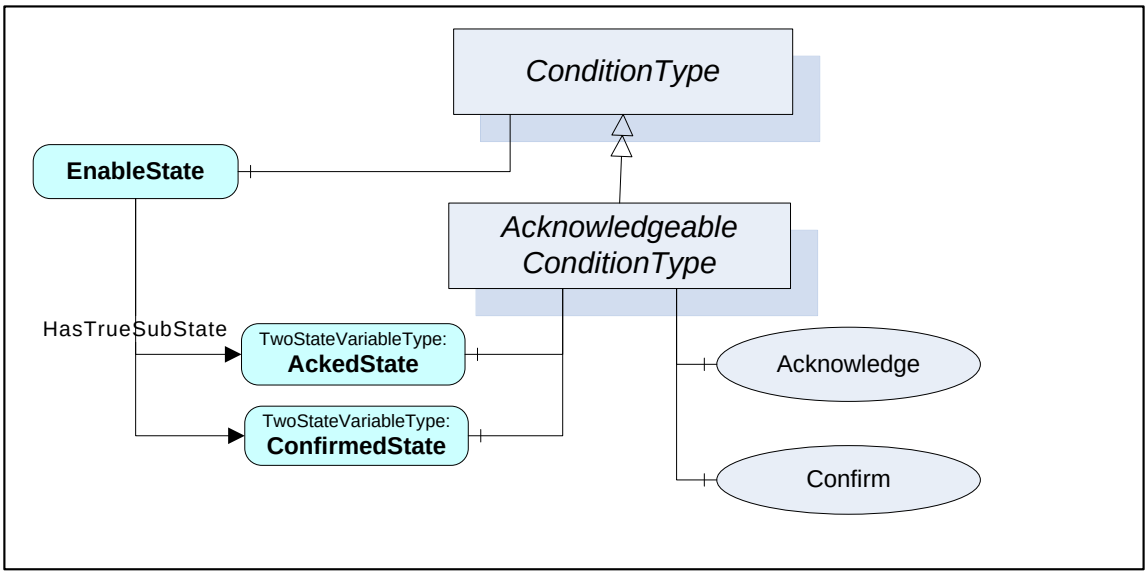


Figure 13 – AcknowledgeableConditionType overview

Table 34 – AcknowledgeableConditionType definition

Attribute	**Value**				
BrowseName	AcknowledgeableConditionType				
IsAbstract	False				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**Modelling Rule**
Subtype of the *ConditionType* defined in clause 5.5.2.					
HasSubtype	ObjectType	AlarmConditionType	Defined in Clause 5.8.2		
HasComponent	Variable	AckedState	LocalizedText	TwoStateVariableType	Mandatory
HasComponent	Variable	ConfirmedState	LocalizedText	TwoStateVariableType	Optional
HasComponent	Method	Acknowledge	Defined in Clause 5.7.3		Mandatory
HasComponent	Method	Confirm	Defined in Clause 5.7.4		Optional
ConformanceUnits					
A & C Acknowledge					

Table 35 – AcknowledgeableConditionType Additional Subcomponents

BrowsePath	**References**	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**Others**
AckedState	HasProperty	Variable	TrueState	LocalizedText	PropertyType	
AckedState	HasProperty	Variable	FalseState	LocalizedText	PropertyType	
ConfirmedState	HasProperty	Variable	TrueState	LocalizedText	PropertyType	
ConfirmedState	HasProperty	Variable	FalseState	LocalizedText	PropertyType	

The empty “Others” column indicates that no *ModellingRule* applies.

The *AcknowledgeableConditionType* inherits all *Properties* of the *ConditionType*.

AckedState when False indicates that the *Condition* instance requires acknowledgement for the reported *Condition* state. When the *Condition* instance is acknowledged the *AckedState* is set to True. *ConfirmedState* indicates whether it requires confirmation. Recommended state names are described in A.1. The two states are sub-states of the True *EnabledState*. See 4.3 for more information about acknowledgement and confirmation models. The *EventId* used in the *Event Notification* is considered the identifier of this state and has to be used when calling the *Methods* for acknowledgement or confirmation.

A *Server* may require that previous states be acknowledged. If the acknowledgement of a previous state is still open and a new state also requires acknowledgement, the *Server* shall create a branch of the *Condition* instance as specified in 4.2. *Clients* are expected to keep track of all *ConditionBranches* where *AckedState*/Id is False to allow acknowledgement of those. See also 5.5.2 for more information about *ConditionBranches* and the examples in Clause B.1. The handling of the *AckedState* and branches also applies to the *ConfirmedState*.

In the event of a restart of an *AlarmManager*, the *AlarmManager* should recover the *AckedState* and *ConfirmedState* (if supported) of all current conditions. If the system can not determine if the condition is *Acknowledged* or *Confirmed*, they shall be set to false (not *Acknowledged* and not *Confirmed*).

5.7.3 Acknowledge Method

The *Acknowledge Method* is used to acknowledge an *Event Notification* for a *Condition* instance state where *AckedState* is False. Normally, the *NodeId* of the object instance is passed as the *ObjectId* to the *Call Service*. However, some *Servers* do not expose *Condition* instances in the *AddressSpace.* Therefore, *Servers* shall allow *Clients* to call the *Acknowledge Method* by specifying *ConditionId* as the *ObjectId.* The *Method* cannot be called with an *ObjectId* of the *AcknowledgeableConditionType Node*.

Signature

```
Acknowledge(
    [in] ByteString EventId
    [in] LocalizedText Comment
    );
```

The parameters are defined in Table 36

Table 36 – Acknowledge parameters

Argument	Description
EventId	EventId identifying a particular *Event Notification*. Only *Event Notifications* where AckedState/Id was False can be acknowledged.
Comment	A localized text to be applied to the *Condition*.

Method result codes in Table 37 (defined in Call Service)

Table 37 – Acknowledge result codes

Result Code	Description
Bad_ConditionBranchAlreadyAcked	See Table 137 for the description of this result code.
Bad_MethodInvalid	The *MethodId* is not the well-known method of the *AcknowledgeableConditionType* or *MethodId* does not refer to a *Method* for the specified *Object* or *ConditionId*.
Bad_EventIdUnknown	See Table 137 for the description of this result code.
Bad_NodeIdInvalid	Used to indicate that the specified *ObjectId* is not valid or that the *Method* was called on the *AcknowledgeableConditionType Node*. See 10000-4 for the general description of this result code.

Comments

A *Server* is responsible to ensure that each *Event* has a unique *EventId*. This allows *Clients* to identify and acknowledge a particular *Event Notification*.

The *EventId* identifies a specific *Event Notification* where a state to be acknowledged was reported. Acknowledgement and the optional comment will be applied to the state identified with the *EventId*. If the comment field is NULL (both locale and text are empty) it will be ignored and any existing comments will remain unchanged. If the comment is to be reset, an empty text with a locale shall be provided.

A valid *EventId* will result in an *Event Notification* where *AckedState*/Id is set to True and the *Comment Property* contains the text of the optional comment argument. If a previous state is acknowledged, the *BranchId* and all *Condition* values of this branch will be reported. Table 38 specifies the *AddressSpace* representation for the *Acknowledge Method*.

Table 38 – Acknowledge Method AddressSpace definition

Attribute	**Value**				
BrowseName	Acknowledge				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**ModellingRule**
HasProperty	*Variable*	InputArguments	Argument[]	PropertyType	Mandatory
AlwaysGeneratesEvent	ObjectType	AuditConditionAcknowledgeEventType	Defined in 5.10.5		
ConformanceUnits					
A & C Acknowledge					

If *Auditing* is supported, this *Method* shall generate an *Event* of *AuditConditionAcknowledgeEventType* for all invocations of the *Method*.

5.7.4 Confirm Method

The *Confirm Method* is used to confirm an *Event Notifications* for a *Condition* instance state where *ConfirmedState* is False. Normally, the *NodeId* of the object instance is passed as the *ObjectId* to the *Call Service*. However, some *Servers* do not expose *Condition* instances in the *AddressSpace.* Therefore, *Servers* shall allow *Clients* to call the *Confirm Method* by specifying *ConditionId* as the *ObjectId.* The *Method* cannot be called with an *ObjectId* of the *AcknowledgeableConditionType Node.*

Signature

```
Confirm(
   [in] ByteString        EventId
   [in] LocalizedText     Comment
   );
```

The parameters are defined in Table 39

Table 39 – Confirm Method parameters

Argument	**Description**
EventId	*EventId* identifying a particular *Event Notification*. Only *Event Notifications* where the Id property of the *ConfirmedState* is False can be confirmed.
Comment	A localized text to be applied to the *Conditions*.

Method result codes in Table 40 (defined in Call Service)

Table 40 – Confirm result codes

Result Code	**Description**
Bad_ConditionBranchAlreadyConfirmed	See Table 137 for the description of this result code.
Bad_MethodInvalid	The method id does not refer to a method for the specified object or *ConditionId*. See 10000-4 for the general description of this result code.
Bad_EventIdUnknown	See Table 137 for the description of this result code.
Bad_NodeIdInvalid	Used to indicate that the specified *ObjectId* is not valid or that the *Method* was called on the *AcknowledgeableConditionType Node*. See 10000-4 for the general description of this result code.

Comments

A *Server* is responsible to ensure that each *Event* has a unique *EventId*. This allows *Clients* to identify and confirm a particular *Event Notification*.

The *EventId* identifies a specific *Event Notification* where a state to be confirmed was reported. A *Comment* can be provided which will be applied to the state identified with the *EventId*. If the comment field is NULL (both locale and text are empty) it will be ignored and any existing comments will remain unchanged. If the comment is to be reset, an empty text with a locale shall be provided.

A valid *EventId* will result in an *Event Notification* where *ConfirmedState*/Id is set to True and the *Comment Property* contains the text of the optional comment argument. If a previous state is confirmed, the *BranchId* and all *Condition* values of this branch will be reported. A *Client* can confirm only events that have a *ConfirmedState*/Id set to False. The logic for setting *ConfirmedState*/Id to False is *Server* specific and may even be event or condition specific.

Table 41 specifies the *AddressSpace* representation for the *Confirm Method*.

Table 41 – Confirm Method AddressSpace definition

Attribute	**Value**				
BrowseName	Confirm				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**ModellingRule**
HasProperty	*Variable*	InputArguments	Argument[]	PropertyType	Mandatory
AlwaysGenerates Event	ObjectType	AuditConditionConfirmEventType	Defined in 5.10.7		
ConformanceUnits					
A & C Confirm					

If *Auditing* is supported, this *Method* shall generate an *Event* of *AuditConditionConfirmEventType* for all invocations of the *Method*.

5.8 Alarm model

5.8.1 General

Figure 14 informally describes the AlarmConditionType, its sub-types and where it is in the hierarchy of *Event Types*.

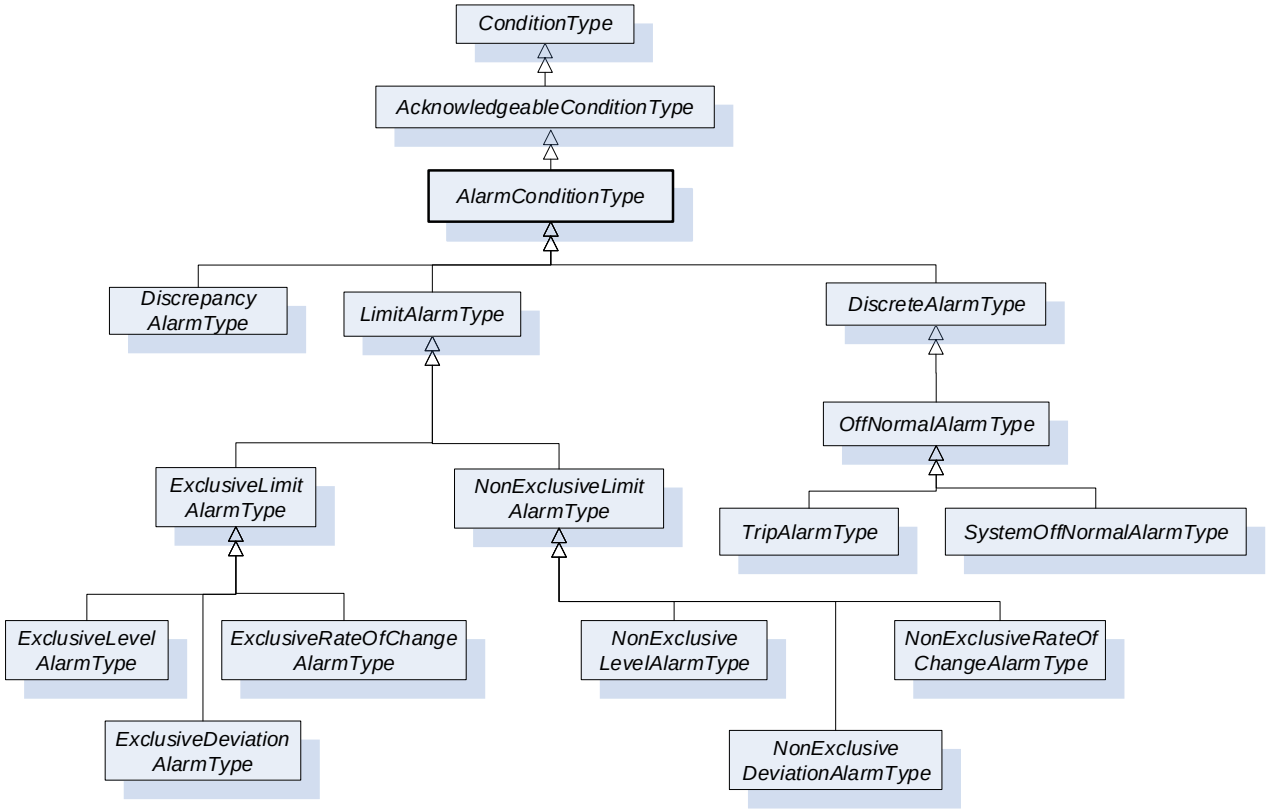


Figure 14 – AlarmConditionType Hierarchy Model

5.8.2 AlarmConditionType

The *AlarmConditionType* extends the *AcknowledgeableConditionType* by introducing an *ActiveState*, *SuppressedState* and *ShelvingState*. It also adds the ability to set a delay time, re-alarm time, *Alarm* groups and audible *Alarm* settings. The *Alarm* model is illustrated in Figure 15. This illustration is not intended to be a complete definition. It is formally defined in Table 42 and Table 43.

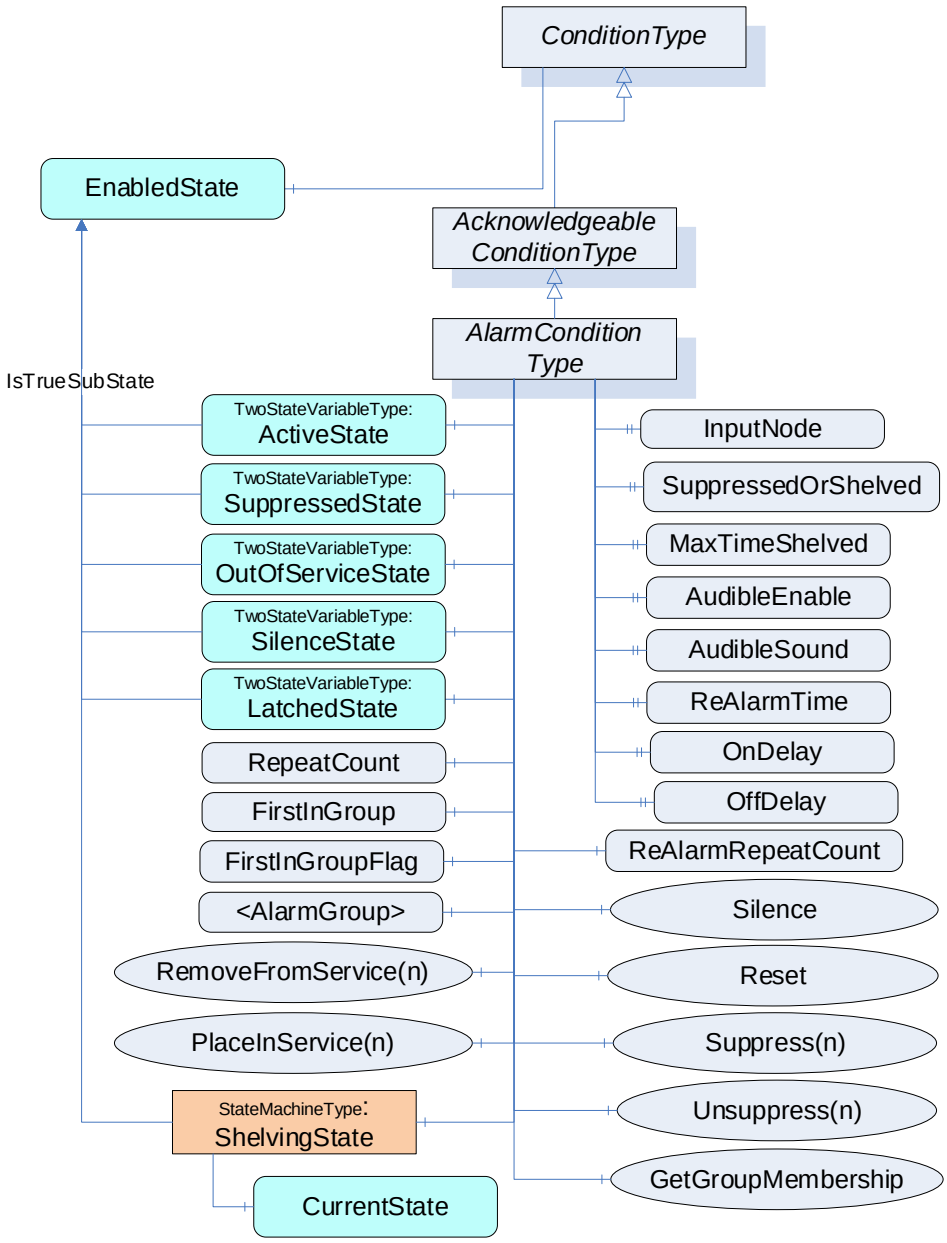


Figure 15 – Alarm Model

Table 42 – AlarmConditionType definition

Attribute	**Value**				
BrowseName	AlarmConditionType				
IsAbstract	False				
References	**Node Class**	**BrowseName**	**DataType**	**TypeDefinition**	**Modelling Rule**
Subtype of the *AcknowledgeableConditionType* defined in clause 5.7.2					
HasComponent	Variable	ActiveState	LocalizedText	TwoStateVariableType	Mandatory
HasProperty	Variable	InputNode	NodeId	PropertyType	Mandatory
HasComponent	Variable	SuppressedState	LocalizedText	TwoStateVariableType	Optional
HasComponent	Variable	OutOfServiceState	LocalizedText	TwoStateVariableType	Optional
HasComponent	Object	ShelvingState		ShelvedStateMachineType	Optional
HasProperty	Variable	SuppressedOrShelved	Boolean	PropertyType	Mandatory
HasProperty	Variable	MaxTimeShelved	Duration	PropertyType	Optional
HasProperty	Variable	AudibleEnabled	Boolean	PropertyType	Optional

HasComponent	Variable	AudibleSound	AudioDataType	AudioVariableType	Optional
HasComponent	Variable	SilenceState	LocalizedText	TwoStateVariableType	Optional
HasProperty	Variable	OnDelay	Duration	PropertyType	Optional
HasProperty	Variable	OffDelay	Duration	PropertyType	Optional
HasComponent	Variable	FirstInGroupFlag	Boolean	BaseDataVariableType	Optional
HasComponent	Object	FirstInGroup		AlarmGroupType	Optional
HasComponent	Variable	LatchedState	LocalizedText	TwoStateVariableType	Optional
HasAlarmSuppressionGroup	Object	<AlarmGroup>		AlarmGroupType	OptionalPlaceholder
HasProperty	Variable	ReAlarmTime	Duration	PropertyType	Optional
HasComponent	Variable	ReAlarmRepeatCount	Int16	BaseDataVariableType	Optional
HasComponent	Method	Reset	Defined in 5.8.5		Optional
HasComponent	Method	Reset2	Defined in 5.8.65.8.5		Optional
HasComponent	Method	Silence	Defined in 5.8.7		Optional
HasComponent	Method	Suppress	Defined in 5.8.8		Optional
HasComponent	Method	Suppress2	Defined in 5.8.9		Optional
HasComponent	Method	Unsuppress	Defined in 5.8.10		Optional
HasComponent	Method	Unsuppress2	Defined in 5.8.11		Optional
HasComponent	Method	RemoveFromService	Defined in 5.8.12		Optional
HasComponent	Method	RemoveFromService2	Defined in 5.8.13		Optional
HasComponent	Method	PlaceInService	Defined in 5.8.14		Optional
HasComponent	Method	PlaceInService2	Defined in 5.8.15		Optional
HasComponent	Method	GetGroupMemberships	Defined in 5.8.16		Optional
HasSubtype	ObjectType	DiscreteAlarmType			
HasSubtype	ObjectType	LimitAlarmType			
HasSubtype	ObjectType	DiscrepancyAlarmType			
ConformanceUnits					
A & C Alarm					

Table 43 – AlarmConditionType Additional Subcomponents

BrowsePath	References	NodeClass	BrowseName	DataType	TypeDefinition	Others
ActiveState	HasProperty	Variable	TrueState	LocalizedText	PropertyType	
ActiveState	HasProperty	Variable	FalseState	LocalizedText	PropertyType	
SuppressedState	HasProperty	Variable	TrueState	LocalizedText	PropertyType	
SuppressedState	HasProperty	Variable	FalseState	LocalizedText	PropertyType	
OutOfServiceState	HasProperty	Variable	TrueState	LocalizedText	PropertyType	
OutOfServiceState	HasProperty	Variable	FalseState	LocalizedText	PropertyType	
SilenceState	HasProperty	Variable	TrueState	LocalizedText	PropertyType	
SilenceState	HasProperty	Variable	FalseState	LocalizedText	PropertyType	
LatchedState	HasProperty	Variable	TrueState	LocalizedText	PropertyType	
LatchedState	HasProperty	Variable	FalseState	LocalizedText	PropertyType	

The empty *"*Others" column indicates that no *ModellingRule* applies.

The *AlarmConditionType* inherits all *Properties* of the *AcknowledgeableConditionType*. The following states are sub-states of the True *EnabledState*.

ActiveState/Id when set to True indicates that the situation the *Condition* is representing currently exists. When a *Condition* instance is in the inactive state (*ActiveState/Id* when set to False) it is representing a situation that has returned to a normal state. The transitions of *Conditions* to the inactive and *Active* states are triggered by *Server* specific actions. Subtypes of the *AlarmConditionType* specified later in this document will have sub-state models that further define the *Active* state. Recommended state names are described inA.1. In the event of a restart of an *AlarmManager*, the *AlarmManager* shall recover the *ActiveState.*

The *InputNode Property* provides the *NodeId* of the *Variable* the *Value* of which is used as primary input in the calculation of the *Alarm* state. If this *Variable* is not in the *AddressSpace*,

a NULL *NodeId* shall be provided. In some systems, an *Alarm* may be calculated based on multiple *Variables Values*; it is up to the system to determine which *Variable's NodeId* is used.

SuppressedState, *OutOfServiceState* and *ShelvingState* together allow the suppression of *Alarms* on display systems. These three suppressions are generally used by different personnel or systems at a plant, i.e. automatic systems, maintenance personnel and *Operators*.

SuppressedState is used internally by a *Server* to automatically suppress *Alarms* due to system specific reasons. For example, a system may be configured to suppress *Alarms* that are associated with machinery that is in a state such as shutdown. For example, a low level *Alarm* for a tank that is currently not in use might be suppressed. Recommended state names are described in A.1. In the event of a restart of an *AlarmManager*, the *AlarmManager* should recover the *SuppressedState*. If the system cannot determine if the alarm is *Suppressed*, the state shall be set to false (not *Suppressed*).

OutOfServiceState is used by maintenance personnel to suppress *Alarms* due to a maintenance issue. For example, if an instrument is taken out of service for maintenance or is removed temporarily while it is being replaced or serviced the item would have the *OutOfServiceState* set. Recommended state names are described in A.1. In the event of a restart of an *AlarmManager*, the *AlarmManager* should recover the *OutOfServiceState.* If the system cannot determine if the alarm is *OutOfService*, the state shall be set to false (not *OutOfService*).

ShelvingState suggests whether an *Alarm* shall (temporarily) be prevented from being displayed to the user. It is quite often used by *Operators* to block nuisance *Alarms*. The *ShelvingState* is defined in 5.8.17.

When an *Alarm* has any or all of the *SuppressedState, OutOfServiceState* or *ShelvingState* set to True, the *SuppressedOrShelved* property shall be set True and this *Alarm* is then typically not displayed by the *Client*. State transitions associated with the *Alarm* do occur, but they are not typically displayed by the *Client*s as long as the *Alarm* remains in any of the *SuppressedState, OutOfServiceState* or *Shelved* state.

The optional *Property MaxTimeShelved* is used to set the maximum time that an *Alarm Condition* may be shelved. The value is expressed as duration. Systems can use this *Property* to prevent permanent *Shelving* of an *Alarm.* If this *Property* is present, it will be an upper limit on the duration passed into a *TimedShelve Method* call. If a value that exceeds the value of this *Property* is passed to the *TimedShelve Method*, then a *Bad_ShelvingTimeOutOfRange* error code is returned on the call. If this *Property* is present, it will also be enforced for the *OneShotShelved* state, in that an *Alarm Condition* will transition to the *Unshelved* state from the *OneShotShelved* state if the duration specified in this *Property* expires following a *OneShotShelve* operation without a change of any of the other items associated with the *Condition*.

The optional *Property AudibleEnabled* is a Boolean that indicates if the current state of this *Alarm* includes an audible *Alarm*.

The optional *Property AudibleSound* contains the sound file that is to be played if an audible *Alarm* is to be generated. This file would be play/generated as long as the *Alarm* is active and unacknowledged, unless the silence *StateMachine* is included, in which case it may also be silenced by this *StateMachine*.

The *SilenceState* is used to suppress the generation of audible *Alarms*. Typically, it is used when an *Operator* silences all *Alarms* on a screen, but needs to acknowledge the *Alarms* individually. Silencing an *Alarm* shall silence the *Alarm* on all systems (screens) that it is being reported on. Not all *Clients* will make use of this *StateMachine*, but it allows multiple *Clients* to synchronize audible *Alarm* states. Acknowledging an *Alarm* shall automatically silence an *Alarm*. In the event of a restart of an *AlarmManager*, the *AlarmManager* should recover the *SilenceState*. If the system cannot determine if the *Alarm* is silenced, it shall set the *SilenceState,* based on the *AcknowledgeState.* If it is *Acknowledged*, it is silenced, If it has not been *Acknowledged*, it shall not be silenced.

The *OnDelay* and *OffDelay Properties* can be used to eliminate nuisance *Alarms*. The *OnDelay* is used to avoid unnecessary Alarms when a signal temporarily overshoots its setpoint, thus

preventing the *Alarm* from being triggered until the signal remains in the *Alarm* state continuously for a specified length of time (*OnDelay* time). The *OffDelay* is used to reduce chattering *Alarms* by locking the *Alarm* indication for a certain holding period after the condition has returned to normal. I.e., the *Alarm* shall stay active for the *OffDelay* time and shall not regenerate if it returns to active in that period. If the *Alarm* remains in the inactive zone for *OffDelay* it will then become inactive.

The optional variable *FirstInGroupFlag* is used together with the *FirstInGroup* object. The FirstInGroup Object is an instance of an AlarmGroupType that groups a number of related *Alarm*s. The *FirstInGroupFlag* is set on the *Alarm* instance that was the first *Alarm* to trigger in a *FirstInGroup*. If this variable is present, then the *FirstInGroup* shall also be present. These two nodes allow an alarming system to determine which *Alarm* in the list was the trigger. It is commonly used in situations where *Alarm*s are interrelated and usually multiple *Alarm*s occur. For example, vibration sensors in a turbine, usually all sensors trigger if any one triggers, but what is important for an *Operator* is the first sensor that triggered.

The *LatchedState Object*, if present, indicates that this *Alarm* supports being latched. The *Alarm* will remain with a retain bit of True until it is no longer active, is acknowledged, is confirmed (if *ConfirmedState* is provided) and is reset. The *Reset Method,* if called while active has no effect on the *Alarm* and is ignored and an error of Bad_InvalidState is return on the call. The *Object* indicates the current state, latched or not latched. Recommended state names are described in A.1. If this *Object* is provided the *Reset Method* must also be provided. In the event of a restart of an *AlarmManager*, the *AlarmManager* shall recover the *LatchedState.*

An *Alarm* instance may contain *HasAlarmSuppressionGroup* reference(s) to instance(s) of *AlarmGroupType* (or subtype of it). Each instance is an *AlarmSuppressionGroup.* When an *AlarmSuppressionGroup* goes active, the *Server* shall set the *SuppressedState* of the *Alarm* containing the *HasAlarmSuppressionGroup* reference to True. When all of referenced *AlarmSuppressionGroups* are no longer active, then the Server shall set *SuppressedState* to False. A single *AlarmSuppressionGroup* can manage multiple *Alarms*. *AlarmSuppressionGroups* are used to control *Alarm* floods and to help manage *Alarms*.

ReAlarmTime if present sets a time that is used to bring an *Alarm* back to the top of an *Alarm* list. If an *Alarm* has not returned to normal within the provided time (from when it last was alarmed), the *Server* will generate a new *Alarm* for it (as if it just went into alarm). If it has been silenced it shall return to an un-silenced state, if it has been acknowledged it shall return to unacknowledged. The *Alarm* active time is set to the time of the re-alarm.

ReAlarmRepeatCount if present counts the number times an *Alarm* was re-alarmed. Some smart alarming system would use this count to raise the priority or otherwise generate additional or different annunciations for the given *Alarm*. The count is reset when an *Alarm* returns to normal.

Silence Method can be used to silence an instance of an *Alarm*. It is defined in 5.8.7.

Suppress and *Suppress2 Method* can be used to suppress an instance of an *Alarm*. Most *Alarm* suppression occurs via advanced alarming, but this method allows additional access to suppress a particular *Alarm* instance. Additional details are provided in the definition in 5.8.8 and 5.8.9

Unsuppress and *Unsuppress2 Method* can be used to remove an instance of an *Alarm* from SuppressedState. Additional details are provided in the definition in 5.8.10 and 5.8.11.

PlaceInService and *PlaceInService2 Method* can be used to remove an instance of an *Alarm* from *OutOfServiceState*. It is defined in 5.8.14 and 5.8.15.

RemoveFromService and *RemoveFromService2 Method* can be used to place an instance of an *Alarm* in *OutOfServiceState*. It is defined in 5.8.12 and 5.8.13.

Reset Method is used to clear a latched *Alarm*. It is defined in 5.8.5. If this *Object* is provided the *LatchedState Object* shall also be provided.

More details about the *Alarm* Model and the various states can be found in Sub clause 4.8. and in Annex E.

5.8.3 AlarmGroupType

The *AlarmGroupType* provides a simple manner of grouping *Alarms*. This grouping can be used for *Alarm* suppression or for identifying related *Alarms*. The actual usage of the *AlarmGroupType* is specified where it is used.

Table 44 – AlarmGroupType definition

Attribute	**Value**				
BrowseName	AlarmGroupType				
IsAbstract	False				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**Modelling Rule**
Subtype of the *FolderType* defined in 10000-5					
AlarmGroupMember	Object	<AlarmConditionInstance>		AlarmConditionType	OptionalPlaceholder
ConformanceUnits					
A & C First in Group Alarm					
A & C Suppression Group					

The instance of an *AlarmGroupType* should be given a name and description that describes the purpose of the *Alarm* group.

The *AlarmGroupType* instance will contain a list of instances of *AlarmConditionType* or sub type of *AlarmConditionType* referenced by *AlarmGroupMember* references. At least one *Alarm* must be present in an instance of an *AlarmGroupType*.

5.8.4 AlarmSuppressionGroupType

This is a subtype of *AlarmGroupType* that can be used to suppress other alarms. This subtype of *AlarmGroup* extends the *AlarmGroupType* to allow the addition of *Variables* that have a *Boolean DataType*. The *Variable* can be thought of as representing the *Id* of the *ActiveState* of an *Alarm*, i.e. when any of the included *Variables* have a value of true the *AlarmSuppressionGroup* is active.

Table 45 – AlarmSuppressionGroupType definition

Attribute	**Value**				
BrowseName	AlarmSuppressionGroupType				
IsAbstract	False				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**Modelling Rule**
Subtype of the *AlarmGroupType*					
AlarmSuppressionGroup Member	Variable	<DigitalVariable>	Boolean	BaseDataVariableType	OptionalPlaceholder
ConformanceUnits					
A & C Suppression Group					

The instance of an *AlarmSuppressionGroupType* should be given a name and description that describes the purpose of the *Alarm* group.

The *AlarmSuppressionGroupType* instance will contain a list of instances of *AlarmConditionType* or sub type of *AlarmConditionType* or *BaseDataVaribleType* with a *DataType* of *Boolean* referenced by *AlarmSuppressionGroupMember* references. At least one *Node* must be present in an instance of an *AlarmGroupType*.

5.8.5 Reset Method

The *Reset Method* is used reset a latched *Alarm* instance. It is only available on an instance of an *AlarmConditionType* that exposes the *LatchedState*. Normally, the *NodeId* of the *Object* instance is passed as the *ObjectId* to the *Call Service*. However, some *Servers* do not expose *Condition* instances in the *AddressSpace.* Therefore, *Servers* shall allow *Clients* to call the *Reset Method* by specifying *ConditionId* as the *ObjectId.* The *Method* cannot be called with an *ObjectId* of the *AlarmConditionType Node*.

Signature

```
Reset();
```

This method has no arguments.

Method result codes in Table 46 (defined in *Call* service)

Table 46 – Reset result codes

Result Code	Description
Bad_MethodInvalid	The *MethodId* provided does not correspond to the *ObjectId* provided. See 10000-4 for the general description of this result code.
Bad_NodeIdInvalid	Used to indicate that the specified *ObjectId* is not valid or that the *Method* was called on the *AlarmConditionType Node*. See 10000-4 for the general description of this result code.
Bad_InvalidState	The *Alarm* instance was not latched or is still active or still requires acknowledgement / confirmation. For an *Alarm* Instance to be reset it must have been in *Alarm*, and returned to normal and have been acknowledged/confirmed prior to being reset.

Table 47 specifies the *AddressSpace* representation for the *Reset Method*.

Table 47 – Reset Method AddressSpace definition

Attribute	**Value**				
BrowseName	Reset				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**ModellingRule**
AlwaysGeneratesEvent	ObjectType	AuditConditionResetEventType	Defined in 5.10.11		
ConformanceUnits					
A & C Latched State					

If *Auditing* is supported, this *Method* shall generate an *Event* of *AuditConditionResetEventType* for all invocations of the *Method*.

5.8.6 Reset2 Method

The *Reset2 Method* extends the *Reset Method*, by adding an optional *Comment*. For other functionality see the *Reset Method* definition.

Signature

```
Reset2(
   [in] LocalizedText     Comment
   );
```

The parameters are defined in Table 48.

Table 48 – Reset2 Method parameters

Argument	Description
Comment	A localized text to be applied to the *Condition*.

If the *Comment* argument is NULL (both locale and text are empty) it will be ignored and any existing comments will remain unchanged. If the comment is to be reset, an empty text with a locale shall be provided.

Method result codes in **Table 49** (defined in *Call* service)

Table 49 – Reset2 result codes

Result Code	Description
Bad_MethodInvalid	The *MethodId* provided does not correspond to the *ObjectId* provided. See 10000-4 for the general description of this result code.
Bad_NodeIdInvalid	Used to indicate that the specified *ObjectId* is not valid or that the *Method* was called on the *AlarmConditionType Node*. See 10000-4 for the general description of this result code.
Bad_InvalidState	The *Alarm* instance was not latched or is still active or still requires acknowledgement / confirmation. For an *Alarm* Instance to be reset it must have been in *Alarm*, and returned to normal and have been acknowledged/confirmed prior to being reset.

Table 50 specifies the *AddressSpace* representation for the *Reset2 Method*.

Table 50 – Reset2 Method AddressSpace definition

Attribute	Value				
BrowseName	Reset2				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**ModellingRule**
HasProperty	*Variable*	InputArguments	Argument[]	PropertyType	Mandatory
AlwaysGeneratesEvent	ObjectType	AuditConditionResetEventType	Defined in 5.10.11		
ConformanceUnits					
A & C Latched State					

If *Auditing* is supported, this *Method* shall generate an *Event* of *AuditConditionResetEventType* for all invocations of the *Method*.

5.8.7 Silence Method

The *Silence Method* is used silence a specific *Alarm* instance. It is only available on an instance of an *AlarmConditionType* that also exposes the *SilenceState*. Normally, the *NodeId* of the *Object* instance is passed as the *ObjectId* to the *Call Service*. However, some *Servers* do not expose *Condition* instances in the *AddressSpace.* Therefore, *Servers* shall allow *Clients* to call the *Silence Method* by specifying *ConditionId* as the *ObjectId.* The *Method* cannot be called with an *ObjectId* of the *AlarmConditionType Node*.

Signature

```
Silence();
```

This method has no arguments.

Method result codes in **Table 51** (defined in *Call* service)

Table 51 – Silence result codes

Result Code	Description
Bad_MethodInvalid	The *MethodId* provided does not correspond to the *ObjectId* provided. See 10000-4 for the general description of this result code.
Bad_NodeIdInvalid	Used to indicate that the specified *ObjectId* is not valid or that the *Method* was called on the *AlarmConditionType Node*. See 10000-4 for the general description of this result code.

Comments

If the instance is not currently in an audible state, the command is ignored.

Table 52 specifies the *AddressSpace* representation for the *Silence Method*.

Table 52 – Silence Method AddressSpace definition

Attribute	Value				
BrowseName	Silence				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**Modelling Rule**
AlwaysGeneratesEvent	ObjectType	AuditConditionSilenceEventType	Defined in 5.10.10		
ConformanceUnits					
A & C Silencing					

If *Auditing* is supported, this *Method* shall generate an *Event* of *AuditConditionSilenceEventType* for all invocations of the *Method*.

5.8.8 Suppress Method

The *Suppress Method* is used to suppress a specific *Alarm* instance. It is only available on an instance of an *AlarmConditionType* that also exposes the *SuppressedState*. This *Method* can be used to change the *SuppressedState* of an *Alarm* and overwrite any suppression caused by an associated *AlarmSuppressionGroup*. This *Method* works in parallel with any suppression triggered by an *AlarmSuppressionGroup*, in that if the *Method* is used to suppress an *Alarm*, an *AlarmSuppressionGroup* might clear the suppression.

Normally, the *NodeId* of the object instance is passed as the *ObjectId* to the *Call Service*. However, some *Servers* do not expose *Condition* instances in the *AddressSpace.* Therefore, *Servers* shall allow *Clients* to call the *Suppress Method* by specifying *ConditionId* as the *ObjectId.* The *Method* cannot be called with an *ObjectId* of the *AlarmConditionType Node*.

Signature

```
Suppress();
```

Method Result Codes in Table 53 (defined in Call Service)

Table 53 – Suppress result codes

Result Code	Description
Bad_MethodInvalid	The *MethodId* provided does not correspond to the ObjectId provided. See 10000-4 for the general description of this result code.
Bad_NodeIdInvalid	Used to indicate that the specified *ObjectId* is not valid or that the *Method* was called on the *AlarmConditionType Node*. See 10000-4 for the general description of this result code.

Comments

Suppress Method applies to an *Alarm* instance, even if it is not currently active.

Table 54 specifies the *AddressSpace* representation for the *Suppress Method*.

Table 54 – Suppress Method AddressSpace definition

Attribute	Value				
BrowseName	Suppress				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**Modelling Rule**
AlwaysGeneratesEvent	ObjectType	AuditConditionSuppressionEventType	Defined in 5.10.4		
ConformanceUnits					
A & C Suppression by Operator					

If *Auditing* is supported, this *Method* shall generate an *Event* of *AuditConditionSuppressionEventType* for all invocations of the *Method*.

5.8.9 Suppress2 Method

The *Suppress2 Method* extends the *Suppress Method*, by adding an optional *Comment*. For other functionality see the *Suppress Method* definition.

Signature

```
Suppress2(
    [in] LocalizedText     Comment
    );
```

The parameters are defined in Table 55

Table 55 – Suppress2 Method parameters

Argument	Description
Comment	A localized text to be applied to the *Condition*.

If the *Comment* argument is NULL (both locale and text are empty) it will be ignored and any existing comments will remain unchanged. If the comment is to be reset, an empty text with a locale shall be provided.

Table 56 specifies the *AddressSpace* representation for the *Suppress2 Method*.

Table 56 – Suppress2 Method AddressSpace definition

Attribute	Value				
BrowseName	Suppress2				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**ModellingRule**
HasProperty	*Variable*	InputArguments	Argument[]	PropertyType	Mandatory
AlwaysGeneratesEvent	ObjectType	AuditConditionSuppressionEventType	Defined in 5.10.4		
ConformanceUnits					
A & C Suppression2 by Operator					

If *Auditing* is supported, this *Method* shall generate an *Event* of *AuditConditionSuppressionEventType* for all invocations of the *Method*.

5.8.10 Unsuppress Method

The *Unsuppress Method* is used to clear the *SuppressedState* of a specific *Alarm* instance. It is only available on an instance of an *AlarmConditionType* that also exposes the *SuppressedState*. This *Method* can be used to overwrite any suppression cause by an associated AlarmSuppressionGroup. This *Method* works in parallel with any suppression triggered by an AlarmSuppressionGroup, in that if the *Method* is used to clear the *SuppressedState* of an *Alarm*, any change in an AlarmSuppressionGroup might again suppress the *Alarm*.

Normally, the *NodeId* of the ObjectInstance is passed as the *ObjectId* to the *Call Service*. However, some *Servers* do not expose *Condition* instances in the *AddressSpace.* Therefore, *Servers* shall allow *Clients* to call the *Unsuppress Method* by specifying *ConditionId* as the *ObjectId.* The *Method* cannot be called with an *ObjectId* of the *AlarmConditionType Node*.

Signature

```
Unsuppress();
```

Method Result Codes in Table 57 (defined in Call Service).

Table 57 – Unsuppress result codes

Result Code	Description
Bad_MethodInvalid	The *MethodId* provided does not correspond to the *ObjectId* provided. See 10000-4 for the general description of this result code.
Bad_NodeIdInvalid	Used to indicate that the specified *ObjectId* is not valid or that the *Method* was called on the *AlarmConditionType Node*. See 10000-4 for the general description of this result code.

Comments

Unsuppress Method applies to an *Alarm* instance, even if it is not currently active.

Table 58 specifies the *AddressSpace* representation for the *Suppress Method*.

Table 58 – Unsuppress Method AddressSpace definition

Attribute	Value				
BrowseName	Unsuppress				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**Modelling Rule**
AlwaysGeneratesEvent	ObjectType	AuditConditionSuppressionEventType	Defined in 5.10.4		
ConformanceUnits					
A & C Suppression by Operator					

If *Auditing* is supported, this *Method* shall generate and event of *AuditConditionSuppressionEventType* for all invocations of the *Method.*

5.8.11 Unsuppress2 Method

The *Unsuppress2 Method* extends the *Suppress Method*, by adding an optional *Comment*. For other functionality see the *Unsuppress Method* definition.

Signature

```
Unsuppress2(
   [in] LocalizedText     Comment
   );
```

The parameters are defined in Table 59.

Table 59 – Unsuppress2 Method parameters

Argument	Description
Comment	A localized text to be applied to the *Condition*.

If the *Comment* argument is NULL (both locale and text are empty) it will be ignored and any existing comments will remain unchanged. If the comment is to be reset, an empty text with a locale shall be provided.

Unsuppress2 Method applies to an *Alarm* instance, even if it is not currently active.

Table 60 specifies the *AddressSpace* representation for the *Unsuppress2 Method*.

Table 60 – Unsuppress2 Method AddressSpace definition

Attribute	Value				
BrowseName	Unsuppress2				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**Modelling Rule**
HasProperty	*Variable*	InputArguments	Argument[]	PropertyType	Mandatory
AlwaysGeneratesEvent	ObjectType	AuditConditionSuppressionEventType	Defined in 5.10.4		
ConformanceUnits					
A & C Suppression2 by Operator					

If *Auditing* is supported, this *Method* shall generate an *Event* of *AuditConditionSuppressionEventType* for all invocations of the *Method*.

5.8.12 RemoveFromService Method

The *RemoveFromService Method* is used to suppress a specific *Alarm* instance. It is only available on an instance of an AlarmConditionType that also exposes the *OutOfServiceState*. Normally, the *NodeId* of the object instance is passed as the *ObjectId* to the *Call Service*. However, some *Servers* do not expose *Condition* instances in the *AddressSpace.* Therefore, *Servers* shall allow *Clients* to call the *RemoveFromService Method* by specifying *ConditionId* as the *ObjectId.* The *Method* cannot be called with an *ObjectId* of the *AlarmConditionType Node*.

Signature

```
RemoveFromService();
```

Method result codes in Table 61 (defined in *Call Service*).

Table 61 – RemoveFromService result codes

Result Code	Description
Bad_MethodInvalid	The *MethodId* provided does not correspond to the *ObjectId* provided. See 10000-4 for the general description of this result code.
Bad_NodeIdInvalid	Used to indicate that the specified *ObjectId* is not valid or that the *Method* was called on the *AlarmConditionType Node*. See 10000-4 for the general description of this result code.

Comments

Instances that do not expose the *OutOfService State* shall reject *RemoveFromService* calls. *RemoveFromService Method* applies to an *Alarm* instance, even if it is not currently in the *Active State*.

Table 62 specifies the *AddressSpace* representation for the *RemoveFromService Method*.

Table 62 – RemoveFromService Method AddressSpace definition

Attribute	Value				
BrowseName	RemoveFromService				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**Modelling Rule**
AlwaysGeneratesEvent	ObjectType	AuditConditionOutOfServiceEventType	Defined in 5.10.12		
ConformanceUnits					
A & C OutOfService					

If *Auditing* is supported, this *Method* shall generate an *Event* of *AuditConditionOutOfServiceEventType* for all invocations of the *Method*.

5.8.13 RemoveFromService2 Method

The *RemoveFromService2 Method* extends the *RemoveFromService Method*, by adding an optional *Comment*. For other functionality see the *RemoveFromService Method* definition.

Signature

```
RemoveFromService2(
    [in] LocalizedText     Comment
    );
```

The parameters are defined in Table 63

Table 63 – RemoveFromService2 Method parameters

Argument	Description
Comment	A localized text to be applied to the *Condition*.

If the *Comment* argument is NULL (both locale and text are empty) it will be ignored and any existing comments will remain unchanged. If the comment is to be reset, an empty text with a locale shall be provided.

Method result codes in Table 64 (defined in *Call Service*)

Table 64 – RemoveFromService2 result codes

Result Code	Description
Bad_MethodInvalid	The *MethodId* provided does not correspond to the *ObjectId* provided. See 10000-4 for the general description of this result code.
Bad_NodeIdInvalid	Used to indicate that the specified *ObjectId* is not valid or that the *Method* was called on the *AlarmConditionType Node*. See 10000-4 for the general description of this result code.

Comments

Instances that do not expose the *OutOfService State* shall reject *RemoveFromService2* calls. *RemoveFromService2 Method* applies to an *Alarm* instance, even if it is not currently in the *Active State*.

Table 65 specifies the *AddressSpace* representation for the *RemoveFromService2 Method*.

Table 65 – RemoveFromService2 Method AddressSpace definition

Attribute	Value				
BrowseName	RemoveFromService2				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**ModellingRule**
HasProperty	*Variable*	InputArguments	Argument[]	PropertyType	Mandatory
AlwaysGeneratesEvent	ObjectType	AuditConditionOutOfServiceEventType	Defined in 5.10.12		
ConformanceUnits					
A & C OutOfService2					

If *Auditing* is supported, this *Method* shall generate an *Event* of *AuditConditionOutOfServiceEventType* for all invocations of the *Method*.

5.8.14 PlaceInService Method

The *PlaceInService Method* is used to set the OutOfServiceState to False of a specific *Alarm* instance. It is only available on an instance of an *AlarmConditionType* that also exposes the *OutOfServiceState*. Normally, the *NodeId* of the ObjectInstance is passed as the *ObjectId* to the *Call Service*. However, some *Servers* do not expose *Condition* instances in the *AddressSpace.* Therefore, *Servers* shall allow *Clients* to call the *PlaceInService Method* by specifying *ConditionId* as the *ObjectId.* The *Method* cannot be called with an *ObjectId* of the *AlarmConditionType Node*.

Signature

```
PlaceInService();
```

Method result codes in Table 66 (defined in *Call Service*).

Table 66 – PlaceInService result codes

Result Code	Description
Bad_MethodInvalid	The *MethodId* provided does not correspond to the *ObjectId* provided. See 10000-4 for the general description of this result code.
Bad_NodeIdInvalid	Used to indicate that the specified *ObjectId* is not valid or that the *Method* was called on the *AlarmConditionType Node*. See 10000-4 for the general description of this result code.

Comments

The *PlaceInService Method* applies to an *Alarm* instance, even if it is not currently in the *Active State*.

Table 67 specifies the *AddressSpace* representation for the *PlaceInService Method*.

Table 67 – PlaceInService Method AddressSpace definition

Attribute	Value				
BrowseName	PlaceInService				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**ModellingRule**
AlwaysGeneratesEvent	ObjectType	AuditConditionOutOfService EventType	Defined in 5.10.12		
ConformanceUnits					
A & C OutOfService					

If *Auditing* is supported, this *Method* shall generate an *Event* of *AuditConditionOutOfServiceEventType* for all invocations of the *Method*.

5.8.15 PlaceInService2 Method

The *PlaceInService2 Method* extends the *PlaceInService Method*, by adding an optional *Comment*. For other functionality see the *PlaceInService Method* definition.

Signature

```
PlaceInService2(
   [in] LocalizedText     Comment
   );
```

The parameters are defined in Table 68.

Table 68 – PlaceInService2 Method parameters

Argument	Description
Comment	A localized text to be applied to the *Condition*.

If the *Comment* argument is NULL (both locale and text are empty) it will be ignored and any existing comments will remain unchanged. If the comment is to be reset, an empty text with a locale shall be provided.

Method result codes in Table 69 (defined in *Call Service*)

Table 69 – PlaceInService2 result codes

Result Code	Description
Bad_MethodInvalid	The *MethodId* provided does not correspond to the *ObjectId* provided. See 10000-4 for the general description of this result code.
Bad_NodeIdInvalid	Used to indicate that the specified *ObjectId* is not valid or that the *Method* was called on the *AlarmConditionType Node*. See 10000-4 for the general description of this result code.

Comments

The *PlaceInService2 Method* applies to an *Alarm* instance, even if it is not currently in the *Active State*.

Table 70 specifies the *AddressSpace* representation for the *PlaceInService2 Method*.

Table 70 – PlaceInService2 Method AddressSpace definition

Attribute	**Value**				
BrowseName	PlaceInService2				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**ModellingRule**
HasProperty	*Variable*	InputArguments	Argument[]	PropertyType	Mandatory
AlwaysGeneratesEvent	ObjectType	AuditConditionOutOfService EventType	Defined in 5.10.12		
ConformanceUnits					
A & C OutOfService2					

If *Auditing* is supported, this *Method* shall generate an *Event* of *AuditConditionOutOfServiceEventType* for all invocations of the *Method*.

5.8.16 GetGroupMemberships Method

The *GetGroupMemberships Method* is used to find the list of AlarmGroups that this alarm is in.

Signature

```
GetGroupMemberships (
[out] NodeId[] Group
);
```

Method result codes in Table 71 (defined in *Call Service*)

Table 71 – GetGroupMemberships result codes

Result Code	**Description**
Bad_MethodInvalid	The *MethodId* provided does not correspond to the *ObjectId* provided. See 10000-4 for the general description of this result code.
Bad_NodeIdInvalid	Used to indicate that the specified *ObjectId* is not valid or that the *Method* was called on the *AlarmConditionType Node*. See 10000-4 for the general description of this result code.

Comments

The *GetGroupMemberships Method* applies to an *Alarm* instance, even if it is not currently in the *Active State*.

Table 72 specifies the *AddressSpace* representation for the *GetGroupMemberships Method*.

Table 72 – GetGroupMemberships Method AddressSpace definition

Attribute	**Value**				
BrowseName	GetGroupMemberships				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**ModellingRule**
HasProperty	*Variable*	OutputArguments	Argument[]	PropertyType	Mandatory
ConformanceUnits					
A & C GetGroupMemberships					

5.8.17 ShelvedStateMachineType

5.8.17.1 Overview

The *ShelvedStateMachineType* defines a sub-state machine that represents an advanced *Alarm* filtering model. This model is illustrated in Figure 17.

The state model supports two types of *Shelving*: *OneShotShelving* and *TimedShelving*. They are illustrated in Figure 16. The illustration includes the allowed transitions between the various sub-states. *Shelving* is an *Operator* initiated activity.

In *OneShotShelving*, a user requests that an *Alarm* be *Shelved* for its current *Active* state or if not *Active* its next *Active* state. This type of *Shelving* is typically used when an *Alarm* is continually occurring on a boundary (i.e. a *Condition* is jumping between High *Alarm* and HighHigh *Alarm*, always in the *Active* state). The *OneShotShelving* will automatically clear when an *Alarm* returns to an inactive state. Another use for this type of *Shelving* is for a plant area that is shutdown i.e. a long running *Alarm* such as a low level *Alarm* for a tank that is not in use. When the tank starts operation again the *Shelving* state will automatically clear.

In *TimedShelving*, a user specifies that an *Alarm* be shelved for a fixed time period. This type of *Shelving* is quite often used to block nuisance *Alarms*. For example, an *Alarm* that occurs more than 10 times in a minute may get shelved for a few minutes. The *Alarm* is shelved for the time period, no matter how many transitions the *Alarm* has between *Active* state and *Inactive* state.

In all states, the *Unshelve* can be called to cause a transition to the Unshelve state; this includes *Un-shelving* an *Alarm* that is in the *TimedShelve* state before the time has expired and the *OneShotShelve* state without a transition to an inactive state. In the event of a restart of an *AlarmManager*, the *AlarmManager* should recover the *ShelvedStateMachine.* If the system cannot determine if the state of the *ShelvedStateMachine* for a given alarm instance, the *ShelvedStateMachine* shall be set to *Unshelved*.

All but two transitions are caused by *Method* calls as illustrated in Figure 16. The “Time Expired” transition is simply a system generated transition that occurs when the time value defined as part of the “Timed Shelved Call” has expired. The “Any Transition Occurs” transition is also a system generated transition; this transition is generated when the *Condition* goes to an inactive state.

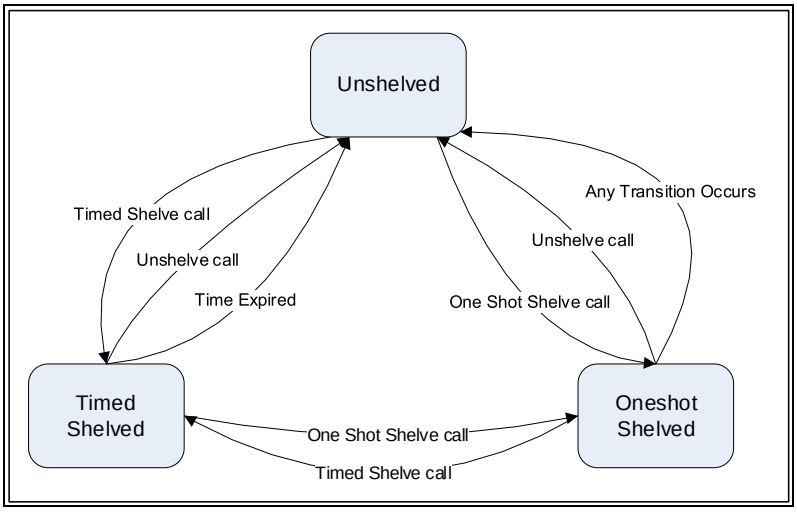


Figure 16 – Shelve state transitions

The *ShelvedStateMachineType* includes a hierarchy of sub-states. It supports all transitions between *Unshelved*, *OneShotShelved* and *TimedShelved*.

The state machine is illustrated in Figure 17 and formally defined in Table 73.

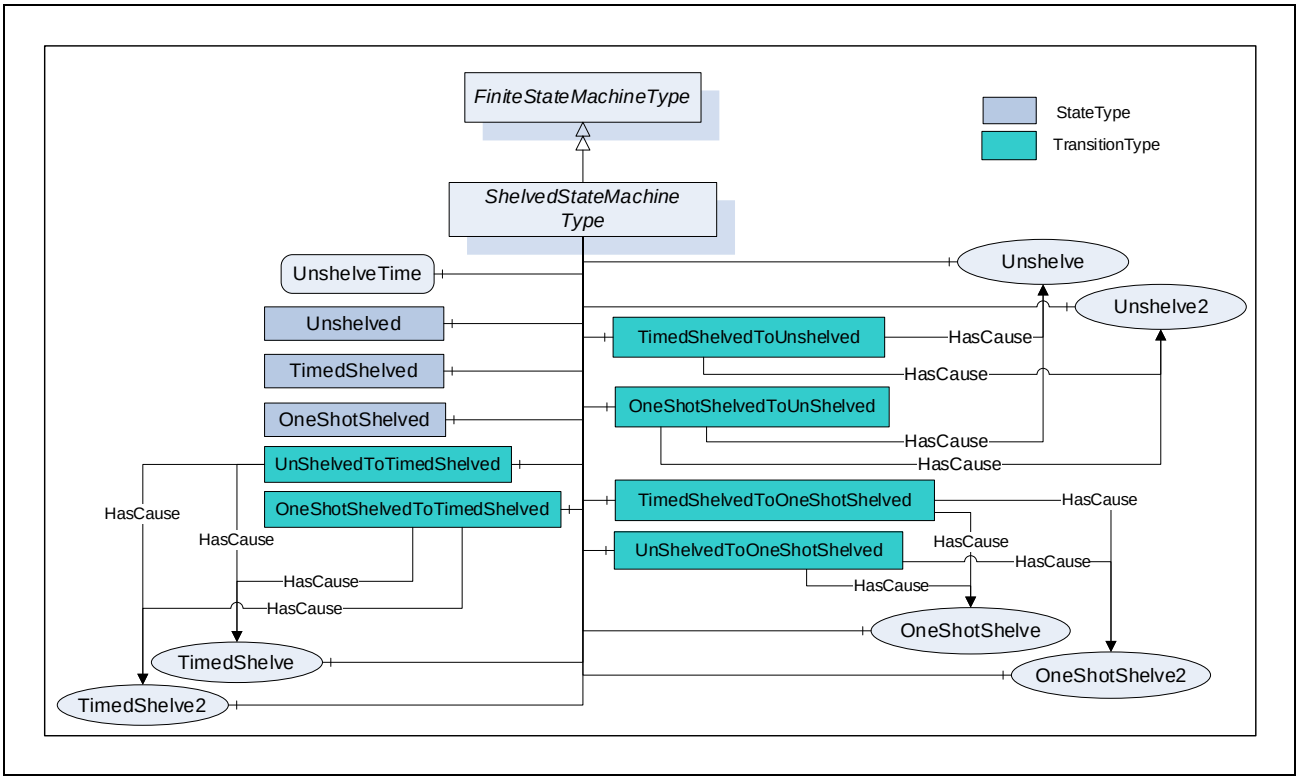


Figure 17 – ShelvedStateMachineType model

Table 73 – ShelvedStateMachineType definition

Attribute	**Value**				
BrowseName	ShelvedStateMachineType				
IsAbstract	False				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**ModellingRule**
Subtype of the *FiniteStateMachineType* defined in 10000-16					
HasProperty	Variable	UnshelveTime	Duration	PropertyType	Mandatory
HasComponent	Object	Unshelved		StateType	
HasComponent	Object	TimedShelved		StateType	
HasComponent	Object	OneShotShelved		StateType	
HasComponent	Object	UnshelvedToTimedShelved		TransitionType	
HasComponent	Object	TimedShelvedToUnshelved		TransitionType	
HasComponent	Object	TimedShelvedToOneShotShelved		TransitionType	
HasComponent	Object	UnshelvedToOneShotShelved		TransitionType	
HasComponent	Object	OneShotShelvedToUnshelved		TransitionType	
HasComponent	Object	OneShotShelvedToTimedShelved		TransitionType	
HasComponent	Method	TimedShelve	Defined in Clause 5.8.17.4		Mandatory
HasComponent	Method	OneShotShelve	Defined in Clause 5.8.17.6		Mandatory
HasComponent	Method	Unshelve	Defined in Clause 5.8.17.2		Mandatory
HasComponent	Method	TimedShelve2	Defined in Clause 5.8.17.5		Optional
HasComponent	Method	OneShotShelve2	Defined in Clause 5.8.17.7		Optional
HasComponent	Method	Unshelve2	Defined in Clause 5.8.17.3		Optional
ConformanceUnits					
A & C Shelving					

UnshelveTime specifies the remaining time in milliseconds until the *Alarm* automatically transitions into the *Un-shelved* state. For the *TimedShelved* state this time is initialised with the *ShelvingTime* argument of the *TimedShelve Method* call. For the *OneShotShelved* state the *UnshelveTime* will be initialized to the *Value* of *MaxTimeShelved Property* if it is present otherwise it is initialized to the maximum *Duration*.

This *FiniteStateMachine* supports three *Active* states; *Unshelved*, *TimedShelved* and *OneShotShelved*. It also supports six transitions. The states and transitions are described in Table 74. This *FiniteStateMachine* also supports three *Method*s; *TimedShelve*, *OneShotShelve* and *Unshelve*.

Table 74 – ShelvedStateMachineType Additional References

SourceBrowsePath	References	IsForward	TargetBrowsePath
UnshelvedToTimedShelved	FromState	True	Unshelved
	ToState	True	TimedShelved
	HasEffect	True	AlarmConditionType
	HasCause	True	TimedShelve
	HasCause	True	TimedShelve2
UnshelvedToOneShotShelved	FromState	True	Unshelved
	ToState	True	OneShotShelved
	HasEffect	True	AlarmConditionType
	HasCause	True	OneShotShelve
	HasCause	True	OneShotShelve2
TimedShelvedToUnshelved	FromState	True	TimedShelved
	ToState	True	Unshelved
	HasEffect	True	AlarmConditionType
TimedShelvedToOneShotShelved	FromState	True	TimedShelved
	ToState	True	OneShotShelved
	HasEffect	True	AlarmConditionType
	HasCause	True	OneShotShelve
	HasCause	True	OneShotShelve2
OneShotShelvedToUnshelved	FromState	True	OneShotShelved
	ToState	True	Unshelved
	HasEffect	True	AlarmConditionType
OneShotShelvedToTimedShelved	FromState	True	OneShotShelved
	ToState	True	TimedShelved
	HasEffect	True	AlarmConditionType
	HasCause	True	TimedShelve
	HasCause	True	TimedShelve2

The component *Variables* of the ShelvedStateMachineType have additional *Attributes* defined in Table 75**.**

Table 75 – ShelvedStateMachineType Attribute values for child Nodes

BrowsePath	Value Attribute
Unshelved 0:StateNumber	1
TimedShelved 0:StateNumber	2
OneShotShelved 0:StateNumber	3
UnshelvedToTimedShelved 0:TransitionNumber	12
TimedShelvedToUnshelved 0:TransitionNumber	21
TimedShelvedToOneShotShelved 0:TransitionNumber	23
UnshelvedToOneShotShelved 0:TransitionNumber	13
OneShotShelvedToUnshelved 0:TransitionNumber	31
OneShotShelvedToTimedShelved 0:TransitionNumber	32

5.8.17.2 Unshelve Method

The *Unshelve Method* sets the instance of *AlarmConditionType* to the *Unshelved* state. Normally, the *MethodId* found in the *Shelving* child of the *Condition* instance and the *NodeId* of the *Shelving* object as the *ObjectId* are passed to the *Call Service*. However, some *Servers* do not expose *Condition* instances in the *AddressSpace.* Therefore, all *Servers* shall also allow *Clients* to call the *Unshelve Method* by specifying *ConditionId* as the *ObjectId* where the *ConditionId* is the *Condition* that has *Shelving* child. The *Method* cannot be called with an *ObjectId* of the *ShelvedStateMachineType Node*.

Signature

```
Unshelve();
```

Method Result Codes in Table 76 (defined in Call Service)

Table 76 – Unshelve result codes

Result Code	Description
Bad_ConditionNotShelved	See Table 137 for the description of this result code.

Table 77 specifies the *AddressSpace* representation for the *Unshelve Method*.

Table 77 – Unshelve Method AddressSpace definition

Attribute	Value				
BrowseName	Unshelve				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**ModellingRule**
AlwaysGeneratesEvent	ObjectType	AuditConditionShelvingEventType	Defined in 5.10.7		
ConformanceUnits					
A & C Shelving					

If *Auditing* is supported, this *Method* shall generate an *Event* of *AuditConditionShelvingEventType* for all invocations of the *Method*.

5.8.17.3 Unshelve2 Method

The *Unshelve2 Method* extends the *Unshelve Method*, by adding an optional *Comment*. For other functionality see the *Unshelve Method* definition.

Signature

```
Unshelve2(
   [in] LocalizedText     Comment
   );
```

The parameters are defined in Table 78

Table 78 – Unshelve2 Method parameters

Argument	Description
Comment	A localized text to be applied to the *Conditions*.

If the *Comment* argument is NULL (both locale and text are empty) it will be ignored and any existing comments will remain unchanged. If the comment is to be reset, an empty text with a locale shall be provided.

Method Result Codes in Table 79 (defined in Call Service)

Table 79 – Unshelve2 result codes

Result Code	Description
Bad_ConditionNotShelved	See Table 137 for the description of this result code.

Table 80 specifies the *AddressSpace* representation for the *Unshelve2 Method*.

Table 80 – Unshelve2 Method AddressSpace definition

Attribute	Value				
BrowseName	Unshelve2				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**ModellingRule**
HasProperty	*Variable*	InputArguments	Argument[]	PropertyType	Mandatory
AlwaysGeneratesEvent	ObjectType	AuditConditionShelvingEventType	Defined in 5.10.7		
ConformanceUnits					
A & C Shelving2					

If *Auditing* is supported, this *Method* shall generate an *Event* of *AuditConditionShelvingEventType* for all invocations of the *Method*.

5.8.17.4 TimedShelve Method

The *TimedShelve Method* sets the instance of *AlarmConditionType* to the *TimedShelved* state (parameters are defined in Table 81 and result codes are described in Table 82). Normally, the *MethodId* found in the *Shelving* child of the *Condition* instance and the *NodeId* of the *Shelving* object as the *ObjectId* are passed to the *Call Service*. However, some *Servers* do not expose *Condition* instances in the *AddressSpace.* Therefore, all *Servers* shall also allow *Clients* to call the *TimedShelve Method* by specifying *ConditionId* as the *ObjectId* where the *ConditionId* is the *Condition* that has the *Shelving* child*.* The *Method* cannot be called with an *ObjectId* of the *ShelvedStateMachineType Node*.

This *Method* can be called on any *ConditionId*, even if it is not active. The timer will start on *Method* invocation. The *Alarm* may go active and inactive multiple times during this *Duration*, but it will remain shelved for the *Duration*, unless it is changed to a different *Shelving State*.

Signature

```
TimedShelve(
   [in] Duration ShelvingTime
   );
```

The parameters are defined in Table 81

Table 81 – TimedShelve parameters

Argument	Description
ShelvingTime	Specifies a fixed time for which the *Alarm* is to be shelved. The *Server* may refuse the provided duration. If a *MaxTimeShelved* Property exist on the *Alarm* than the *Shelving* time shall be less than or equal to the value of this Property.

Method Result Codes (defined in Call Service)

Table 82 – TimedShelve result codes

Result Code	Description
Bad_ConditionAlreadyShelved	See Table 137 for the description of this result code. The *Alarm* is already in *TimedShelved* state and the system does not allow a reset of the shelved timer.
Bad_ShelvingTimeOutOfRange	See Table 137 for the description of this result code.

Comments

Shelving for some time is quite often used to block nuisance *Alarms*. For example, an *Alarm* that occurs more than 10 times in a minute may get shelved for a few minutes.

In some systems the length of time covered by this duration may be limited and the *Server* may generate an error refusing the provided duration. This limit may be exposed as the *MaxTimeShelved Property*.

Table 83 specifies the *AddressSpace* representation for the *TimedShelve Method*.

Table 83 – TimedShelve Method AddressSpace definition

Attribute	**Value**				
BrowseName	TimedShelve				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**ModellingRule**
HasProperty	Variable	InputArguments	Argument[]	PropertyType	Mandatory
AlwaysGeneratesEvent	ObjectType	AuditConditionShelvingEventType	Defined in 5.10.7		
ConformanceUnits					
A & C Shelving					

If *Auditing* is supported, this *Method* shall generate an *Event* of *AuditConditionShelvingEventType* for all invocations of the *Method*.

5.8.17.5 TimedShelve2 Method

The *TimedShelve Method* extends the *TimedShelve Method*, by adding an optional *Comment*. For other functionality see the *TimedShelve Method* definition.

Signature

```
TimedShelve2(
   [in] Duration          ShelvingTime
   [in] LocalizedText     Comment
   );
```

The parameters are defined in Table 84.

Table 84 – TimedShelve2 parameters

Argument	**Description**
ShelvingTime	Specifies a fixed time for which the *Alarm* is to be shelved. The *Server* may refuse the provided duration. If a *MaxTimeShelved* Property exist on the *Alarm* than the *Shelving* time shall be less than or equal to the value of this Property.
Comment	A localized text to be applied to the *Condition*.

Method Result Codes in Table 85 (defined in Call Service)

Table 85 – TimedShelve2 result codes

Result Code	**Description**
Bad_ConditionAlreadyShelved	See Table 137 for the description of this result code. The *Alarm* is already in *TimedShelved* state and the system does not allow a reset of the shelved timer.
Bad_ShelvingTimeOutOfRange	See Table 137 for the description of this result code.

Table 86 specifies the *AddressSpace* representation for the *TimedShelve2 Method*.

Table 86 – TimedShelve2 Method AddressSpace definition

Attribute	Value				
BrowseName	TimedShelve2				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**ModellingRule**
HasProperty	Variable	InputArguments	Argument[]	PropertyType	Mandatory
AlwaysGeneratesEvent	ObjectType	AuditConditionShelvingEventType	Defined in 5.10.7		
ConformanceUnits					
A & C Shelving2					

If *Auditing* is supported, this *Method* shall generate an *Event* of *AuditConditionShelvingEventType* for all invocations of the *Method*.

5.8.17.6 OneShotShelve Method

The *OneShotShelve Method* sets the instance of *AlarmConditionType* to the *OneShotShelved* state. Normally, the *MethodId* found in the *Shelving* child of the *Condition* instance and the *NodeId* of the *Shelving* object as the *ObjectId* are passed to the *Call Service*. However, some *Servers* do not expose *Condition* instances in the *AddressSpace.* Therefore, all *Servers* shall also allow *Clients* to call the *OneShotShelve Method* by specifying *ConditionId* as the *ObjectId* where the *ConditionId* is the *Condition* that has the *Shelving* child. The *Method* cannot be called with an *ObjectId* of the *ShelvedStateMachineType Node*. This *Method* can be called on any *ConditionId*, even if it is not active.

Signature

```
OneShotShelve( );
```

Method Result Codes are defined in Table 87 (status code field is defined in *Call* Service)

Table 87 – OneShotShelve result codes

Result Code	Description
Bad_ConditionAlreadyShelved	See Table 137 for the description of this result code. The *Alarm* is already in *OneShotShelved* state.

Table 88 specifies the *AddressSpace* representation for the *OneShotShelve Method*.

Table 88 – OneShotShelve Method AddressSpace definition

Attribute	Value				
BrowseName	OneShotShelve				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**ModellingRule**
AlwaysGeneratesEvent	ObjectType	AuditConditionShelvingEventType	Defined in 5.10.7		
ConformanceUnits					
A & C Shelving					

If *Auditing* is supported, this *Method* shall generate an *Event* of *AuditConditionShelvingEventType* for all invocations of the *Method*.

5.8.17.7 OneShotShelve2 Method

The *OneShotShelve2 Method*

Signature

```
OneShotShelve2(
   [in] LocalizedText     Comment
   );
```

The parameters are defined in Table 89.

Table 89 – OneShotShelve2 Method parameters

Argument	Description
Comment	A localized text to be applied to the *Conditions*.

If the *Comment* argument is NULL (both locale and text are empty) it will be ignored and any existing comments will remain unchanged. If the comment is to be reset, an empty text with a locale shall be provided.

Method Result Codes are defined in Table 90 (status code field is defined in *Call* Service)

Table 90 – OneShotShelve2 result codes

Result Code	Description
Bad_ConditionAlreadyShelved	See Table 137 for the description of this result code. The *Alarm* is already in *OneShotShelved* state.

Table 91 specifies the *AddressSpace* representation for the *OneShotShelve2 Method*.

Table 91 – OneShotShelve2 Method AddressSpace definition

Attribute	Value				
BrowseName	OneShotShelve2				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**ModellingRule**
HasProperty	*Variable*	InputArguments	Argument[]	PropertyType	Mandatory
AlwaysGeneratesEvent	ObjectType	AuditConditionShelvingEventType	Defined in 5.10.7		
ConformanceUnits					
A & C Shelving2					

If *Auditing* is supported, this *Method* shall generate an *Event* of *AuditConditionShelvingEventType* for all invocations of the *Method*.

5.8.18 LimitAlarmType

Alarms can be modelled with multiple exclusive sub-states and assigned limits or they may be modelled with nonexclusive limits that can be used to group multiple states together.

The *LimitAlarmType* is used to provide a base *Type* for *AlarmConditionTypes* with multiple limits. The *LimitAlarmType* is illustrated in Figure 18.

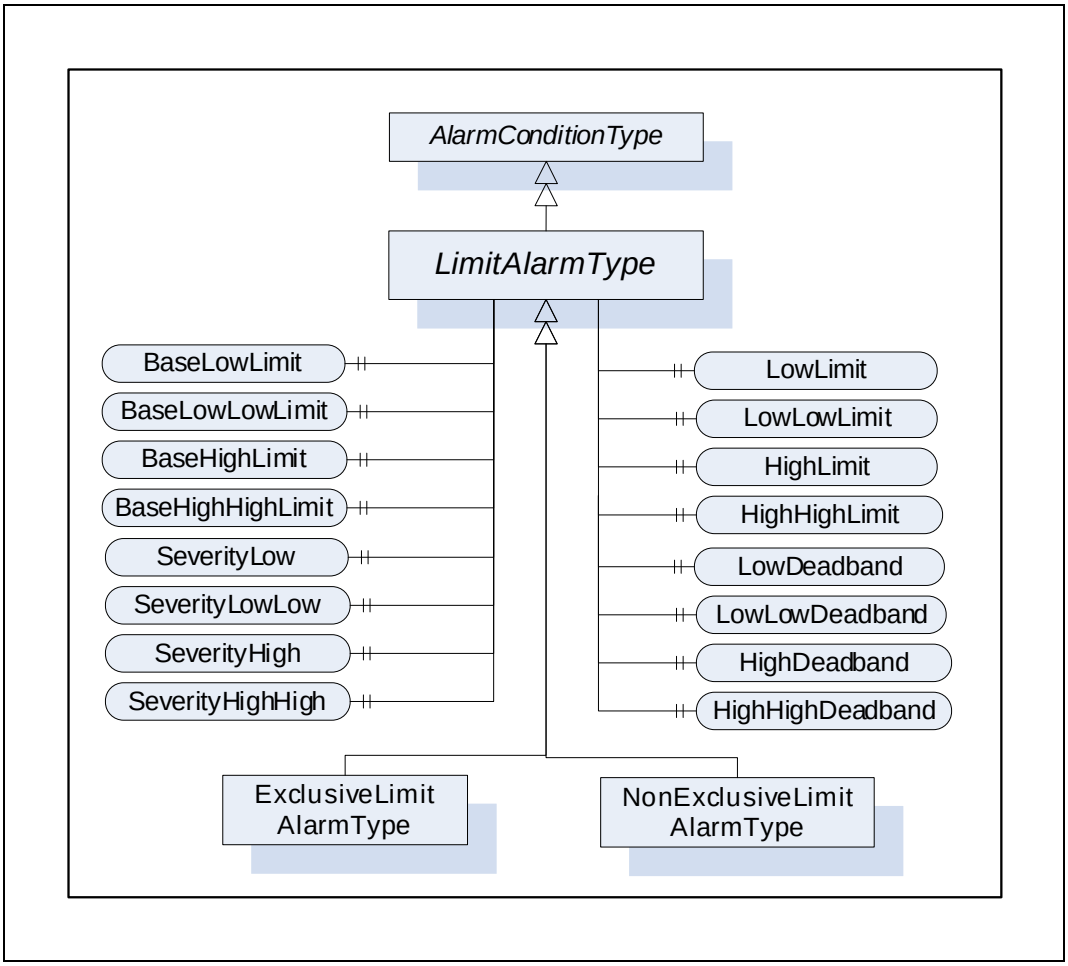


Figure 18 – LimitAlarmType

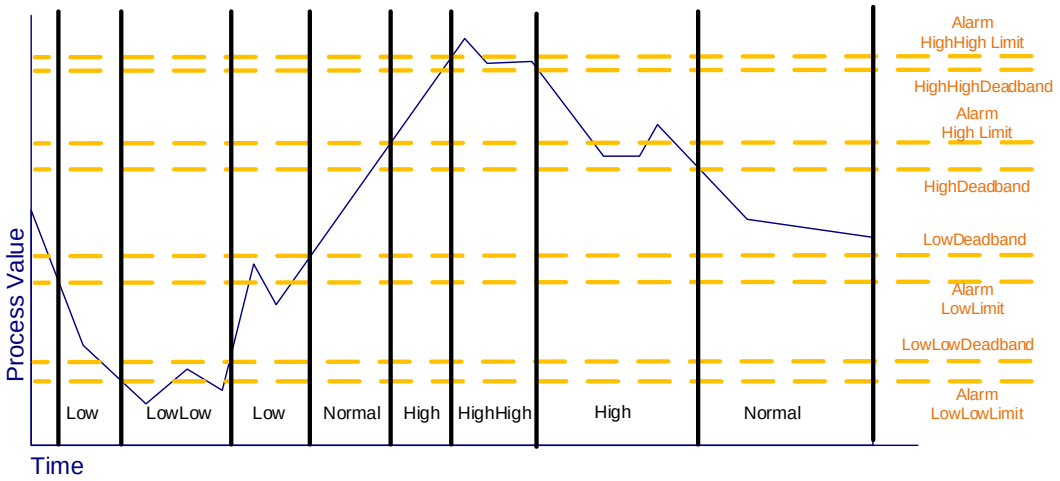
The *LimitAlarmType* is formally defined in Table 92.

Table 92 – LimitAlarmType definition

Attribute	Value				
BrowseName	LimitAlarmType				
IsAbstract	False				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**Modelling Rule**
Subtype of the AlarmConditionType defined in clause 5.8.2.					
HasSubtype	ObjectType	ExclusiveLimitAlarmType	Defined in Clause 5.8.19.3		
HasSubtype	ObjectType	NonExclusiveLimitAlarmType	Defined in Clause 5.8.20		
HasProperty	Variable	HighHighLimit	Double	PropertyType	Optional
HasProperty	Variable	HighLimit	Double	PropertyType	Optional
HasProperty	Variable	LowLimit	Double	PropertyType	Optional
HasProperty	Variable	LowLowLimit	Double	PropertyType	Optional
HasProperty	Variable	BaseHighHighLimit	Double	PropertyType	Optional
HasProperty	Variable	BaseHighLimit	Double	PropertyType	Optional
HasProperty	Variable	BaseLowLimit	Double	PropertyType	Optional
HasProperty	Variable	BaseLowLowLimit	Double	PropertyType	Optional
HasProperty	Variable	SeverityHighHigh	UInt16	PropertyType	Optional
HasProperty	Variable	SeverityHigh	UInt16	PropertyType	Optional
HasProperty	Variable	SeverityLow	UInt16	PropertyType	Optional
HasProperty	Variable	SeverityLowLow	UInt16	PropertyType	Optional
HasProperty	Variable	HighHighDeadband	Double	PropertyType	Optional
HasProperty	Variable	HighDeadband	Double	PropertyType	Optional
HasProperty	Variable	LowDeadband	Double	PropertyType	Optional
HasProperty	Variable	LowLowDeadband	Double	PropertyType	Optional
ConformanceUnits					
A & C Exclusive Limit					
A & C Non-Exclusive Limit					

Four optional limits are defined that configure the states of the derived limit *Alarm* Types. These *Properties* shall be set for any *Alarm* limits that are exposed by the derived limit *Alarm* types. These *Properties* are listed as optional but at least one is required. For cases where an underlying system cannot provide the actual value of a limit, the limit *Property* shall still be provided, but will have its *AccessLevel* set to not readable. It is assumed that the limits are described using the same Engineering Unit that is assigned to the variable that is the source of the *Alarm*. For Rate of change limit *Alarms*, it is assumed this rate is units per second unless otherwise specified. The limits shall follow the following inequality HighHigh > High > Low > LowLow. If Deadband properties are provided then:

- HighHighLimit - HighHighDeadband > HighLimit
- HighLimit – HighDeadband > LowLimit
- LowLimit + LowDeadband < HighLimit
- LowLowLimit + LowLowDeadband < LowLimit



Four optional base limits are defined that are used for *AdaptiveAlarming*. They contain the configured *Alarm* limit. If a *Server* supports *AdaptiveAlarming* for *Alarm* limits, the corresponding base *Alarm* limit shall be provided for any limits that are exposed by the derived limit Alarm types. The value of this property is the value of the limit to which an *AdaptiveAlarm* can be reset if any algorithmic changes need to be discarded.

The *Alarm* limits listed may cause an *Alarm* to be generated when a value equals the limit or it may generate the *Alarm* when the limit is exceeded, (i.e. the Value is above the limit for *HighLimit* and below the limit for *LowLimit*). The exact behaviour when the value is equal to the limit is *Server* specific.

The *Variable* that is the source of the *LimitAlarmType Alarm* shall be a scalar. This *LimitAlarmType* can be subtyped if the *Variable* that is the source is an array. The subtype shall describe the expected behaviour with respect to limits and the array values. Some possible options:

- if any element of the array exceeds the limit an *Alarm* is generated,
- if all elements exceed the limit an *Alarm* is generated,
- the limits may also be an array, in which case if any array limit is exceeded by the corresponding source array element, an *Alarm* is generated.

The four optional severity Properties, if defined, provided the severity for each of the limits.

The four optional deadband *Properties*, if they are defined, are used to delay the return to normal until the value is within the limit by the value of the deadband. For example, if a Value exceeds a HighLimit of 20, and there is a HighDeadband define of 1, the value will remain in alarm until the Value drops below 19. An *Alarm* deadband can be used to limit *Alarms* in a system where values may bounce or have some noise (i.e. the value is jumping up and down by 0.2). They keep the *Alarm* from being reactivated until it has dropped enough to not retrigger by noise.

In the event of a restart of an *AlarmManager*, *the AlarmManager* shall recover the *LimitAlarm* state, this also applies to all subtypes.

5.8.19 Exclusive Limit Types

5.8.19.1 Overview

This clause describes the state machine and the base *Alarm* Type behaviour for *AlarmConditionTypes* with multiple mutually exclusive limits.

5.8.19.2 ExclusiveLimitStateMachineType

The *ExclusiveLimitStateMachineType* defines the state machine used by *AlarmConditionTypes* that handle multiple mutually exclusive limits. It is illustrated in Figure 19.

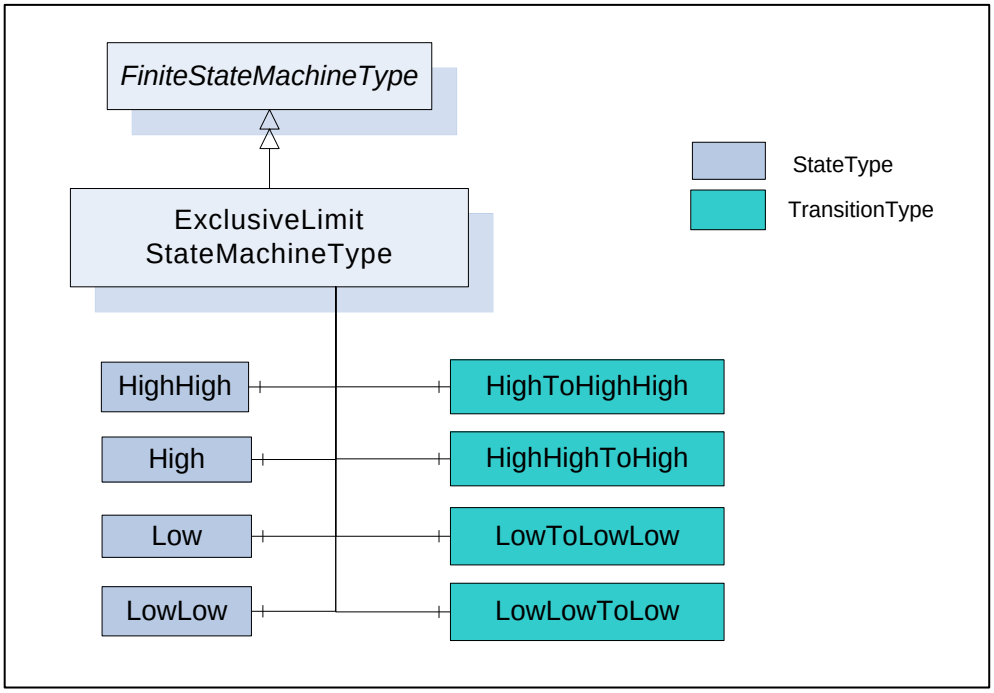


Figure 19 – ExclusiveLimitStateMachineType

It is created by extending the *FiniteStateMachineType*. It is formally defined in Table 93 and the state transitions are described in Table 94.

Table 93 – ExclusiveLimitStateMachineType definition

Attribute	**Value**				
BrowseName	ExclusiveLimitStateMachineType				
IsAbstract	False				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**ModellingRule**
Subtype of the *FiniteStateMachineType*					
HasComponent	Object	HighHigh		StateType	
HasComponent	Object	High		StateType	
HasComponent	Object	Low		StateType	
HasComponent	Object	LowLow		StateType	
HasComponent	Object	LowToLowLow		TransitionType	
HasComponent	Object	LowLowToLow		TransitionType	
HasComponent	Object	HighToHighHigh		TransitionType	
HasComponent	Object	HighHighToHigh		TransitionType	
ConformanceUnits					
A & C Exclusive Limit					

Table 94 – ExclusiveLimitStateMachineType Additional References

SourceBrowsePath	References	IsForward	TargetBrowsePath
HighHighToHigh	FromState	True	HighHigh
	ToState	True	High
	HasEffect	True	AlarmConditionType
HighToHighHigh	FromState	True	High
	ToState	True	HighHigh
	HasEffect	True	AlarmConditionType
LowLowToLow	FromState	True	LowLow
	ToState	True	Low
	HasEffect	True	AlarmConditionType
LowToLowLow	FromState	True	Low
	ToState	True	LowLow
	HasEffect	True	AlarmConditionType

The component *Variables* of the ExclusiveLimitStateMachineType have additional *Attributes* defined in Table 95.

Table 95 – ExclusiveLimitStateMachineType Attribute values for child Nodes

BrowsePath	Value Attribute
HighHigh 0:StateNumber	1
High 0:StateNumber	2
Low 0:StateNumber	3
LowLow 0:StateNumber	4
LowToLowLow 0:TransitionNumber	34
LowLowToLow 0:TransitionNumber	43
HighToHighHigh 0:TransitionNumber	21
HighHighToHigh 0:TransitionNumber	12

The *ExclusiveLimitStateMachineType* defines the sub state machine that represents the actual level of a multilevel *Alarm* when it is in the *Active* state. The sub state machine defined here includes *High*, *Low*, *HighHigh* and *LowLow* states. This model also includes in its transition state a series of transition to and from a parent state, the inactive state. This state machine as it is defined shall be used as a sub state machine for a state machine which has an *Active* state. This *Active* state could be part of a “level” *Alarm* or “deviation” *Alarm* or any other *Alarm* state machine.

The *LowLow*, *Low*, *High*, *HighHigh* are typical for many industries. Vendors can introduce sub-state models that include additional limits; they may also omit limits in an instance. If a model omits states or transitions in the *StateMachine*, it is recommended that they provide the optional *Property AvailableStates* and/or *AvailableTransitions* (see 10000-16).

5.8.19.3 ExclusiveLimitAlarmType

The *ExclusiveLimitAlarmType* is used to specify the common behaviour for *Alarm Types* with multiple mutually exclusive limits. The *ExclusiveLimitAlarmType* is illustrated in Figure 20.

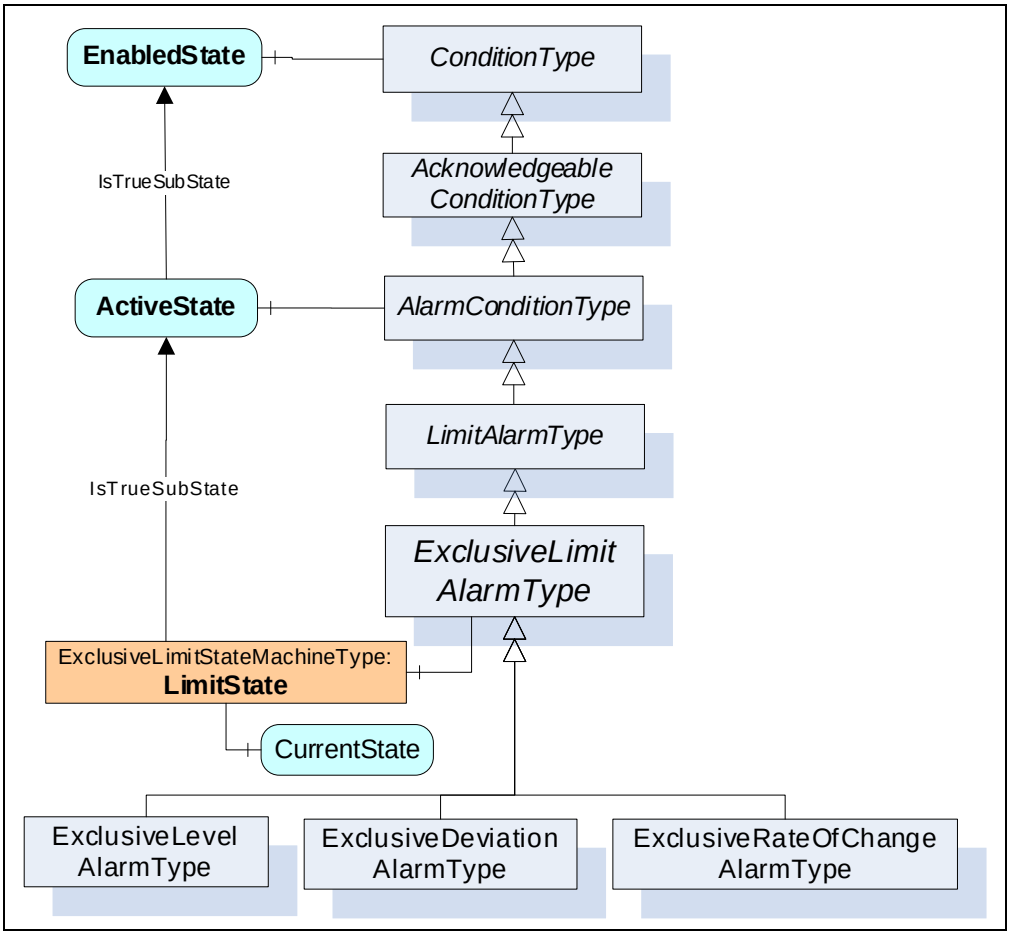


Figure 20 – ExclusiveLimitAlarmType

The *ExclusiveLimitAlarmType* is formally defined in Table 96.

Table 96 – ExclusiveLimitAlarmType definition

Attribute	**Value**				
BrowseName	ExclusiveLimitAlarmType				
IsAbstract	False				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**Modelling Rule**
Subtype of the LimitAlarmType defined in clause 5.8.18.					
HasSubtype	ObjectType	ExclusiveLevelAlarmType	Defined in Clause 5.8.21.3		
HasSubtype	ObjectType	ExclusiveDeviationAlarmType	Defined in Clause 5.8.22.3		
HasSubtype	ObjectType	ExclusiveRateOfChangeAlarm Type	Defined in Clause 5.8.23.3		
HasComponent	Object	LimitState		*ExclusiveLimitStateMachineType*	Mandatory
ConformanceUnits					
A & C Exclusive Limit					

The *LimitState* is a sub state of the ActiveState and has an *IsTrueSubStateOf* reference to the *ActiveState*. The *LimitState* represents the actual limit that is violated in an instance of *ExclusiveLimitAlarmType*. When the *ActiveState* of the *AlarmConditionType* is inactive the *LimitState* shall not be available and shall return NULL on read. Any *Events* that subscribe for fields from the *LimitState* when the *ActiveState* is inactive shall return a NULL for these unavailable fields.

5.8.20 NonExclusiveLimitAlarmType

The *NonExclusiveLimitAlarmType* is used to specify the common behaviour for *Alarm Types* with multiple non-exclusive limits. The *NonExclusiveLimitAlarmType* is illustrated in Figure 21.

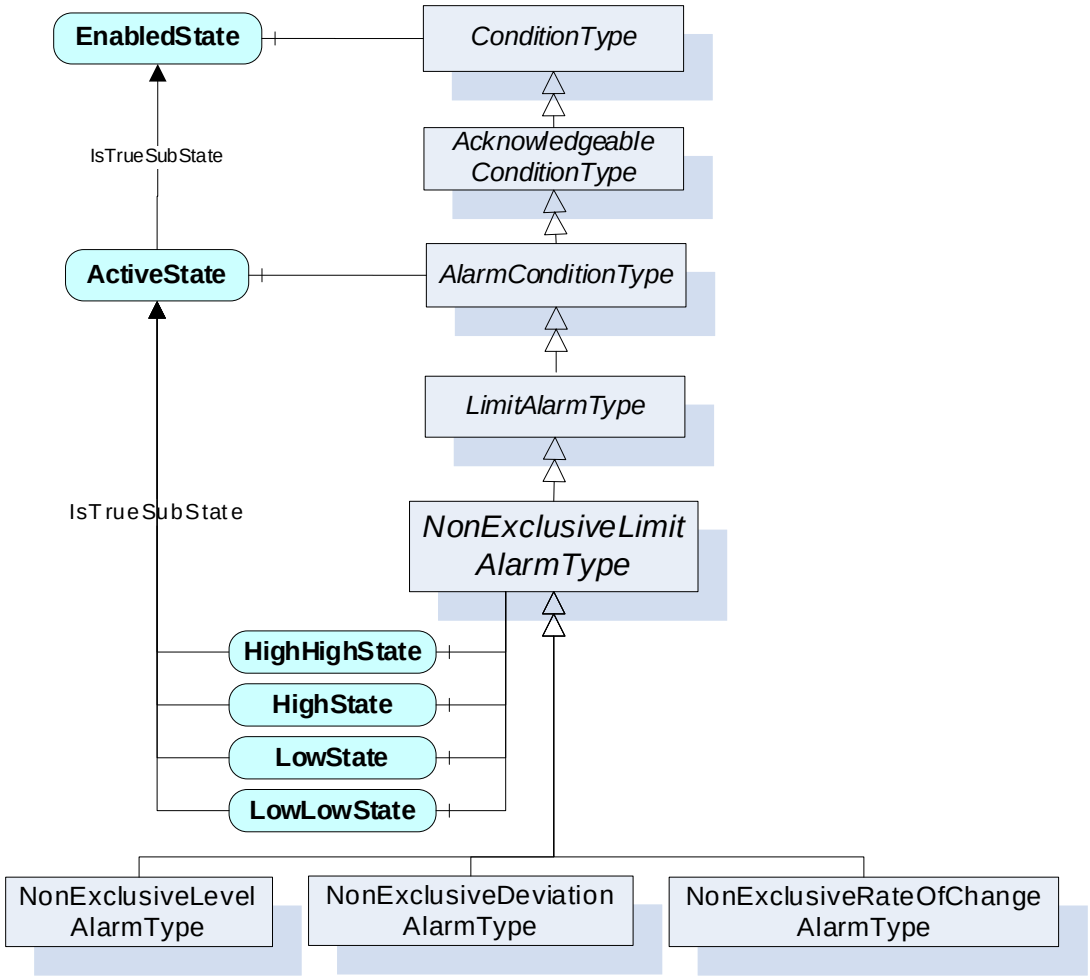


Figure 21 – NonExclusiveLimitAlarmType

The *NonExclusiveLimitAlarmType* is formally defined in Table 97 and Table 98.

Table 97 – NonExclusiveLimitAlarmType definition

Attribute	**Value**				
BrowseName	NonExclusiveLimitAlarmType				
IsAbstract	False				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**Modelling Rule**
Subtype of the LimitAlarmType defined in clause 5.8.18.					
HasSubtype	ObjectType	NonExclusiveLevelAlarmType	Defined in Clause 5.8.21.2		
HasSubtype	ObjectType	NonExclusiveDeviationAlarmType	Defined in Clause 5.8.22.2		
HasSubtype	ObjectType	NonExclusiveRateOfChangeAlarmType	Defined in Clause 5.8.23.2		
HasComponent	Variable	HighHighState	LocalizedText	TwoStateVariableType	Optional
HasComponent	Variable	HighState	LocalizedText	TwoStateVariableType	Optional
HasComponent	Variable	LowState	LocalizedText	TwoStateVariableType	Optional
HasComponent	Variable	LowLowState	LocalizedText	TwoStateVariableType	Optional
ConformanceUnits					
A & C Non-Exclusive Limit					

Table 98 – NonExclusiveLimitAlarmType Additional Subcomponents

BrowsePath	References	NodeClass	BrowseName	DataType	TypeDefinition	Others
HighHighState	HasProperty	Variable	TrueState	LocalizedText	PropertyType	
HighHighState	HasProperty	Variable	FalseState	LocalizedText	PropertyType	
HighState	HasProperty	Variable	TrueState	LocalizedText	PropertyType	
HighState	HasProperty	Variable	FalseState	LocalizedText	PropertyType	
LowState	HasProperty	Variable	TrueState	LocalizedText	PropertyType	
LowState	HasProperty	Variable	FalseState	LocalizedText	PropertyType	
LowLowState	HasProperty	Variable	TrueState	LocalizedText	PropertyType	
LowLowState	HasProperty	Variable	FalseState	LocalizedText	PropertyType	

The empty "Others" column indicates that no *ModellingRule* applies.

HighHighState, *HighState*, *LowState*, and *LowLowState* represent the non-exclusive states. As an example, it is possible that both *HighState* and *HighHighState* are in their True state. Vendors may choose to support any subset of these states. Recommended state names are described in A.1.

Four optional limits are defined that configure these states. At least the *HighState* or the *LowState* shall be provided even though all states are optional. It is implied by the definition of a *HighState* and a *LowState*, that these groupings are mutually exclusive. A value cannot exceed both a *HighState* value and a *LowState* value simultaneously.

5.8.21 Level Alarm

5.8.21.1 Overview

A level *Alarm* is commonly used to report when a limit is exceeded. It typically relates to an instrument – e.g. a temperature meter. The level *Alarm* becomes active when the observed value is above a high limit or below a low limit.

5.8.21.2 NonExclusiveLevelAlarmType

The *NonExclusiveLevelAlarmType* is a special level *Alarm* utilized with one or more non-exclusive states. If for example both the High and *HighHigh* states need to be maintained as active at the same time then an instance of *NonExclusiveLevelAlarmType* should be used.

The *NonExclusiveLevelAlarmType* is based on the *NonExclusiveLimitAlarmType*. It is formally defined in Table 99.

Table 99 – NonExclusiveLevelAlarmType definition

Attribute	Value				
BrowseName	NonExclusiveLevelAlarmType				
IsAbstract	False				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**ModellingRule**
Subtype of the NonExclusiveLimitAlarmType defined in clause 5.8.20.					
ConformanceUnits					
A & C Non-Exclusive Level					

No additional *Properties* to the *NonExclusiveLimitAlarmType* are defined.

5.8.21.3 ExclusiveLevelAlarmType

The *ExclusiveLevelAlarmType* is a special level *Alarm* utilized with multiple mutually exclusive limits. It is formally defined in Table 100.

Table 100 – ExclusiveLevelAlarmType definition

Attribute	Value				
BrowseName	ExclusiveLevelAlarmType				
IsAbstract	False				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**ModellingRule**
Inherits the Properties of the ExclusiveLimitAlarmType defined in clause 5.8.19.3.					
ConformanceUnits					
A & C Exclusive Level					

No additional *Properties* to the *ExclusiveLimitAlarmType* are defined.

5.8.22 Deviation Alarm

5.8.22.1 Overview

A deviation *Alarm* is commonly used to report an excess deviation between a desired set point level of a process value and an actual measurement of that value. The deviation *Alarm* becomes active when the deviation exceeds or drops below a defined limit.

For example, if a set point had a value of 10, a high deviation *Alarm* limit of 2 and a low deviation *Alarm* limit of -1 then the low sub state is entered if the process value drops below 9; the high sub state is entered if the process value raises above 12. If the set point were changed to 11 then the new deviation values would be 10 and 13 respectively. The set point can be fixed by a configuration, adjusted by an *Operator* or it can be adjusted by an algorithm, the actual functionality exposed by the set point is application specific. The deviation *Alarm* can also be used to report a problem between a redundant data source where the difference between the primary source and the secondary source exceeds the included limit. In this case, the *SetpointNode* would point to the secondary source.

The *LowLimit* and *LowLowLimit* shall be negative, indicating a number below the target value and the *HighLimit* and *HighHighLimit* shall be positive, indicating a number above the target value. If provided, the limits shall not be zero and shall follow these rules:

- *HighHighLimit* > *HighLimit*
- *LowLimit* > *LowLowLimit*.

For example, if the *LowLimit* is -2 then a *LowLowLimit* of -1 would not be allowed, but a *LowLowLimit* of -3 would be allowed.

5.8.22.2 NonExclusiveDeviationAlarmType

The *NonExclusiveDeviationAlarmType* is a special level *Alarm* utilized with one or more non-exclusive states. If for example both the High and HighHigh states need to be maintained as active at the same time then an instance of *NonExclusiveDeviationAlarmType* should be used.

The *NonExclusiveDeviationAlarmType* is based on the *NonExclusiveLimitAlarmType*. It is formally defined in Table 101.

Table 101 – NonExclusiveDeviationAlarmType definition

Attribute	Value				
BrowseName	NonExclusiveDeviationAlarmType				
IsAbstract	False				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**ModellingRule**
Subtype of the NonExclusiveLimitAlarmType defined in clause 5.8.20.					
HasProperty	Variable	SetpointNode	NodeId	PropertyType	Mandatory
HasProperty	Variable	BaseSetpointNode	NodeId	PropertyType	Optional
ConformanceUnits					
A & C Non-Exclusive Deviation					

The *SetpointNode Property* provides the *NodeId* of the set point used in the deviation calculation. In cases where the *Alarm* is generated by an underlying system and if the *Variable* is not in the *AddressSpace*, a NULL *NodeId* shall be provided.

The *BaseSetpointNode Property* provides the *NodeId* of the original or base setpoint. The value of this node is the value of the setpoint to which an *AdaptiveAlarm* can be reset if any algorithmic changes need to be discarded. The value of this node usually contains the originally configured set point.

5.8.22.3 ExclusiveDeviationAlarmType

The *ExclusiveDeviationAlarmType* is utilized with multiple mutually exclusive limits. It is formally defined in Table 102.

Table 102 – ExclusiveDeviationAlarmType definition

Attribute	**Value**				
BrowseName	ExclusiveDeviationAlarmType				
IsAbstract	False				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**Modelling Rule**
Inherits the *Properties* of the *ExclusiveLimitAlarmType* defined in clause 5.8.19.3.					
HasProperty	Variable	SetpointNode	NodeId	PropertyType	Mandatory
HasProperty	Variable	BaseSetpointNode	NodeId	PropertyType	Optional
ConformanceUnits					
A & C Exclusive Deviation					

The *SetpointNode Property* provides the *NodeId* of the set point used in the *Deviation* calculation. If this *Variable* is not in the *AddressSpace*, a NULL *NodeId* shall be provided.

The *BaseSetpointNode Property* provides the *NodeId* of the original or base setpoint. The value of this node is the value of the set point to which an *AdaptiveAlarm* can be reset if any algorithmic changes need to be discarded. The value of this node usually contains the originally configured set point.

5.8.23 Rate of change Alarms

5.8.23.1 Overview

A *Rate* of *Change Alarm* is commonly used to report an unusual change or lack of change in a measured value related to the speed at which the value has changed. The *Rate* of *Change Alarm* becomes active when the rate at which the value changes exceeds or drops below a defined limit.

A *Rate* of *Change* is measured in some time unit, such as seconds or minutes and some unit of measure such as percent or meter. For example, a tank may have a High limit for the *Rate* of *Change* of its level (measured in meters) which would be 4 meters per minute. If the tank level changes at a rate that is greater than 4 meters per minute then the High sub state is entered.

5.8.23.2 NonExclusiveRateOfChangeAlarmType

The *NonExclusiveRateOfChangeAlarmType* is a special level *Alarm* utilized with one or more non-exclusive states. If for example both the High and HighHigh states need to be maintained as active at the same time this *AlarmConditionType* should be used

The *NonExclusiveRateOfChangeAlarmType* is based on the *NonExclusiveLimitAlarmType*. It is formally defined in Table 103.

Table 103 – NonExclusiveRateOfChangeAlarmType definition

Attribute	Value				
BrowseName	NonExclusiveRateOfChangeAlarmType				
IsAbstract	False				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**ModellingRule**
Subtype of the NonExclusiveLimitAlarmType defined in clause 5.8.20.					
HasProperty	Variable	EngineeringUnits	EUInformation	PropertyType	Optional
ConformanceUnits					
A & C Non-Exclusive RateOfChange					

EngineeringUnits provides the engineering units associated with the limits values. If this is not provided the assumed Engineering Unit is the same as the EU associated with the parent variable per second e.g. if parent is meters, this unit is meters/second.

5.8.23.3 ExclusiveRateOfChangeAlarmType

ExclusiveRateOfChangeAlarmType is utilized with multiple mutually exclusive limits. It is formally defined in Table 104.

Table 104 – ExclusiveRateOfChangeAlarmType definition

Attribute	Value				
BrowseName	ExclusiveRateOfChangeAlarmType				
IsAbstract	False				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**ModellingRule**
Inherits the *Properties* of the *ExclusiveLimitAlarmType* defined in clause 5.8.19.3.					
HasProperty	Variable	EngineeringUnits	EUInformation	PropertyType	Optional
ConformanceUnits					
A & C Exclusive RateOfChange					

EngineeringUnits provides the engineering units associated with the limits values. If this is not provided the assumed Engineering Unit is the same as the EU associated with the parent variable per second e.g. if parent is meters, this unit is meters/second.

5.8.24 Discrete Alarms

5.8.24.1 DiscreteAlarmType

The *DiscreteAlarmType* is used to classify *Types* into *Alarm Conditions* where the input for the *Alarm* may take on only a certain number of possible values (e.g. True/False, running/stopped/terminating). The *DiscreteAlarmType* with sub types defined in this standard is illustrated in Figure 22. It is formally defined in Table 105.

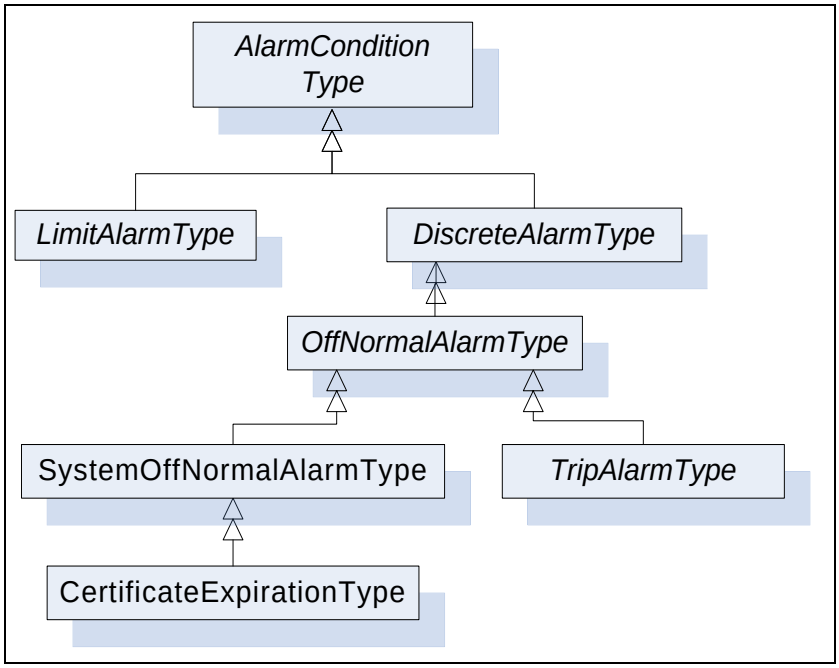


Figure 22 – DiscreteAlarmType Hierarchy

Table 105 – DiscreteAlarmType definition

Attribute	**Value**				
BrowseName	DiscreteAlarmType				
IsAbstract	False				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**Modelling Rule**
Subtype of the AlarmConditionType defined in clause 5.8.2.					
HasSubtype	*ObjectType*	OffNormalAlarmType	Defined in Clause 5.8.22		
ConformanceUnits					
A & C Discrete					

5.8.24.2 OffNormalAlarmType

The *OffNormalAlarmType* is a specialization of the *DiscreteAlarmType* intended to represent a discrete *Condition* that is considered to be not normal. It is formally defined in Table 106. This sub type is usually used to indicate that a discrete value is in an *Alarm* state, it is active as long as a non-normal value is present.

Table 106 – OffNormalAlarmType definition

Attribute	**Value**				
BrowseName	OffNormalAlarmType				
IsAbstract	False				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**ModellingRule**
Subtype of the DiscreteAlarmType defined in clause 5.8.24.1					
HasSubtype	*ObjectType*	TripAlarmType	Defined in Clause 5.8.24.4		
HasSubtype	*ObjectType*	SystemOffNormalAlarmType	Defined in Clause 5.8.24.3		
HasProperty	*Variable*	NormalState	NodeId	PropertyType	Mandatory
ConformanceUnits					
A & C OffNormal					

The *NormalState Property* is a *Property* that points to a *Variable* which has a value that corresponds to one of the possible values of the *Variable* pointed to by the *InputNode Property* where the *NormalState Property Variable* value is the value that is considered to be the normal state of the *Variable* pointed to by the *InputNode Property*. When the value of the *Variable* referenced by the *InputNode Property* is not equal to the value of the *NormalState Property* the *Alarm* is *Active*. If this *Variable* is not in the *AddressSpace*, a NULL *NodeId* shall be provided.

5.8.24.3 SystemOffNormalAlarmType

This *Condition* is used by a *Server* to indicate that an underlying system that is providing *Alarm* information is having a communication problem and that the *Server* may have invalid or incomplete *Condition* state in the *Subscription*. Its representation in the *AddressSpace* is formally defined in Table 107.

Table 107 – SystemOffNormalAlarmType definition

Attribute	**Value**				
BrowseName	SystemOffNormalAlarmType				
IsAbstract	False				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**ModellingRule**
HasSubtype	*ObjectType*	CertificateExpirationAlarm Type	Defined in Clause 5.8.24.7		
Subtype of the *OffNormalAlarmType*, i.e. it has HasProperty *References* to the same *Nodes*.					
ConformanceUnits					
A & C SystemOffNormal					

5.8.24.4 TripAlarmType

The *TripAlarmType* is a specialization of the *OffNormalAlarmType* intended to represent an equipment trip *Condition*. The *Alarm* becomes active when the monitored piece of equipment experiences some abnormal fault such as a motor shutting down due to an overload condition. It is formally defined in Table 108. This *Type* is mainly used for categorization.

Table 108 – TripAlarmType definition

Attribute	**Value**				
BrowseName	TripAlarmType				
IsAbstract	False				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**Modelling Rule**
Subtype of the OffNormalAlarmType defined in clause 5.8.24.2.					
ConformanceUnits					
A & C Trip					

5.8.24.5 InstrumentDiagnosticAlarmType

The *InstrumentDiagnosticAlarmType* is a specialization of the *OffNormalAlarmType* intended to represent a fault in a field device. The *Alarm* becomes active when the monitored device experiences a fault such as a sensor failure. It is formally defined in Table 108. This *Type* is mainly used for categorization.

Table 109 – InstrumentDiagnosticAlarmType definition

Attribute	**Value**				
BrowseName	InstrumentDiagnosticAlarmType				
IsAbstract	False				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**Modelling Rule**
Subtype of the OffNormalAlarmType defined in clause 5.8.24.2.					
ConformanceUnits					
A & C InstrumentDiagnostic					

5.8.24.6 SystemDiagnosticAlarmType

The *SystemDiagnosticAlarmType* is a specialization of the *OffNormalAlarmType* intended to represent a fault in a system or sub-system. The *Alarm* becomes active when the monitored system experiences a fault. It is formally defined in Table 108. This *Type* is mainly used for categorization.

Table 110 – SystemDiagnosticAlarmType definition

Attribute	Value				
BrowseName	SystemDiagnosticAlarmType				
IsAbstract	False				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**Modelling Rule**
Subtype of the OffNormalAlarmType defined in clause 5.8.24.2.					
ConformanceUnits					
A & C SystemDiagnostic					

5.8.24.7 CertificateExpirationAlarmType

This *SystemOffNormalAlarmType* is raised by the *Server* when the *Server's* Certificate is within the *ExpirationLimit* of expiration. This *Alarm* automatically returns to normal when the certificate is updated.

Table 111 – CertificateExpirationAlarmType definition

Attribute	Value				
BrowseName	CertificateExpirationAlarmType				
IsAbstract	False				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**ModellingRule**
Subtype of the SystemOffNormalAlarmType defined in clause 5.8.24.3					
HasProperty	Variable	ExpirationDate	DateTime	PropertyType	Mandatory
HasProperty	Variable	ExpirationLimit	Duration	PropertyType	Optional
HasProperty	Variable	CertificateType	NodeId	PropertyType	Mandatory
HasProperty	Variable	Certificate	ByteString	PropertyType	Mandatory
ConformanceUnits					
A & C CertificateExpiration					

ExpirationDate is the date and time this certificate will expire.

ExpirationLimit is the time interval before the *ExpirationDate* at which this *Alarm* will trigger. This shall be a positive number. If the property is not provided, a default of 2 weeks shall be used.

CertificateType – See Part 12 for definition of *CertificateType.*

Certificate is the certificate that is about to expire.

5.8.25 DiscrepancyAlarmType

The *DiscrepancyAlarmType* is commonly used to report an action that did not occur within an expected time range.

The *DiscrepancyAlarmType* is based on the *AlarmConditionType*. It is formally defined in Table 112.

Table 112 – DiscrepancyAlarmType definition

Attribute	Value				
BrowseName	DiscrepancyAlarmType				
IsAbstract	False				
References	**Node Class**	**BrowseName**	**DataType**	**TypeDefinition**	**Modelling Rule**
Subtype of the *AlarmConditionType* defined in 5.8.2.					
HasProperty	Variable	TargetValueNode	NodeId	PropertyType	Mandatory
HasProperty	Variable	ExpectedTime	Duration	PropertyType	Mandatory
HasProperty	Variable	Tolerance	Double	PropertyType	Optional
ConformanceUnits					
A & C Discrepancy					

The *TargetValueNode Property* provides the *NodeId* of the *Variable* that is used for the target value.

The *ExpectedTime Property* provides the *Duration* within which the value pointed to by the InputNode shall equal the value specified by the *TargetValueNode* (or be within the *Tolerance* range, if specified).

The *Tolerance Property* is a value that can be added to or subtracted from the *TargetValueNode's* value, providing a range that the value can be in without generating the *Alarm*.

A *DiscrepancyAlarmType* can be used to indicate a motor has not responded to a start request within a given time, or that a process value has not reached a given value after a setpoint change within a given time interval.

The *DiscrepancyAlarmType* shall return to normal when the value has reached the target value.

5.9 ConditionClasses

5.9.1 Overview

Conditions are used in specific application domains like Maintenance, System or Process. The *ConditionClass* hierarchy is used to specify domains and is orthogonal to the *ConditionType* hierarchy. The *ConditionClassId Property* of the *ConditionType* is used to assign a *Condition* to a *ConditionClass*. *Clients* can use this *Property* to filter out essential classes. OPC UA defines the base *ObjectType* for all *ConditionClasses* and a set of common classes used across many industries. Figure 23 informally describes the hierarchy of *ConditionClass Types* defined in this standard.

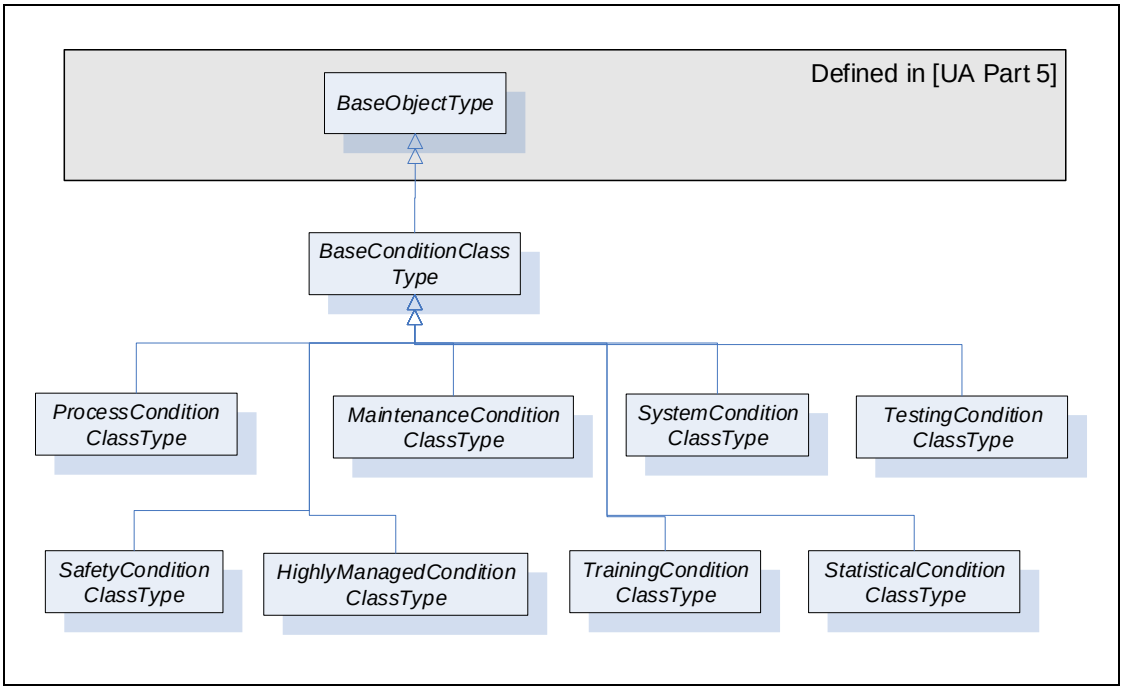


Figure 23 – ConditionClass type hierarchy

ConditionClasses are not representations of *Objects* in the underlying system and, therefore, only exist as *Type Nodes* in the *Address Space*.

5.9.2 BaseConditionClassType

BaseConditionClassType is used as class whenever a *Condition* cannot be assigned to a more concrete class. *Servers* should use a more specific *ConditionClass*, if possible. All *ConditionClass Types* derive from *BaseConditionClassType*. It is formally defined in Table 113.

Table 113 – BaseConditionClassType definition

Attribute	Value				
BrowseName	BaseConditionClassType				
IsAbstract	True				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**ModellingRule**
Subtype of the BaseObjectType defined in 10000-5.					
ConformanceUnits					
A & C ConditionClasses					

5.9.3 ProcessConditionClassType

The *ProcessConditionClassType* is used to classify *Conditions* related to the process itself. Examples of a process would be a control system in a boiler or the instrumentation associated with a chemical plant or paper machine. The *ProcessConditionClassType* is formally defined in Table 114.

Table 114 – ProcessConditionClassType definition

Attribute	Value				
BrowseName	ProcessConditionClassType				
IsAbstract	True				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**Modelling Rule**
Subtype of the BaseConditionClassType defined in clause 5.9.2.					
ConformanceUnits					
A & C ConditionClasses					

5.9.4 MaintenanceConditionClassType

The *MaintenanceConditionClassType* is used to classify *Conditions* related to maintenance. Examples of maintenance would be Asset Management systems or conditions, which occur in process control systems, which are related to calibration of equipment. The *MaintenanceConditionClassType* is formally defined in Table 115. No further definition is provided here. It is expected that other standards groups will define domain-specific sub-types.

Table 115 – MaintenanceConditionClassType definition

Attribute	Value				
BrowseName	MaintenanceConditionClassType				
IsAbstract	True				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**ModellingRule**
Subtype of the BaseConditionClassType defined in clause 5.9.2.					
ConformanceUnits					
A & C ConditionClasses					

5.9.5 SystemConditionClassType

The *SystemConditionClassType* is used to classify *Conditions* related to the System. It is formally defined in Table 116. System *Conditions* occur in the controlling or monitoring system process. Examples of System related items could include available disk space on a computer, Archive media availability, network loading issues or a controller error. It is expected that other standards groups or vendors will define domain-specific sub-types.

Table 116 – SystemConditionClassType definition

Attribute	Value				
BrowseName	SystemConditionClassType				
IsAbstract	True				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**ModellingRule**
Subtype of the *BaseConditionClassType* defined in clause 5.9.2.					
ConformanceUnits					
A & C ConditionClasses					

5.9.6 SafetyConditionClassType

The *SafetyConditionClassType* is used to classify *Conditions* related to safety. It is formally defined in Table 117.

Safety *Conditions* occur in the controlling or monitoring system process. Examples of safety related items could include, emergency shutdown systems or fire suppression systems.

Table 117 – SafetyConditionClassType definition

Attribute	Value				
BrowseName	SafetyConditionClassType				
IsAbstract	True				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**ModellingRule**
Subtype of the *BaseConditionClassType* defined in clause 5.9.2.					
ConformanceUnits					
A & C ConditionClasses					

5.9.7 HighlyManagedAlarmConditionClassType

In *Alarm* systems some *Alarms* may be classified as highly managed *Alarms*. This class of *Alarm* requires special handling that varies according to the individual requirements. It might require individual acknowledgement or not allow suppression or any of a number of other special behaviours. The *HighlyManagedAlarmConditionClassType* is used to classify *Conditions* as highly managed *Alarms*. It is formally defined in Table 118.

Table 118 – HighlyManagedAlarmConditionClassType definition

Attribute	Value				
BrowseName	HighlyManagedAlarmConditionClassType				
IsAbstract	True				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**ModellingRule**
Subtype of the *BaseConditionClassType* defined in clause 5.9.2.					
ConformanceUnits					
A & C ConditionClasses					

5.9.8 TrainingConditionClassType

The *TrainingConditionClassType* is used to classify *Conditions* related to training system or training exercises. It is formally defined in Table 119. These *Conditions* typically occur in a training system or are generated as part of a simulation for a training exercise. Training *Conditions* might be process or system conditions. It is expected that other standards groups or vendors will define domain-specific sub-types.

Table 119 – TrainingConditionClassType definition

Attribute	Value				
BrowseName	TrainingConditionClassType				
IsAbstract	True				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**ModellingRule**
Subtype of the *BaseConditionClassType* defined in clause.					
ConformanceUnits					
A & C ConditionClasses					

5.9.9 StatisticalConditionClassType

The *StatisticalConditionClassType* is used to classify *Conditions* related that are based on statistical calculations. It is formally defined in Table 120. These *Conditions* are generated as part of a statistical analysis. They might be any of an *Alarm* number of types.

Table 120 – StatisticalConditionClassType definition

Attribute	Value				
BrowseName	StatisticalConditionClassType				
IsAbstract	True				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**ModellingRule**
Subtype of the *BaseConditionClassType* defined in clause.					
ConformanceUnits					
A & C ConditionClasses					

5.9.10 TestingConditionClassType

The *TestingConditionClassType* is used to classify *Conditions* related to testing of an *Alarm* system or *Alarm* function. It is formally defined in Table 121. Testing *Conditions* might include a condition to test an alarm annunciation such as a horn or other panel. It might also be used to temporarily reclassify a *Condition* to check response times or suppression logic. It is expected that other standards groups or vendors will define domain-specific sub-types.

Table 121 – TestingConditionClassType definition

Attribute	Value				
BrowseName	TestingConditionClassType				
IsAbstract	True				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**ModellingRule**
Subtype of the *BaseConditionClassType* defined in clause 5.9.2.					
ConformanceUnits					
A & C ConditionClasses					

5.10 Audit Events

5.10.1 Overview

If Auditing is supported by a *Server*, *Events* of *AuditConditionEventType* shall be generated. Following are the sub-types of *AuditUpdateMethodEventType* that will be generated in response to the *Methods* defined in this document. They are illustrated in Figure 24.

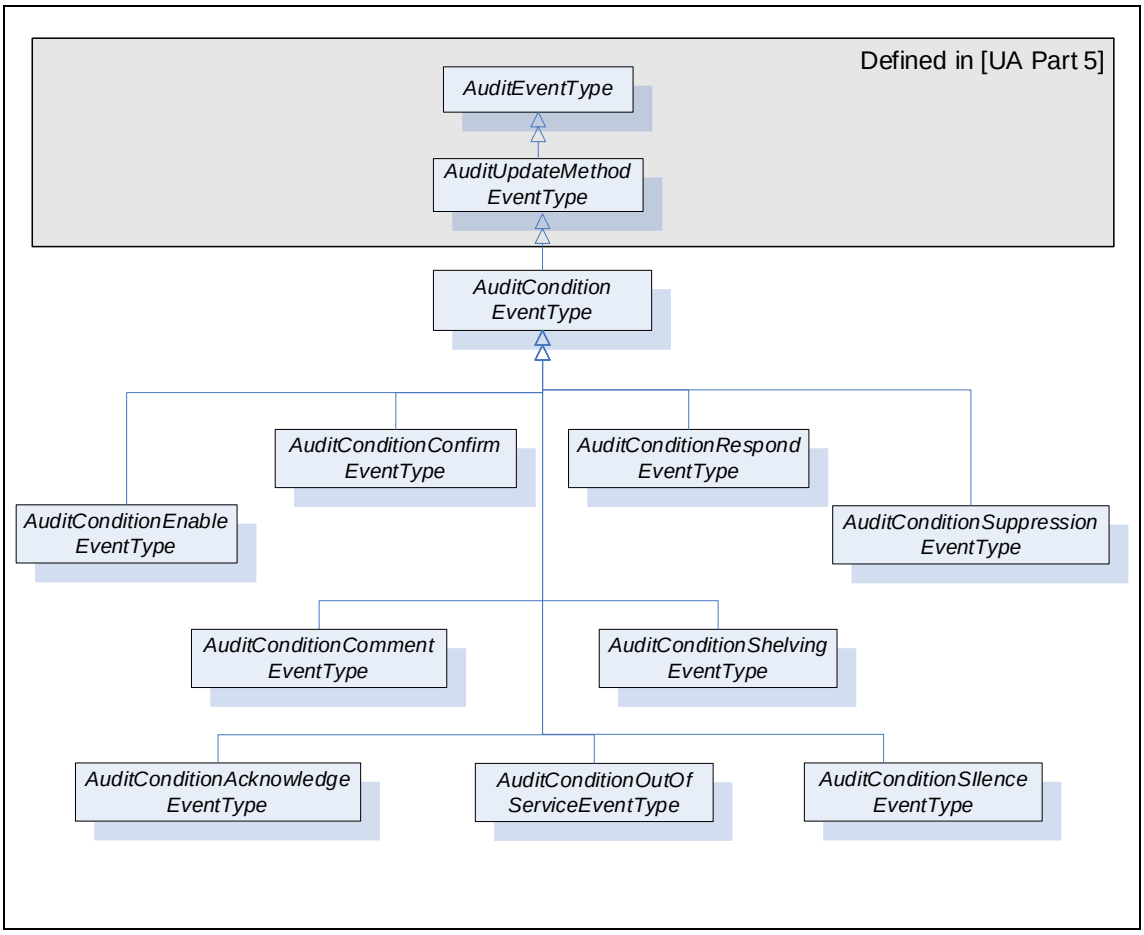


Figure 24 – AuditEvent hierarchy

AuditConditionEventTypes are normally used in response to a *Method* call. However, these *Events* shall also be notified if the functionality of such a *Method* is performed by some other *Server*-specific means. In this case, the *SourceName Property* shall contain a proper description of this internal means and the other *Properties* should be filled in as described for the given *EventType*.

5.10.2 AuditConditionEventType

This *EventType* is used to subsume all *AuditConditionEventTypes*. It is formally defined in Table 122.

Table 122 – AuditConditionEventType definition

Attribute	**Value**				
BrowseName	AuditConditionEventType				
IsAbstract	False				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**ModellingRule**
Subtype of the *AuditUpdateMethodEventType* defined in 10000-5					
ConformanceUnits					
A & C Auditing					

AuditConditionEventTypes inherit all *Properties* of the *AuditUpdateMethodEventType* defined in 10000-5. Unless a subtype overrides the definition, the inherited *Properties* of the *Condition* will be used as defined.

- The inherited *Property SourceNode* shall be filled with the *ConditionId*.
- The *SourceName* shall be “Method/” and the name of the *Service* that generated the *Event* (e.g. *Disable*, *Enable*, *Acknowledge,* etc.*).*

This *EventType* can be further customized to reflect particular *Condition* related actions.

5.10.3 AuditConditionEnableEventType

This *EventType* is used to indicate a change in the enabled state of a *Condition* instance. It is formally defined in Table 123.

Table 123 – AuditConditionEnableEventType definition

Attribute	**Value**				
BrowseName	AuditConditionEnableEventType				
IsAbstract	False				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**ModellingRule**
Subtype of the *AuditConditionEventType* defined in 5.10.2 that is, inheriting the InstanceDeclarations of that Node.					
ConformanceUnits					
A & C Auditing					

The SourceName shall indicate Method/Enable or Method/Disable. If the audit *Event* is not the result of a *Method* call, but due to an internal action of the *Server*, the *SourceName* shall reflect Enable or Disable, it may be preceded by an appropriate description such as “Internal/Enable” or “Remote/Enable”.

5.10.4 AuditConditionCommentEventType

This *EventType* is used to report an *AddComment* action. It is formally defined in Table 124.

Table 124 – AuditConditionCommentEventType definition

Attribute	**Value**				
BrowseName	AuditConditionCommentEventType				
IsAbstract	False				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**ModellingRule**
HasProperty	Variable	ConditionEventId	ByteString	PropertyType	Mandatory
HasProperty	Variable	Comment	LocalizedText	PropertyType	Mandatory
Subtype of the *AuditConditionEventType* defined in 5.10.2 that is, inheriting the InstanceDeclarations of that Node.					
ConformanceUnits					
A & C Auditing					

The *ConditionEventId* field shall contain the id of the event for which the comment was added.

The *Comment* contains the actual comment that was added.

5.10.5 AuditConditionRespondEventType

This *EventType* is used to report a *Respond* action (see 5.6). It is formally defined in Table 125.

Table 125 – AuditConditionRespondEventType definition

Attribute	**Value**				
BrowseName	AuditConditionRespondEventType				
IsAbstract	False				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**ModellingRule**
HasProperty	Variable	SelectedResponse	UInt32	PropertyType	Mandatory
Subtype of the *AuditConditionEventType* defined in 5.10.2 that is, inheriting the InstanceDeclarations of that Node.					
ConformanceUnits					
A & C Dialog Auditing					

The SelectedResponse field shall contain the response that was selected.

5.10.6 AuditConditionAcknowledgeEventType

This *EventType* is used to indicate acknowledgement or confirmation of one or more *Conditions*. It is formally defined in Table 126.

Table 126 – AuditConditionAcknowledgeEventType definition

Attribute		Value			
BrowseName		AuditConditionAcknowledgeEventType			
IsAbstract		False			
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**ModellingRule**
HasProperty	Variable	ConditionEventId	ByteString	PropertyType	Mandatory
HasProperty	Variable	Comment	LocalizedText	PropertyType	Mandatory
Subtype of the *AuditConditionEventType* defined in 5.10.2 that is, inheriting the InstanceDeclarations of that Node.					
ConformanceUnits					
A & C Acknowledge Auditing					

The *ConditionEventId* field shall contain the id of the *Event* that was acknowledged.

The *Comment* contains the actual comment that was added, it may be a blank comment or a NULL.

5.10.7 AuditConditionConfirmEventType

This *EventType* is used to report a *Confirm* action. It is formally defined in Table 127.

Table 127 – AuditConditionConfirmEventType definition

Attribute		Value			
BrowseName		AuditConditionConfirmEventType			
IsAbstract		False			
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**ModellingRule**
HasProperty	Variable	ConditionEventId	ByteString	PropertyType	Mandatory
HasProperty	Variable	Comment	LocalizedText	PropertyType	Mandatory
Subtype of the *AuditConditionEventType* defined in 5.10.2 that is, inheriting the InstanceDeclarations of that Node.					
ConformanceUnits					
A & C Confirm Auditing					

The *ConditionEventId* field shall contain the id of the *Event* that was confirmed.

The *Comment* contains the actual comment that was added, it may be a blank comment or a NULL.

5.10.8 AuditConditionShelvingEventType

This *EventType* is used to indicate a change to the *Shelving* state of a *Condition* instance. It is formally defined in Table 128.

Table 128 – AuditConditionShelvingEventType definition

Attribute		Value			
BrowseName		AuditConditionShelvingEventType			
IsAbstract		False			
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**ModellingRule**
HasProperty	Variable	ShelvingTime	Duration	PropertyType	Optional
Subtype of the *AuditConditionEventType* defined in 5.10.2 that is, inheriting the InstanceDeclarations of that Node.					
ConformanceUnits					
A & C Shelving Auditing					

If the *Method* indicates a *TimedShelve* operation, the *ShelvingTime* field shall contain duration for which the *Alarm* is to be shelved. For other *Shelving Methods*, this parameter may be omitted or NULL.

5.10.9 AuditConditionSuppressionEventType

This *EventType* is used to indicate a change to the *Suppression* state of a *Condition* instance. It is formally defined in Table 129.

Table 129 – AuditConditionSuppressionEventType definition

Attribute	Value				
BrowseName	AuditConditionSuppressionEventType				
IsAbstract	False				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**ModellingRule**
Subtype of the *AuditConditionEventType* defined in 5.10.2 that is, inheriting the InstanceDeclarations of that Node.					
ConformanceUnits					
A & C Suppression Auditing					

This *Event* indicates an *Alarm* suppression operation. An audit *Event* of this type shall be generated, if audit events are supported for any suppression action, including automatic system based suppression.

5.10.10 AuditConditionSilenceEventType

This *EventType* is used to indicate a change to the *Silence* state of a *Condition* instance. It is formally defined in Table 130.

Table 130 – AuditConditionSilenceEventType definition

Attribute	Value				
BrowseName	AuditConditionSilenceEventType				
IsAbstract	False				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**ModellingRule**
Subtype of the *AuditConditionEventType* defined in 5.10.2 that is, inheriting the InstanceDeclarations of that Node.					
ConformanceUnits					
A & C Silencing Auditing					

This event indicates that an *Alarm* was silenced, but not acknowledged. An audit event of this type shall be generated, if Audit events are supported for any silence action, including automatic system based silence.

5.10.11 AuditConditionResetEventType

This *EventType* is used to indicate a change to the *Latched* state of a *Condition* instance. It is formally defined in Table 130.

Table 131 – AuditConditionResetEventType definition

Attribute	Value				
BrowseName	AuditConditionResetEventType				
IsAbstract	False				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**ModellingRule**
Subtype of the *AuditConditionEventType* defined in 5.10.2 that is, inheriting the InstanceDeclarations of that Node.					
ConformanceUnits					
A & C Latching Auditing					

This event indicates that an *Alarm* was reset. An audit event of this type shall be generated, if Audit events are supported for any *Alarm* action.

5.10.12 AuditConditionOutOfServiceEventType

This *EventType* is used to indicate a change to the *OutOfService State* of a *Condition* instance. It is formally defined in Table 132.

Table 132 – AuditConditionOutOfServiceEventType definition

Attribute	Value				
BrowseName	AuditConditionOutOfServiceEventType				
IsAbstract	False				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**ModellingRule**
Subtype of the *AuditConditionEventType* defined in 5.10.2 that is, inheriting the InstanceDeclarations of that Node.					
ConformanceUnits					
A & C OutOfService Auditing					

An audit *Event* of this type shall be generated if audit *Events* are supported.

5.11 Condition Refresh related Events

5.11.1 Overview

Following are sub-types of *SystemEventType* that will be generated in response to a *Refresh Methods* call. They are illustrated in Figure 25.

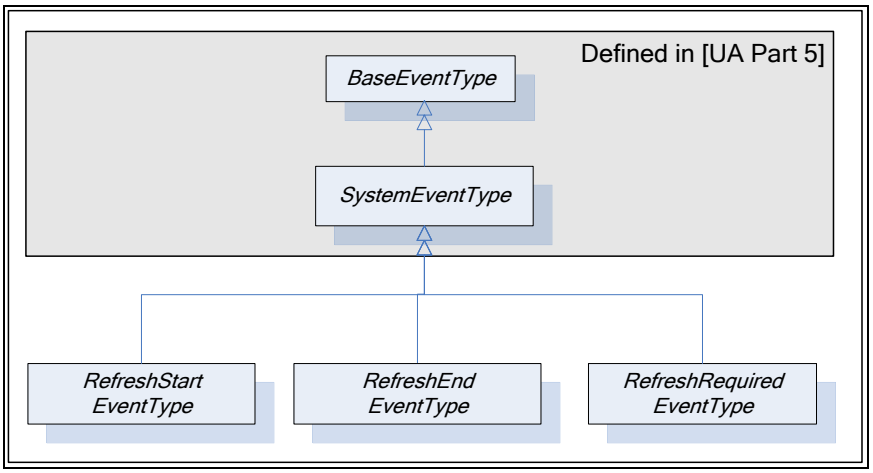


Figure 25 – Refresh Related Event Hierarchy

5.11.2 RefreshStartEventType

This *EventType* is used by a *Server* to mark the beginning of a *Refresh Notification* cycle. Its representation in the *AddressSpace* is formally defined in Table 133.

Table 133 – RefreshStartEventType definition

Attribute	**Value**				
BrowseName	RefreshStartEventType				
IsAbstract	True				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**ModellingRule**
Subtype of the *SystemEventType* defined in 10000-5, i.e. it has HasProperty *References* to the same *Nodes*.					
ConformanceUnits					
A & C Refresh					
A & C Refresh2					

5.11.3 RefreshEndEventType

This *EventType* is used by a *Server* to mark the end of a *Refresh Notification* cycle. Its representation in the *AddressSpace* is formally defined in Table 134.

Table 134 – RefreshEndEventType definition

Attribute	**Value**				
BrowseName	RefreshEndEventType				
IsAbstract	True				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**ModellingRule**
Subtype of the *SystemEventType* defined in 10000-5, i.e. it has HasProperty *References* to the same *Nodes*.					
ConformanceUnits					
A & C Refresh					
A & C Refresh2					

5.11.4 RefreshRequiredEventType

This *EventType* is used by a *Server* to indicate that a significant change has occurred in the *Server* or in the subsystem below the *Server* that may or does invalidate the *Condition* state of a *Subscription*. Its representation in the *AddressSpace* is formally defined in Table 135.

Table 135 – RefreshRequiredEventType definition

Attribute	**Value**				
BrowseName	RefreshRequiredEventType				
IsAbstract	True				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**ModellingRule**
Subtype of the *SystemEventType* defined in 10000-5, i.e. it has HasProperty *References* to the same *Nodes*.					
ConformanceUnits					
A & C Refresh					
A & C Refresh2					

When a *Server* detects an *Event* queue overflow, it shall track if any *Condition Event*s have been lost, if any *Condition Event*s were lost, it shall issue a *RefreshRequiredEventType Event* to the *Client* after the *Event* queue is no longer in an overflow state.

5.12 HasCondition Reference type

The *HasCondition ReferenceType* is a concrete *ReferenceType* and can be used directly. It is a subtype of *NonHierarchicalReferences*. The representation in the *AddressSpace* is specified in Table 136.

The semantic of this *ReferenceType* is to specify the relationship between a *ConditionSource* and its *Conditions*. Each *ConditionSource* shall be the target of a *HasEventSource Reference* or a sub type of *HasEventSource*. The *AddressSpace* organisation that shall be provided for *Clients* to detect *Conditions* and *ConditionSources* is defined in Clause 6. Various examples for the use of this *ReferenceType* can be found in B.2.

HasCondition References can be used in the *Type* definition of an *Object* or a *Variable*. In this case, the *SourceNode* of this *ReferenceType* shall be an *ObjectType* or *VariableType Node* or one of their *InstanceDeclaration Nodes*. The *TargetNode* shall be a *Condition* instance declaration or a *ConditionType*. The following rules for instantiation apply:

- All *HasCondition References* used in a *Type* shall exist in instances of these *Types* as well.
- If the *TargetNode* in the *Type* definition is a *ConditionType*, the same *TargetNode* will be referenced on the instance.

HasCondition References may be used solely in the instance space when they are not available in *Type* definitions. In this case the *SourceNode* of this *ReferenceType* shall be an *Object*, *Variable* or *Method Node*. The *TargetNode* shall be a *Condition* instance or a *ConditionType*.

Table 136 – HasCondition *ReferenceType* Definition

Attributes	**Value**		
BrowseName	HasCondition		
InverseName	IsConditionOf		
Symmetric	False		
IsAbstract	False		
References	**NodeClass**	**BrowseName**	**Comment**
ConformanceUnits			
A & C Basic			

5.13 Alarm & Condition status codes

Table 137 defines the *StatusCodes* defined for *Alarm* & *Conditions*.

Table 137 – Alarm & Condition result codes

Symbolic Id	Description
Bad_ConditionAlreadyEnabled	The addressed Condition is already enabled.
Bad_ConditionAlreadyDisabled	The addressed Condition is already disabled.
Bad_ConditionAlreadyShelved	The Alarm is already in a shelved state.
Bad_ConditionBranchAlreadyAcked	The *EventId* does not refer to a state that needs acknowledgement.
Bad_ConditionBranchAlreadyConfirmed	The *EventId* does not refer to a state that needs confirmation.
Bad_ConditionNotShelved	The Alarm is not in the requested shelved state.
Bad_DialogNotActive	The *DialogConditionType* instance is not in *Active* state.
Bad_DialogResponseInvalid	The selected option is not a valid index in the *ResponseOptionSet* array.
Bad_EventIdUnknown	The specified *EventId* is not known to the *Server*.
Bad_RefreshInProgress	A ConditionRefresh operation is already in progress.
Bad_ShelvingTimeOutOfRange	The provided *Shelving* time is outside the range allowed by the *Server* for *Shelving*

5.14 Expected A & C server behaviours

5.14.1 General

This section describes behaviour that is expected from an OPC UA *Server* that is implementing the *A & C Information Model*. In particular this section describes specific behaviours that apply to various aspect of the A & C *Information Model*.

5.14.2 Communication problems

In some implementation of an OPC UA A & C *Server*, the *Alarms* and *Condition* are provided by an underlying system. The expected behaviour of an A & C *Server* when it is encountering communication problems with the underlying system is:

- If communication fails to the underlying system,
  - For any *Event* field related information that is exposed in the address space, the Value/*StatusCode* obtained when reading the *Event* fields that are associated with the communication failure shall have a value of NULL and a *StatusCode* of Bad_CommunicationError.
  - For *Subscription*s that contain *Conditions* for which the failure applies, the effected *Conditions* generate an *Event,* if the *Retain* field is set to True. These *Events* shall have their *Event* fields that are associated with the communication failure contain a *StatusCode* of Bad_CommunicationError for the value.
  - A *Condition* of the SystemOffNormalAlarmType shall be used to report the communication failure to *Alarm Client*s. The *NormalState* field shall contain the *NodeId* of the *Variable* that indicates the status of the underlying system.
- For start-up of an A & C *Server* that is obtaining A & C information from an already running underlying system:
  - If a value is unavailable for an *Event* field that is being reported due to a start-up of the UA *Server* (i.e. the information is just not available for the *Event*) the *Event* field shall contain a *StatusCode* set to Bad_WaitingForInitialData for the value.
  - If the Time field is normally provided by the underlying system and is unavailable, the Time shall be reported as a *StatusCode* with a value of Bad_WaitingForInitialData.

5.14.3 Redundant A & C servers

In an OPC UA *Server* that is implementing the A & C *Information Model* and that is configured to be a redundant OPC UA *Server* the following behaviour is expected:

- The EventId is used to uniquely identify an *Event*. For an *Event* that is in each of the redundant *Servers*, it shall be identical. This applies to all standard *Event*s, *Alarms* and *Conditions*. This may be accomplished by sharing of information between redundant *Server* (such as actual *Event*s) or it may be accomplished by providing a strict *EventId* generating algorithm that will generate an identical *EventId* for each *Event*
- It is expected that for cold or warm failovers of redundant *Server*s, *Subscription* for *Events* shall require a Refresh operation. The *Client* shall initiate this *Refresh* operation.

- It is expected that for hot failovers of redundant *Server*s, *Subscriptions* for *Events* may require a *Refresh* operation. The *Server* shall issue a *RefreshRequiredEventType Event* if it is required.
- For transparent redundancy, a *Server* shall not require any action be performed by a *Client*.

6 AddressSpace organisation

6.1 General

The *AddressSpace* organisation described in this Clause allows *Clients* to detect *Conditions* and *ConditionSources*. An additional hierarchy of *Object Nodes* that are notifiers may be established to define one or more areas; the *Client* can subscribe to specific areas to limit the *Event Notifications* sent by the *Server*. Additional examples can be found in Clause B.2.

6.2 EventNotifier and source hierarchy

HasNotifier and *HasEventSource References* are used to expose the hierarchical organization of *Event* notifying *Objects* and *ConditionSources*. An *Event* notifying *Object* represents typically an area of *Operator* responsibility. The definition of such an area configuration is outside the scope of this standard. If areas are available, they shall be linked together and with the included *ConditionSources* using the *HasNotifier* and the *HasEventSource Reference Types*. The *Server Object* shall be the root of this hierarchy.

Figure 26 shows such a hierarchy. Note that *HasNotifier* is a sub-type of *HasEventSource*. I.e. the target *Node* of a *HasNotifier Reference* (an *Event* notifying *Object*) may also be a *ConditionSource*. The *HasEventSource Reference* is used if the target *Node* is a *ConditionSource* but cannot be used as *Event* notifier. See 10000-3 for the formal definition of these *Reference Types*.

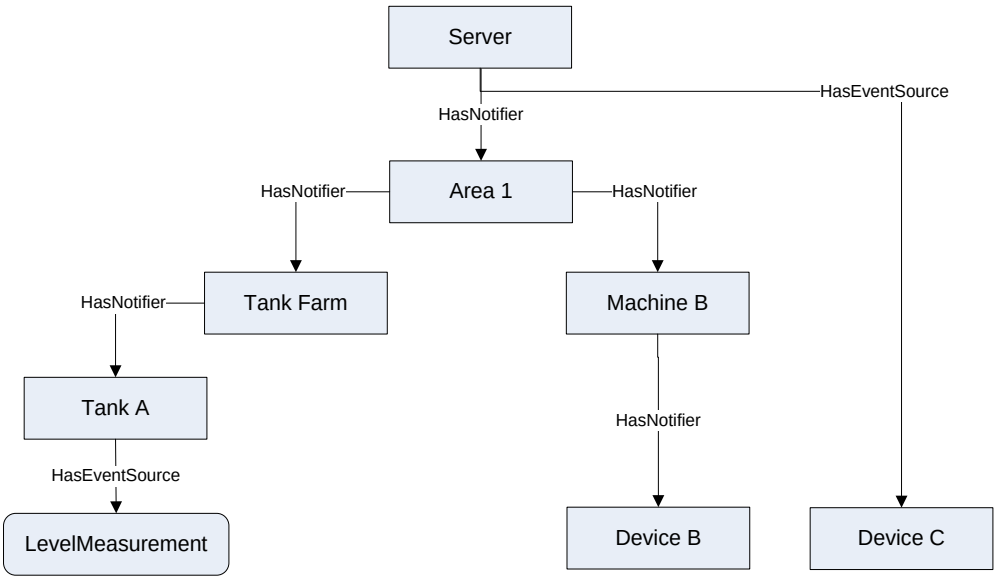


Figure 26 – Typical HasNotifier Hierarchy

6.3 Adding Conditions to the hierarchy

HasCondition is used to reference *Conditions*. The *Reference* is from a *ConditionSource* to a *Condition* instance or – if no instance is exposed by the *Server* – to the *ConditionType*.

Clients can locate *Conditions* by first browsing for *ConditionSources* following *HasEventSource References* (including sub-types like the *HasNotifier Reference*) and then browsing for *HasCondition References* from all target *Nodes* of the discovered *References*.

Figure 27 shows the application of the *HasCondition Reference* in a *HasNotifier* hierarchy. The *Variable* LevelMeasurement and the *Object* “Device B” *Reference Condition* instances. The

Object “Tank A” *References* a *ConditionType* (MySystemAlarmType) indicating that a *Condition* exists but is not exposed in the *AddressSpace*.

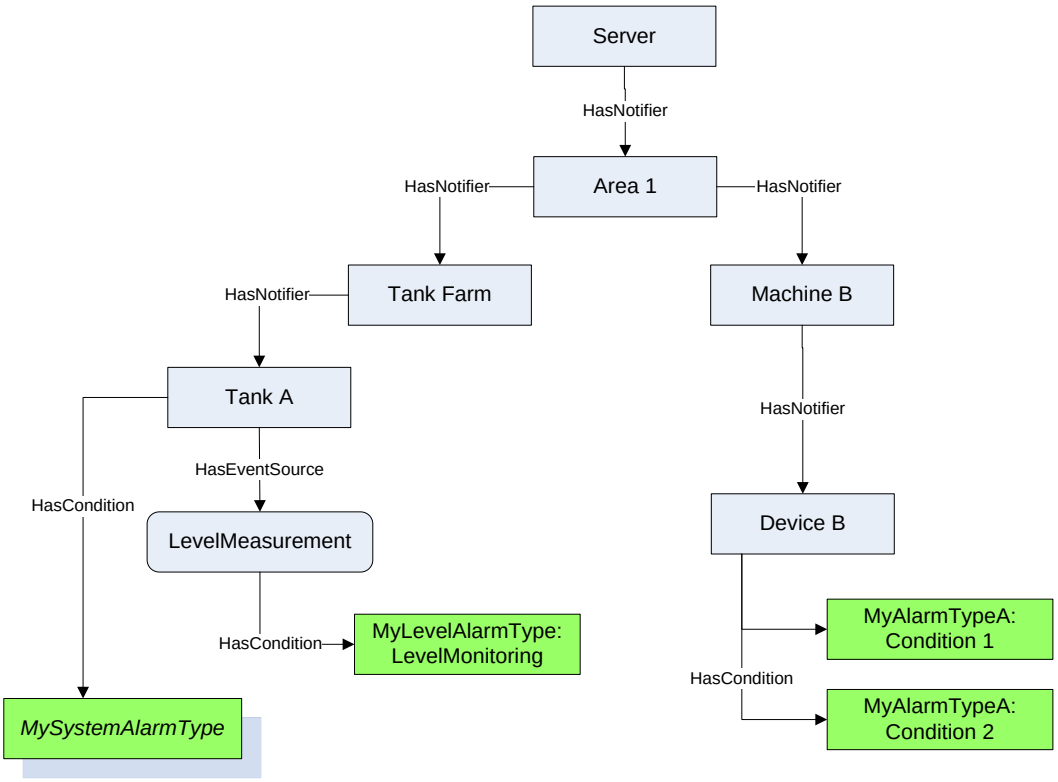


Figure 27 – Use of HasCondition in a HasNotifier hierarchy

6.4 Conditions in InstanceDeclarations

Figure 28 shows the use of the *HasCondition Reference* and the *HasEventSource Reference* in an *InstanceDeclaration*. They are used to indicate what *References* and *Conditions* are available on the instance of the *ObjectType*.

The use of the *HasEventSource Reference* in the context of *InstanceDeclarations* and *TypeDefinition Nodes* has no effect for *Event* generation.

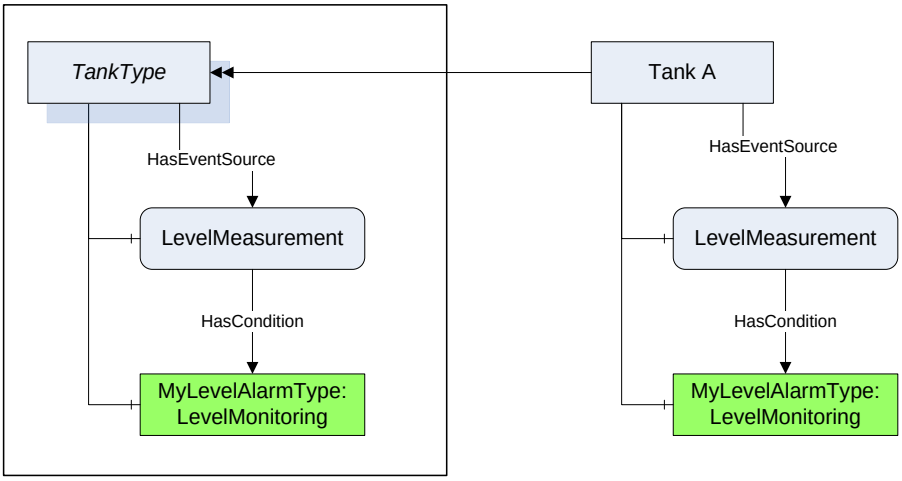


Figure 28 – Use of HasCondition in an InstanceDeclaration

6.5 Conditions in a VariableType

Use of *HasCondition* in a *VariableType* is a special use case since *Variables* (and *VariableTypes*) may not have *Conditions* as components. Figure 29 provides an example of this

use case. Note that there is no component relationship for the “LevelMonitoring” *Alarm*. It is *Server*-specific whether and where they assign a *HasComponent Reference*.

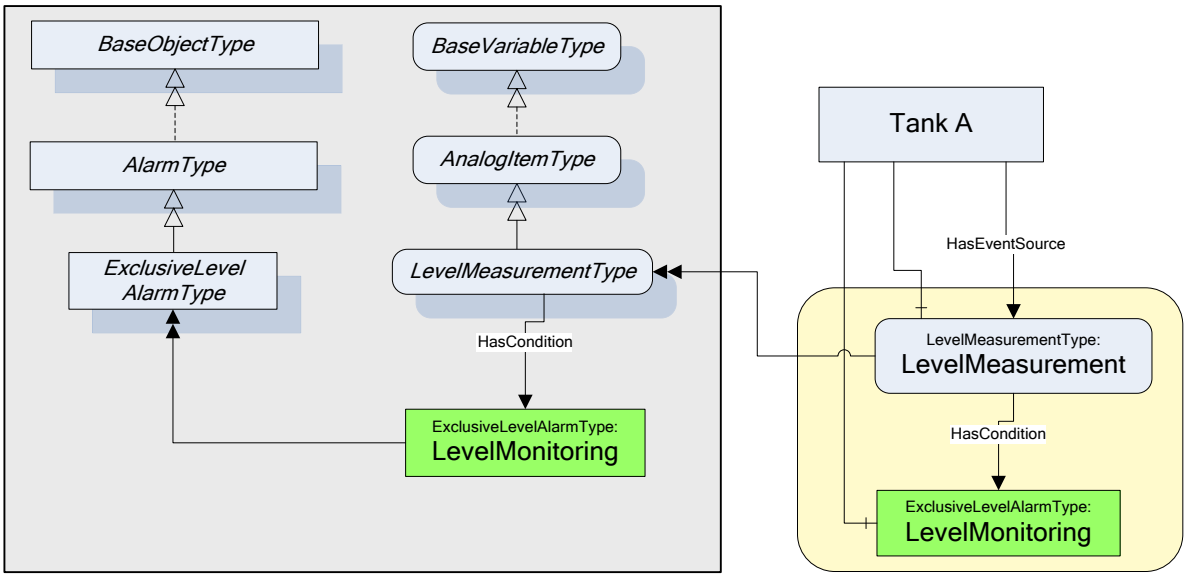


Figure 29 – Use of HasCondition in a VariableType

7 System State & Alarms

7.1 Overview

The state of alarms is affected by the state of the process, equipment, system or plant. For example, when a tank is taken out of service, the level alarms associated with the tank would be no longer used, until the tank is returned to service. This section describes *ReferenceTypes* that can be used by a *StateMachine* to indicate that a specific *Effect* on *Alarm*s caused by the transition of a *StateMachine*. *StateMachines* that describe the state of a process, system or equipment can vary, but an example *StateMachine* is provided in Annex F.

7.2 HasEffectDisable

The *HasEffectDisable ReferenceType* is a concrete *ReferenceType* and can be used directly. It is a subtype of *HasEffect*.

The semantic of this *ReferenceType* is to point form a *Transition* to an *Alarm* that will be disabled.

- If the *Reference* is to an *Object* then all *Alarms* in the *HasNotifier* hierarchy below that *Object* are disabled,
- If the target is an *AlarmType* then all instances of that *AlarmType* in the *HasNotifier* hierarchy below the *Object* containing the *StateMachine* are disabled,
- If the target is an *Alarm* instance then the given *Alarm* instance is disabled.

The *SourceNode* of this *ReferenceType* shall be an *Object* of the *ObjectType TransitionType* or one of its subtypes. The *TargetNode* can be of an *Object* or *AlarmType*.

The representation of the *HasEffectDisable ReferenceType* in the *AddressSpace* is specified in Table 138

Table 138 – HasEffectDisable ReferenceType

Attributes	**Value**		
BrowseName	*HasEffectDisable*		
InverseName	MayBeDisabledBy		
Symmetric	False		
IsAbstract	False		
References	**NodeClass**	**BrowseName**	**Comment**
ConformanceUnits			
A & C StateMachine Trigger			

7.3 HasEffectEnable

The *HasEffectEnable ReferenceType* is a concrete *ReferenceType* and can be used directly. It is a subtype of *HasEffect*.

The semantic of this *ReferenceType* is to point form a *Transition* to an *Alarm* that will be enabled.

- If the *Reference* is to an *Object* then all *Alarms* in the *HasNotifier* hierarchy below that *Object* are enabled,
- If the target is an *AlarmType* then all instances of that *AlarmType* in the *HasNotifier* hierarchy below the *Object* containing the *StateMachine* are enabled
- If the target is an *Alarm* instance then the given *Alarm* instance is enabled.

The *SourceNode* of this *ReferenceType* shall be an *Object* of the *ObjectType TransitionType* or one of its subtypes. The *TargetNode* can be of any *NodeClass*.

The representation of the *HasEffectEnable ReferenceType* in the *AddressSpace* is specified in Table 139

Table 139 – HasEffectEnable ReferenceType

Attributes	**Value**		
BrowseName	HasEffectEnable		
InverseName	MayBeEnabledBy		
Symmetric	False		
IsAbstract	False		
References	**NodeClass**	**BrowseName**	**Comment**
ConformanceUnits			
A & C Statemachine Trigger			

7.4 HasEffectSuppressed

The *HasEffectSuppressed ReferenceType* is a concrete *ReferenceType* and can be used directly. It is a subtype of *HasEffect*.

The semantic of this *ReferenceType* is to point form a *Transition* to an *Alarm* that will be suppressed.

- If the reference is to an *Object* then all *Alarms* in the *EventNotifier* hierarchy below that *Object* are suppressed,
- If the target is an *AlarmType* then all instance of that AlarmType in the *HasNotifier* hierarchy below the *Object* containing the *StateMachine* are suppressed,
- If the target is an *Alarm* instance then the given *Alarm* instance is suppressed.

The *SourceNode* of this *ReferenceType* shall be an *Object* of the *ObjectType TransitionType* or one of its subtypes. The *TargetNode* can be of any *NodeClass*.

The representation of the *HasEffectSuppressed ReferenceType* in the *AddressSpace* is specified in Table 140

Table 140 – HasEffectSuppressed ReferenceType

Attributes	**Value**		
BrowseName	HasEffectSuppressed		
InverseName	MayBeSuppressedBy		
Symmetric	False		
IsAbstract	False		
References	**NodeClass**	**BrowseName**	**Comment**
ConformanceUnits			
A & C Statemachine Suppression Trigger			

7.5 HasEffectUnsuppressed

The *HasEffectUnsuppressed ReferenceType* is a concrete *ReferenceType* and can be used directly. It is a subtype of *HasEffect*.

The semantic of this *ReferenceType* is to point form a *Transition* to an *Alarm* that will no longer be suppressed.

- If the *Reference* is to an *Object* then all *Alarms* in the *HasNotifier* hierarchy below that *Object* are removed from being suppressed,
- If the target is an *AlarmType* then all instance of that AlarmType are no longer suppressed below the *Object* containing the *StateMachine*,
- if the target is an *Alarm* instance then the given *Alarm* instance is no longer suppressed. No errors are logged if the *Alarm* was not suppressed.

The *SourceNode* of this *ReferenceType* shall be an *Object* of the *ObjectType TransitionType* or one of its subtypes. The *TargetNode* can be of any *NodeClass*.

The representation of the *HasEffectUnsuppressed ReferenceType* in the *AddressSpace* is specified in Table 141.

Table 141 – HasEffectUnsuppressed ReferenceType

Attributes	**Value**		
BrowseName	HasEffectUnsuppressed		
InverseName	MayBeUnsuppressedBy		
Symmetric	False		
IsAbstract	False		
References	**NodeClass**	**BrowseName**	**Comment**
ConformanceUnits			
A & C Statemachine Suppression Trigger			

8 Alarm Summary and Objects

8.1 Overview

In a system an *Object* might have multiple *Alarms* associated with it. These *Alarms* might be directly *Referenced* by an *Object* or they might have no direct *References* from the *Object* to the *Alarm*. Alarms might also be related to *Objects* that are nested under the *Object*. When the *Object* is represented in a graphic in a plant, it is often important to be able to see if there is an active *Alarm* associated with it. This indication could just be a flashing value or flashing image or a change in color of the image.

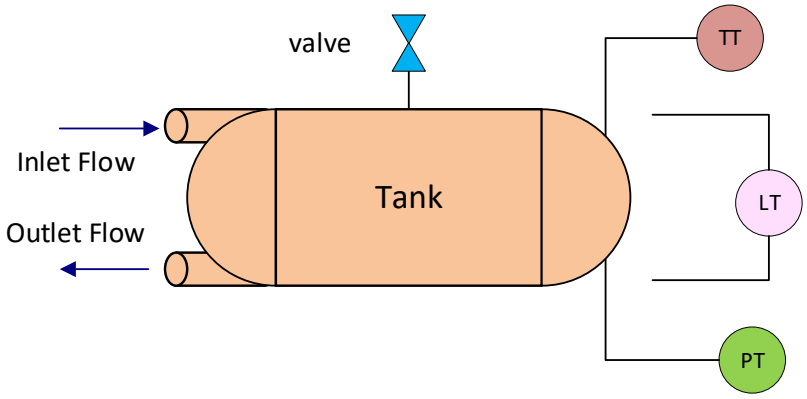


Figure 30 - AlarmSummary equipment example

For example if there is a tank (illustrated in Figure 30). The tank might have a level meter, a temperature gauge and a pressure gauge. It might also have a flow meter on both an inlet and an outlet. The tank might also have a pressure release valve. The information model that might result from this equipment is illustrated in Figure 31

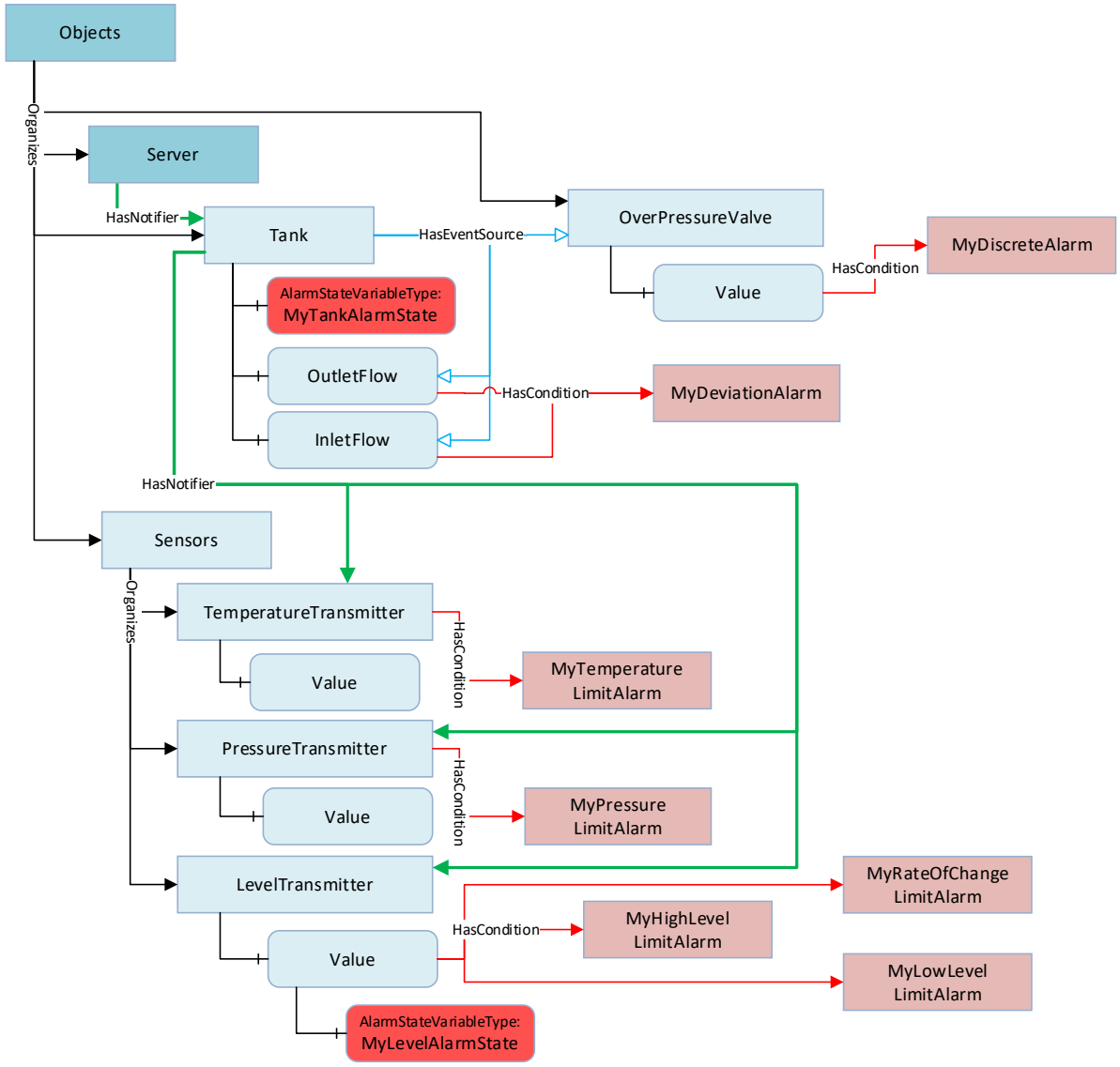


Figure 31 - AlarmSummary Equipment Object Example

All of these sub-objects might have unique alarms associated with them, such as limit alarms on the temperature and levels, maybe rate of change alarm as well as limit alarms on the pressure. Maybe some advanced Alarms that are associated with the tank for an invalid state (in the inlet flow > 0 and the outlet flow is > 0). Maybe a discrete alarm on the pressure release valve, i.e. when it is open it is an alarm. The overall alarm state of the Tank might need to be displayed on a graphic or maybe the LevelTransmitter's value needs to indicate that there is an alarm associated with the value.

8.2 AlarmState Variable

An instance of *AlarmStateVariableType* can be assigned to any *Object* or *Variable*. The instance will provide a summary of the *Alarms* associated with the parent *Variable* or *Object* (the *Source* of the *HasComponent Reference* for this instance)

Table 142 – AlarmStateVariableType definition

Attribute	Value				
BrowseName	AlarmStateVariableType				
DataType	AlarmMask				
ValueRank	-1 (-1 = Scalar)				
IsAbstract	False				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**Modelling Rule**
Subtype of the *BaseDataVariableType* defined in 10000-5.					
HasProperty	Variable	HighestActiveSeverity	UInt16	PropertyType	Mandatory
HasProperty	Variable	HighestUnackSeverity	UInt16	PropertyType	Mandatory
HasProperty	Variable	ActiveCount	UInt32	PropertyType	Mandatory
HasProperty	Variable	UnacknowledgedCount	UInt32	PropertyType	Mandatory
HasProperty	Variable	UnconfirmedCount	UInt32	PropertyType	Mandatory
HasProperty	Variable	Filter	ContentFilter	PropertyType	Mandatory
ConformanceUnits					
A & C Summary					

HighestActiveSeverity – the highest *Severity* of any active *Alarm*.

HighestUnackSeverity – the highest *Severity* of any *Unacknowledged Alarm*

ActiveCount – a count of the number of active *Alarms*

UnacknowledgedCount – a count of the number of *Unacknowledged Alarms*

UnconfirmedCount – a count of the number of *Unconfirmed Alarms.* If alarm confirmation is not supported this count shall be zero.

Filter – provides a *ContentFilter* that can be used to restrict what alarms are processed as part of the *AlarmStateVariableType*. If no filter is required the *ContentFilter* can be null.

8.3 AlarmMask

This *OptionSet* defines flags indicating the summary of alarm states.

The *AlarmMask* values are formally defined in Table 143.

Table 143 – AlarmMask values

Value	Bit No.	Description
Active	0	This bit is set if there are active *Alarms*
Unacknowledged	1	This bit is set if there are *Unacknowledged Alarms*
Unconfirmed	2	This bit is set if there are *Unconfirmed Alarms*

The *AlarmMask* representation in the *AddressSpace* is formally defined in Table 144.

Table 144 – AlarmMask definition

Attribute	Value				
BrowseName	AlarmMask				
IsAbstract	False				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**Other**
Subtype of the UInt16 type defined in 10000-5					
0:HasProperty	Variable	0:OptionSetValues	0:LocalizedText[]	0:PropertyType	
ConformanceUnits					
A & C Summary					

9 Alarm Metrics

9.1 Overview

The goal of a well-designed alarm system is to ensure that an *Operator* is made aware of issues, both critical and non-critical, but is not overwhelmed by alarms/alerts or other messages. When

designing an alarm system, criteria are defined for alarm rates and general performance of the system at various levels (*Operator* station, plant area, overall system etc.). Evaluating the performance of an alarm system with regard to these design criteria requires the collection of alarm metrics. These metrics provide summaries of alarm rates and other alarm related information.

This section defines a standard structure for metrics. This structure can be implemented at multiple levels allowing a *Server* to collect metrics as needed. For example, an *Object* of this type might be added to the *Server Object* providing a summary of the *Alarm* performance for the entire *Server*. An instance might also be provided on an *Object* that includes a *HasNotifier* hierarchy, such as a tank *Object*. In this case, it would provide the summary of all of the *Alarms* that are part of the tank *HasNotifier* hierarchy.

9.2 AlarmMetricsType

This Object*Type* is used for metric information. The *ObjectType* is formally defined in Table 145.

Table 145 – AlarmMetricsType Definition

Attribute		**Value**			
BrowseName		AlarmMetricsType			
IsAbstract		False			
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**Modelling Rule**
Subtype of the BaseObjectType defined in 10000-5.					
HasComponent	Variable	AlarmCount	UInt32	BaseDataVariableType	Mandatory
HasComponent	Variable	StartTime	UtcTime	BaseDataVariableType	Mandatory
HasComponent	Variable	MaximumActiveState	Duration	BaseDataVariableType	Mandatory
HasComponent	Variable	MaximumUnAck	Duration	BaseDataVariableType	Mandatory
HasComponent	Variable	CurrentAlarmRate	Double	AlarmRateVariableType	Mandatory
HasComponent	Variable	MaximumAlarmRate	Double	AlarmRateVariableType	Mandatory
HasComponent	Variable	MaximumReAlarmCount	UInt32	BaseDataVariableType	Mandatory
HasComponent	Variable	AverageAlarmRate	Double	AlarmRateVariableType	Mandatory
HasComponent	Method	Reset			Mandatory
ConformanceUnits					
A & C Alarm Metrics					

An instance of *AlarmMetricsType* can be added, with a *HasComponent* reference, to any *Object* that has its “SubscribeToEvents” bit set within the *EventNotifier Attribute.* It will collect the *Alarm* metrics for all *Alarm* sources assigned to this notifier *Object*. For example, if *Alarm* metrics are desired for Tank A *Object* (see Figure B.5) that is in the *HasNotifier* hierarchy than an instance of this object would be referenced by the Tank A object. When this object is associated with the *Server Object* it will report *Alarm* metrics for the entire *Server*.

AlarmCount is the total count of *Alarm*s since the last restart of the system or reset of this counter.

StartTime is the time at which the *Server* started or the time of the last *Reset* Method invocation, whichever is later.

MaximumActiveState is the maximum time for which an *Alarm* was in the active state.

MaximumUnAck is the maximum time for which an *Alarm* was in the unacknowledged state.

CurrentAlarmRate is the sum of *Alarms* that occurred in the last *Rate* number of minutes (see 9.3). This sum should not include nuisance Alarms (i.e. chattering alarms). It is updated every *Rate* number of minutes.

MaximumAlarmRate is the maximum *Alarm* rate detected since the start of the *Server*, where the rate is calculated as for *CurrentAlarmRate*.

MaximumReAlarmCount is the maximum *ReAlarmCount* for any *Alarm*.

AverageAlarmRate is the average *Alarm* rate since the start of the *Server* or the last invocation of *Reset Method*, where the rate is calculated as for *CurrentAlarmRate*.

Reset is a *Method* that will reset all of the counters, rates or times in this *Object*

9.3 AlarmRateVariableType

This variable type provides a unit field for the rate for which the *Alarm* diagnostic applies.

Table 146 – AlarmRateVariableType Definition

Attribute	**Value**				
BrowseName	AlarmRateVariableType				
IsAbstract	False				
ValueRank	Scalar				
DataType	Double				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**ModellingRule**
HasProperty	Variable	Rate	UInt16	PropertyType	Mandatory
ConformanceUnits					
A & C Alarm Metrics					

Rate – is the number of minutes over which the item is calculated.

9.4 Reset Method

The *Reset Method* is used reset all of the counters, rates and time in the *Object*

Signature

```
Reset();
```

Method Result Codes in **Table 53** (defined in Call Service)

Table 147 – Suppress result codes

Result Code	**Description**
Bad_MethodInvalid	The *MethodId* provided does not correspond to the *ObjectId* provided. See 10000-4 for the general description of this result code.
Bad_NodeIdInvalid	Used to indicate that the specified *ObjectId* is not valid. See 10000-4 for the general description of this result code.

Comments

The Reset Method will clear all setting in the diagnostic object and initialize them to zero.

Table 148 specifies the *AddressSpace* representation for the *Reset Method*.

Table 148 – Reset Method AddressSpace Definition

Attribute	**Value**				
BrowseName	Reset				
References	**NodeClass**	**BrowseName**	**DataType**	**TypeDefinition**	**Modelling Rule**
AlwaysGeneratesEvent	ObjectType	AuditUpdateMethodEventType	Defined in 10000-5		
ConformanceUnits					
A & C Alarm Metrics					

If *Auditing* is supported, this *Method* shall generate an *Event* of *AuditConditionMethodEventType* for all invocations of the *Method*.

Annex A (informative)

Recommended localized names

A.1 Recommended state names for TwoState Variables

A.1.1 LocaleId “en”

The recommended state display values for the LocaleId “en” are listed in Table A.1 and the recommended *DisplayNames* are listed in Table A.2

Table A.1 – Recommended state names for LocaleId “en”

ConditionType	State Variable	False State Name	True State Name
ConditionType	EnabledState	Disabled	Enabled
DialogConditionType	DialogState	Inactive	Active
AcknowledgeableConditionType	AckedState	Unacknowledged	Acknowledged
	ConfirmedState	Unconfirmed	Confirmed
AlarmConditionType	ActiveState	Inactive	Active
	SuppressedState	Unsuppressed	Suppressed
	OutOfServiceState	In Service	Out of Service
	SilenceState	Not Silenced	Silenced
	LatchedState	Unlatched	Latched
NonExclusiveLimitAlarmType	HighHighState	HighHigh inactive	HighHigh active
	HighState	High inactive	High active
	LowState	Low inactive	Low active
	LowLowState	LowLow inactive	LowLow active

Table A.2 – Recommended DisplayNames for LocaleId “en”

ConditionType	BrowseName	DisplayName
Shelved	Unshelved	Unshelved
	TimedShelved	TimedShelved
	OneShotShelved	OneShotShelved
Exclusive	HighHigh	HighHigh
	High	High
	Low	Low
	LowLow	LowLow

A.1.2 LocaleId “de”

The recommended state display values for the LocaleId “de” are listed in Table A.3 and the recommended *DisplayNames* are listed in Table A.4.

Table A.3 – Recommended state names for LocaleId "de"

ConditionType	State Variable	False State Name	True State Name
ConditionType	EnabledState	Ausgeschaltet	Eingeschaltet
DialogConditionType	DialogState	Inaktiv	Aktiv
AcknowledgeableConditionType	AckedState	Unquittiert	Quittiert
	ConfirmedState	Unbestätigt	Bestätigt
AlarmConditionType	ActiveState	Inaktiv	Aktiv
	SuppressedState	Nicht unterdrückt	Unterdrückt
	OutOfServiceState	InBetrieb	AußerBetrieb
	SilenceState	Nicht Stumm	Stumm
	LatchedState	Entriegelt	Verriegelt
NonExclusiveLimitAlarmType	HighHighState	HighHigh inaktiv	HighHigh aktiv
	HighState	High inaktiv	High aktiv
	LowState	Low inaktiv	Low aktiv
	LowLowState	LowLow inaktiv	LowLow aktiv

Table A.4 – Recommended DisplayNames for LocaleId "de"

ConditionType	BrowseName	DisplayName
Shelved	Unshelved	NichtZurückgestellt
	TimedShelved	BefristetZurückgestellt
	OneShotShelved	EinmaligZurückgestellt
Exclusive	HighHigh	HighHigh
	High	High
	Low	Low
	LowLow	LowLow

A.1.3 LocaleId "fr"

The recommended state display values for the LocaleId "fr" are listed in Table A.5 and the recommended *DisaplayNames* are listed inTable A.6.

Table A.5 – Recommended state names for LocaleId "fr"

ConditionType	State Variable	False State Name	True State Name
ConditionType	EnabledState	Hors Service	En Service
DialogConditionType	DialogState	Inactive	Active
AcknowledgeableConditionType	AckedState	Non-acquitté	Acquitté
	ConfirmedState	Non-Confirmé	Confirmé
AlarmConditionType	ActiveState	Inactive	Active
	SuppressedState	Présent	Supprimé
	OutOfServiceState	En Fonction	Hors Fonction
	SilenceState	Non-Muette	Muette
	LatchedState	Déverrouillé	Verrouillé
NonExclusiveLimitAlarmType	HighHighState	Très Haute inactive	Très Haute active
	HighState	Haute inactive	Haute active
	LowState	Basse inactive	Basse active
	LowLowState	Très basse inactive	Très basse active

Table A.6 – Recommended DisplayNames for LocaleId "fr"

ConditionType	BrowseName	DisplayName
Shelved	Unshelved	Surveillée
	TimedShelved	MiseDeCotéTemporelle
	OneShotShelved	MiseDeCotéUnique
Exclusive	HighHigh	TrèsHaute
	High	Haute
	Low	Basse
	LowLow	TrèsBasse

A.2 Recommended dialog response options

The recommended *Dialog* response option names in different locales are listed in Table A.7.

Table A.7 – Recommended dialog response options

Locale “en”	Locale “de”	Locale “fr”
Ok	OK	Ok
Cancel	Abbrechen	Annuler
Yes	Ja	Oui
No	Nein	Non
Abort	Abbrechen	Abandonner
Retry	Wiederholen	Réessayer
Ignore	Ignorieren	Ignorer
Next	Nächster	Prochain
Previous	Vorheriger	Precedent

Annex B (informative)

Examples

B.1 Examples for Event sequences from Condition instances

B.1.1 Overview

The following examples show the *Event* flow for typical *Alarm* situations. The tables list the value of state *Variables* for each *Event Notification*.

B.1.2 Server maintains current state only

This example is for *Servers* that do not support previous states and therefore do not create and maintain *Branches* of a single *Condition*.

Figure B.1 shows an *Alarm* as it becomes active and then inactive and also the acknowledgement and confirmation cycles. Table B.1 lists the values of the state *Variables*. All *Events* are coming from the same *Condition* instance and therefore have the same *ConditionId*.

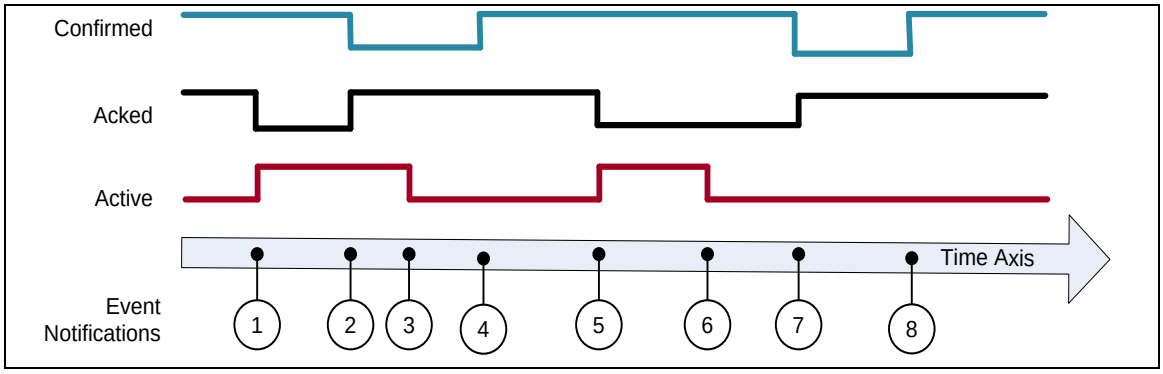


Figure B.1 – Single state example

Table B.1 – Example of a Condition that only keeps the latest state

EventId	BranchId	Active	Acked	Confirmed	Retain	Description
-*)	NULL	False	True	True	False	Initial state of *Condition*.
1	NULL	True	False	True	True	*Alarm* goes active.
2	NULL	True	True	False	True	*Condition* acknowledged Confirm required
3	NULL	False	True	False	True	*Alarm* goes inactive.
4	NULL	False	True	True	False	*Condition* confirmed
5	NULL	True	False	True	True	*Alarm* goes active.
6	NULL	False	False	True	True	*Alarm* goes inactive.
7	NULL	False	True	False	True	*Condition* acknowledged, Confirm required.
8	NULL	False	True	True	False	*Condition* confirmed.
*) The first row is included to illustrate the initial state of the *Condition*. This state will not be reported by an *Event*.						

B.1.3 Server maintains previous states

This example is for *Servers* that are able to maintain previous states of a *Condition* and therefore create and maintain *Branches* of a single *Condition*.

Figure B.2 illustrates the use of branches by a *Server* requiring acknowledgement of all transitions into *Active* state, not just the most recent transition. In this example no acknowledgement is required on a transition into an inactive state. Table B.2 lists the values of the state *Variables*. All *Events* are coming from the same *Condition* instance and have therefore the same *ConditionId*.

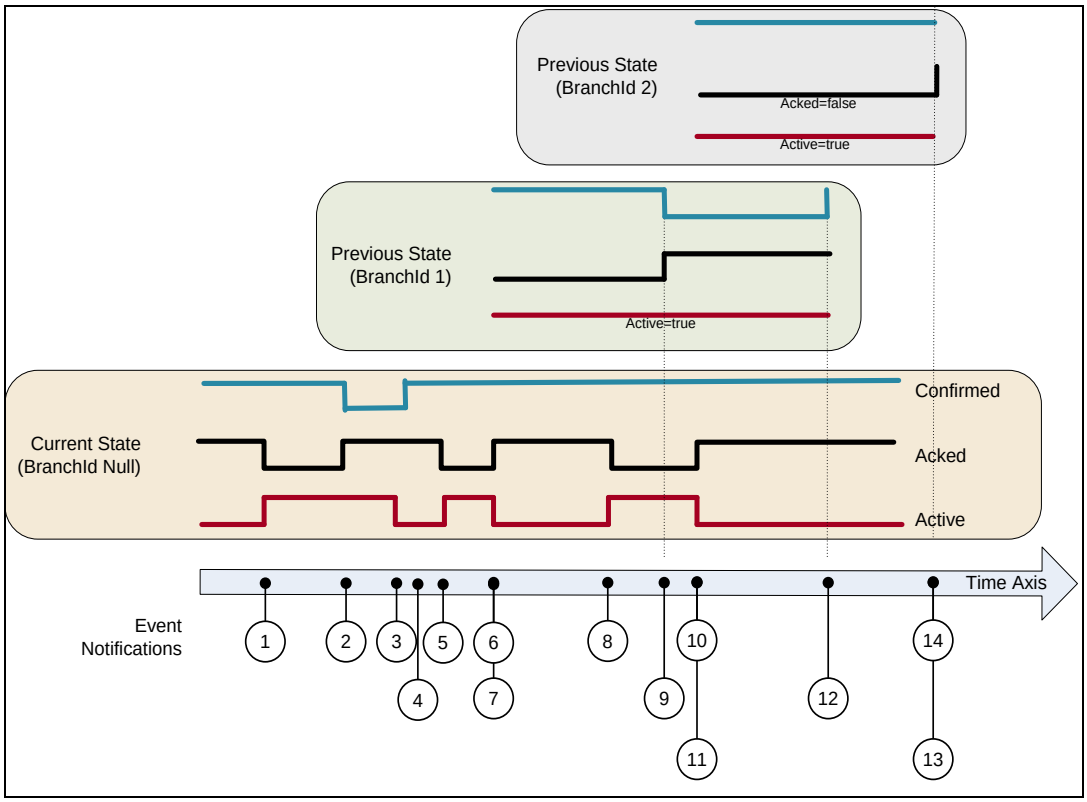


Figure B.2 – Previous state example

Table B.2 – Example of a *Condition* that maintains previous states via branches

EventId	BranchId	Active	Acked	Confirmed	Retain	Description
a)	NULL	False	True	True	False	Initial state of *Condition*.
1	NULL	True	False	True	True	Alarm goes active.
2	NULL	True	True	True	True	Condition acknowledged requires Confirm
3	NULL	False	True	False	True	*Alarm* goes inactive.
4	NULL	False	True	True	False	Confirmed
5	NULL	True	False	True	True	*Alarm* goes active.
6	NULL	False	True	True	True	*Alarm* goes inactive.
7	1	True	False	True	True b)	Prior state needs acknowledgment. Branch #1 created.
8	NULL	True	False	True	True	*Alarm* goes active again.
9	1	True	True	False	True	Prior state acknowledged, Confirm required.
10	NULL	False	True	True	True b)	*Alarm* goes inactive again.
11	2	True	False	True	True	Prior state needs acknowledgment. Branch #2 created.
12	1	True	True	True	False	Prior state confirmed. Branch #1 deleted.
13	2	True	True	True	False	Prior state acknowledged, Auto Confirmed by system Branch #2 deleted. c)
14	NULL	False	True	True	False	No longer of interest.

a) *The first row* is included to illustrate the initial state of the *Condition*. This state will not be reported by an *Event*.

Notes on specific situations shown with this example:

If the current state of the *Condition* is acknowledged then the *Acked* flag is set and the new state is reported (*Event* #2). If the *Condition* state changes before it can be acknowledged (*Event* #6) then a branch state is reported (*Event* #7). Timestamps for the *Event*s #6 and #7 is identical.

The branch state can be updated several times (*Event*s #9) before it is cleared (*Event* #12).

A single *Condition* can have many branch states active (*Event*s #11)

b) *It is recommended* as in this table to leave Retain=True as long as there exist previous states (branches).

c) The system Auto confirms this event, since a confirmation is that the operator has taken some action. The confirmation of the previous state (line 12) indicates that the operator has taken an action and this transition does not require a separate confirmation.

B.1.4 Server current-State Model with Suppression

This example adds additional fields to the model illustrated in B.1.2. This example does not use acknowledge or confirm – it assumes that the alarm is automatically acknowledged (and does not support confirm). It does add *OutOfServiceState* and *SuppressedState.*

Figure B.3 shows an *Alarm* as it becomes active, is suppressed or is placed out of service and then inactive. Table B.3 lists the values of the state *Variables*. All *Events* are coming from the same *Condition* instance and therefore have the same *ConditionId*. The *Client* subscription includes an event filter that excludes suppressed or out of service conditions (i.e. *SuppressedState* = True or *OutOfServiceState* = True). The events shown in green are delivered to the *Client*. The Retain column indicates the global value of the *Retain* flag. The "Retain sent" column indicates the overridden value sent in a notification if *SupportsFilteredRetain* is True. If *SupportsFilteredRetain* is False the value from the Retain column is sent.

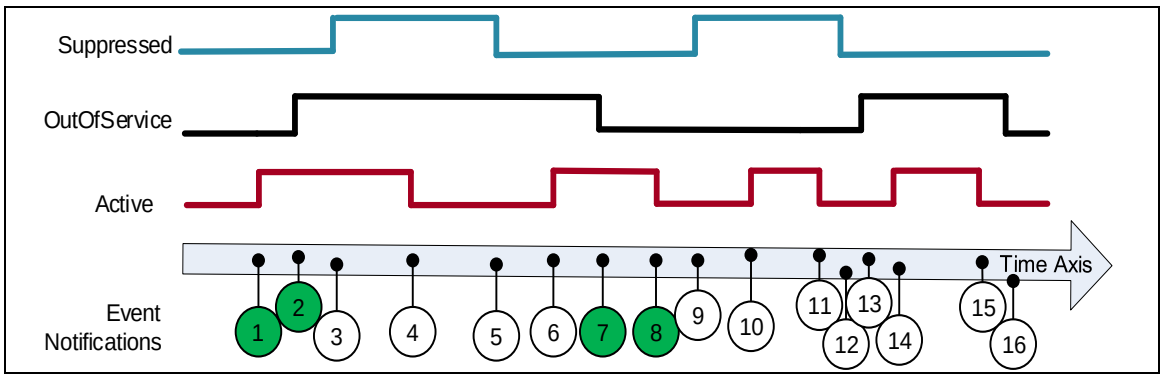


Figure B.3 – SuppressedState and OutOfServiceState example

Table B.3 – Example of a Condition that is Suppressed / OutOfService

EventId	Active	Suppressed State	OutOf Service State	Retain	Retain sent	Event Deliver with Filter	Description
-*)	False	False	False	False	False	-	Initial state of Condition.
1	True	False	False	True	True	Yes	Alarm goes active.
2	True	False	True	True	False	Yes	Placed OutOfService
3	True	True	True	True	False	No	Alarm Suppressed; No event since OutOfService
4	False	True	True	False	False	No	Alarm goes inactive; No event since OutOfService
5	False	False	True	False	False	No	Alarm not Suppressed; No event since not active
6	True	False	True	True	False	No	Alarm goes active; No event since OutOfService
7	True	False	False	True	True	Yes	Alarm no longer OutOfService; Event generated
8	False	False	False	False	False	Yes	Alarm goes inactive
9	False	True	False	False	False	No	Alarm Suppressed; No event since not active
10	True	True	False	True	False	No	Alarm goes active; No event since Suppressed
11	False	True	False	False	False	No	Alarm goes inactive; No event since Suppressed
12	False	False	False	False	False	No	Alarm no longer Suppressed
13	False	False	True	False	False	No	Placed OutOfService
14	True	False	True	True	False	No	Alarm goes active; No event since OutOfService
15	False	False	True	False	False	No	Alarm goes inactive; No event since OutOfService
16	False	False	False	False	False	No	Alarm no longer OutOfService

This behaviour occurs when the implementation supports SupportsFilteredRetain flag subscription.

B.1.5 Example for On-Delay, Off Delay and ReAlarmTime

This example illustrates how on-delay, off-delay and alarm dead bands can be used to reduce the number of alarms that are generated / reported (see 5.8). It also illustrates how *ReAlarmTime* is used to bring an alarm back up to an active state (see Figure B.4).

Some process values may have sudden jumps that are very brief and do not constitute an alarm. For example, a motor on start draws a large current, but quickly come back down. This is a normal motor current load, and should not be alarmed, but a sustained current load is a problem and should be alarmed, by configuring a *OnDelay* time, the momentary spike will not generate an alarm, since the value has to be above the alarm threshold for the duration of *OnDelay*.

An *AlarmDeadband* is used to keep a noise signal from generating multiple Alarm activations a signal once it crosses an alarm limit will not return to norm unless it drops below the limit by the amount of the deadband specified. In the example the process value is jumping up and down around the limit, but the alarm just remains in the same active or acknowledged state. The Alarm can have a deadband for each limit (High vs HighHigh) and these deadbands can be different.

The *OffDelay* can also be used, much as the *OnDelay*, except it will keep a Value in alarm even if it drops below a limit, but only very briefly. Again, this setting is used to limit the number of alarms that occur in a system.

The *ReAlarmTime* is used to ensure that actions are taken to correct the issue that generated an alarm. Some alarms are configured to generate a new alarm if they have been in an active state for the *ReAlarmTime* period. The Alarm, goes back to an Unacknowledged state, as if it had just occurred.

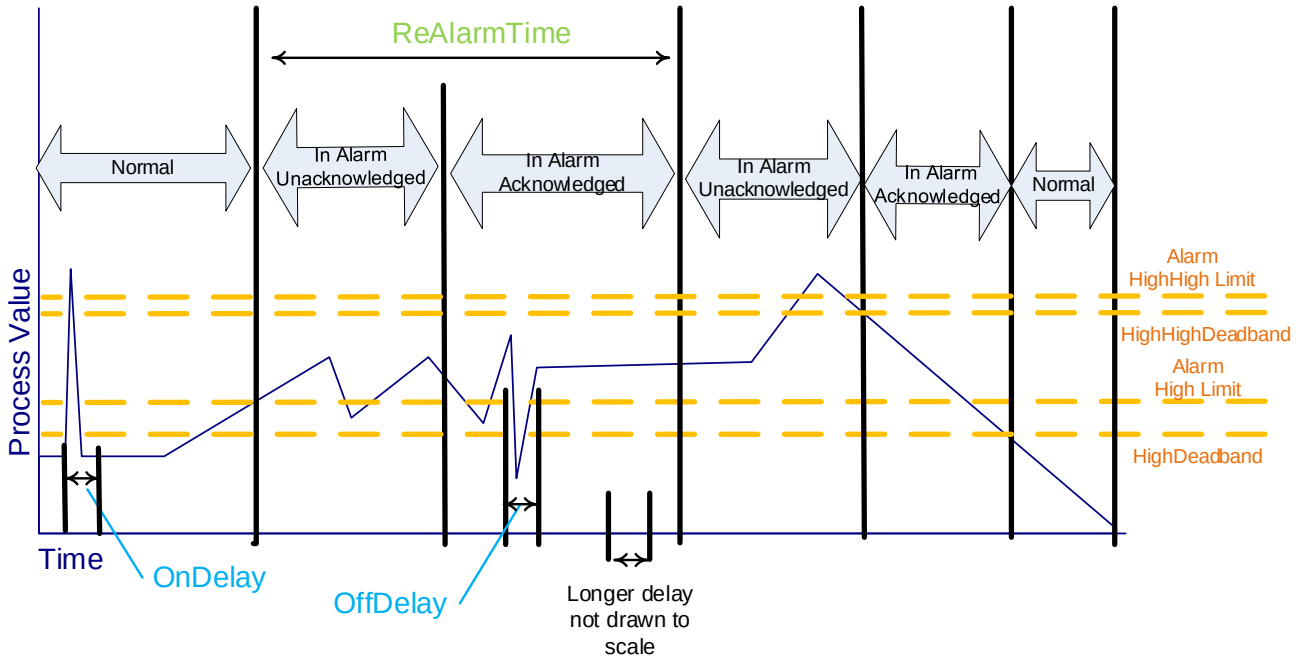


Figure B.4 - Alarm example - On Delay, Off Delay, ReAlarmTime

B.2 AddressSpace examples

This Clause provides additional examples for the use of *HasNotifier*, *HasEventSource* and *HasCondition References* to expose the organization of areas and sources with their associated *Conditions*. This hierarchy is additional to a hierarchy provided with *Organizes* and *Aggregates References*.

Figure B.5 illustrates the use of the *HasCondition Reference* with *Condition* instances.

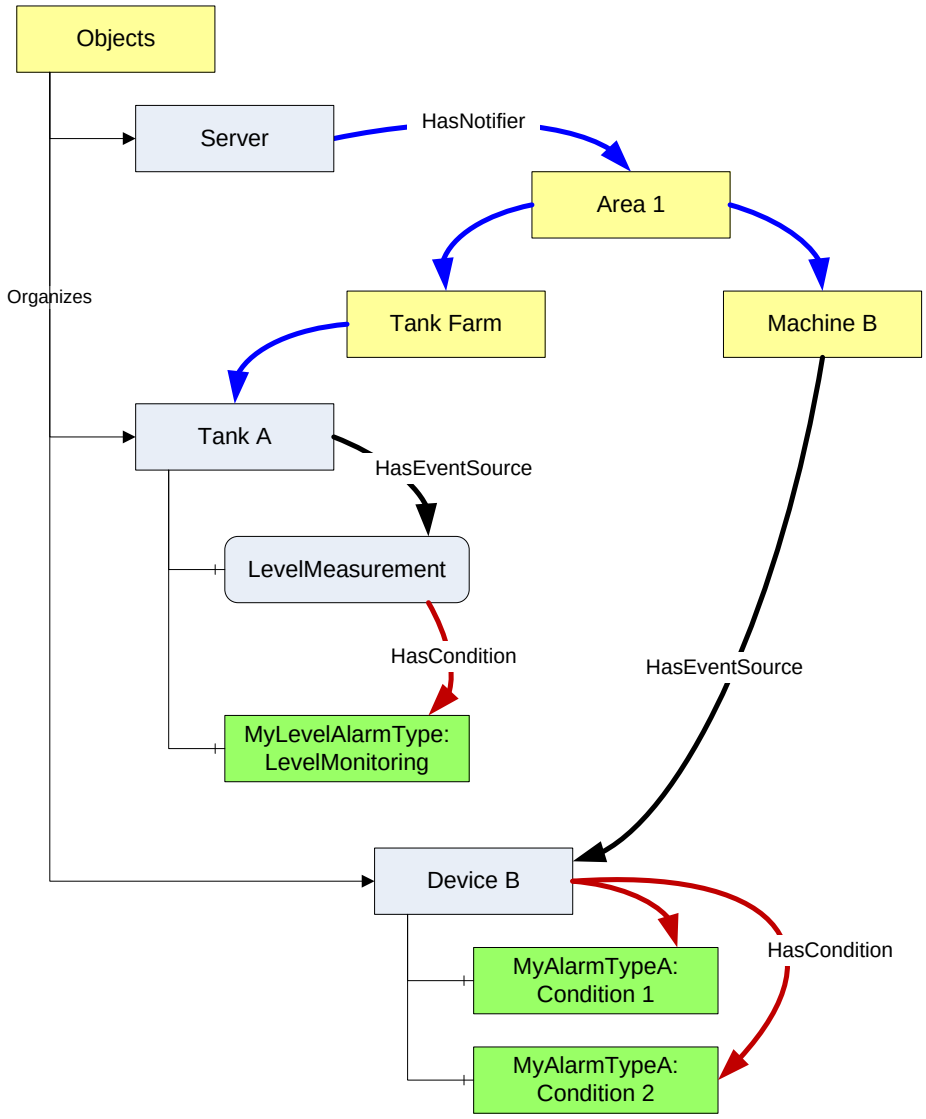


Figure B.5 – HasCondition used with Condition instances

In systems where *Conditions* are not available as instances, the *ConditionSource* can reference the *ConditionTypes* instead. This is illustrated with the example in Figure B.6.

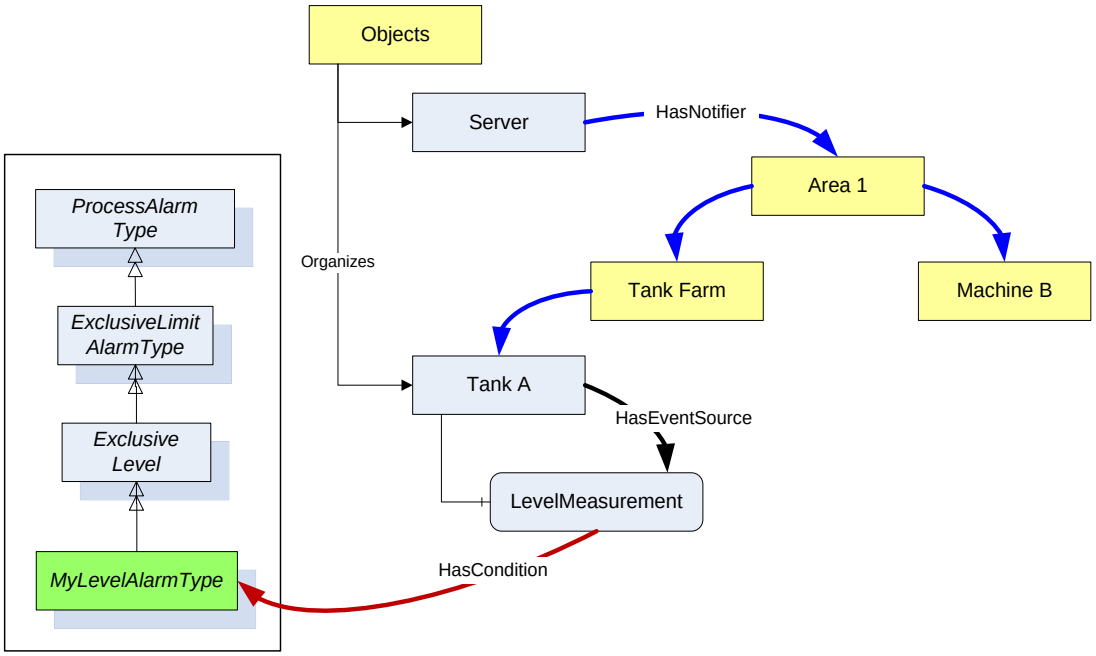


Figure B.6 – HasCondition reference to a Condition type

Figure B.7 provides an example where the *HasCondition Reference* is already defined in the *Type* system. The *Reference* can point to a *Condition Type* or to an instance. Both variants are shown in this example. A *Reference* to a *Condition Type* in the *Type* system will result in a *Reference* to the same *Type Node* in the instance.

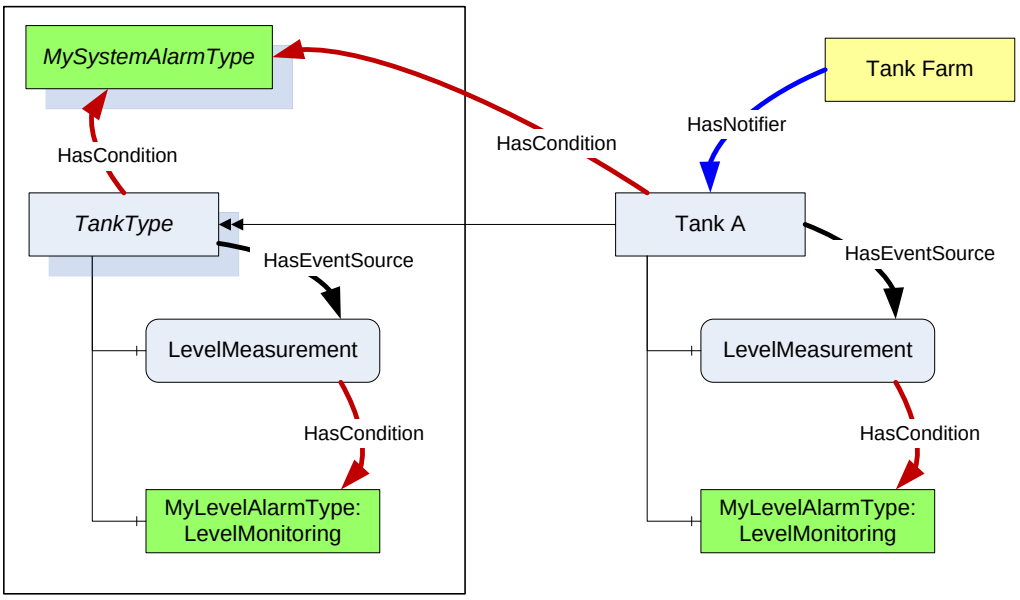


Figure B.7 – HasCondition used with an instance declaration

Annex C
(informative)

Mapping to EEMUA

Table C.1 lists EEMUA terms and how OPC UA terms map to them.

Table C.1 – EEMUA Terms

EEMUA Term	OPC UA Term	EEMUA Definition
Accepted	Acknowledged = True	An *Alarm* is accepted when the *Operator* has indicated awareness of its presence. In OPC UA this can be accomplished with the *Acknowledge Method*.
Active Alarm	Active = True	An *Alarm Condition* which is on (i.e. limit has been exceeded and *Condition* continues to exist).
Alarm Message	Message Property (defined in 10000-5.)	Test information presented to the *Operator* that describes the *Alarm Condition*.
Alarm Priority	Severity Property (defined in 10000-5.)	The ranking of *Alarms* by severity and response time.
Alert	-	A lower priority *Notification* than an *Alarm* that has no serious consequence if ignored or missed. In some Industries also referred to as a Prompt or Warning". No direct mapping! In UA the concept of *Alerts* can be accomplished by the use of severity. E.g., *Alarms* that have a severity below 50 may be considered as *Alerts*.
Cleared	Active = False	An *Alarm* state that indicates the *Condition* has returned to normal.
Disable	Enabled = False	An *Alarm* is disabled when the system is configured such that the *Alarm* will not be generated even though the base *Alarm Condition* is present.
Prompt	Dialog	A request from the control system that the *Operator* perform some process action that the system cannot perform or that requires *Operator* authority to perform.
Raised	Active = True	An *Alarm* is *Raised* or initiated when the *Condition* creating the *Alarm* has occurred.
Release	OneShotShelving	A 'release' is a facility that can be applied to a standing (UA = active) *Alarm* in a similar way to which *Shelving* is applied. A released *Alarm* is temporarily removed from the *Alarm* list and put on the shelf. There is no indication to the *Operator* when the *Alarm* clears, but it is taken off the shelf. Hence, when the *Alarm* is raised again it appears on the *Alarm* list in the normal way.
Reset	Retain = False	An *Alarm* is Reset when it is in a state that can be removed from the Display list. OPC UA includes *Retain* flag which as part of its definition states: "when a *Client* receives an *Event* with the *Retain* flag set to False, the *Client* should consider this as a *Condition*/Branch that is no longer of interest, in the case of a "current *Alarm* display" the *Condition*/Branch would be removed from the display"
Shelving	Shelving	*Shelving* is a facility where the *Operator* is able to temporarily prevent an *Alarm* from being displayed to the *Operator* when it is causing the *Operator* a nuisance. A Shelved *Alarm* will be removed from the list and will not re-annunciate until un-shelved.
Standing	Active = True	An *Alarm* is *Standing* whilst the *Condition* persists (*Raised* and *Standing* are often used interchangeably).
Suppress	Suppress	An *Alarm* is suppressed when logical criteria are applied to determine that the *Alarm* should not occur, even though the base *Alarm Condition* (e.g. *Alarm* setting exceeded) is present.
Unaccepted	Acknowledged = False	An *Alarm* is accepted when the *Operator* has indicated awareness of its presence. It is unaccepted until this has been done.

Annex D(informative)

Mapping from OPC A&E to OPC UA A & C

D.1 Overview

Serving as a bridge between COM and OPC UA components, the Alarms and *Event*s proxy and wrapper enable existing A&E COM *Clients* and *Servers* to connect to UA *Alarms* and *Conditions* components.

Simply stated, there are two aspects to the migration strategy. The first aspect enables a UA *Alarms* and *Conditions Client* to connect to an existing Alarms and *Event*s COM *Server* via a UA *Server* wrapper. This wrapper is notated from this point forward as the A&E COM UA Wrapper. The second aspect enables an existing Alarms and *Event*s COM *Client* to connect to a UA *Alarms* and *Conditions Server* via a COM proxy. This proxy is notated from this point forward as the A&E COM UA Proxy.

An Alarms and *Event*s COM *Client* is notated from this point forward as A&E COM *Client*.

A UA *Alarms* and *Conditions Server* is notated from this point forward as UA A & C *Server*.

The mappings describe generic A&E COM interoperability components. It is recommended that vendors use this mapping if they develop their own components, however, some applications may benefit from vendor specific mappings.

D.2 Alarms and Events COM UA wrapper

D.2.1 Event areas

Event Areas in the A&E COM *Server* are represented in the A&E COM UA Wrapper as *Objects* with a *TypeDefinition* of *BaseObjectType*. The EventNotifier *Attribute* for these *Objects* always has the SubscribeToEvents flag set to True.

The root Area is represented by an *Object* with a *BrowseName* that depends on the UA *Server*. It is always the target of a HasNotifier *Reference* from the *Server Node*. The root Area allows multiple A&E COM *Server*s to be wrapped within a single UA *Server*.

The Area hierarchy is discovered with the BrowseOPCAreas and the GetQualifiedAreaName *Method*s. The Area name returned by BrowseOPCAreas is used as the *BrowseName* and *DisplayName* for each Area *Node*. The QualifiedAreaName is used to construct the *NodeId*. The NamespaceURI qualifying the *NodeId* and *BrowseName* is a unique URI assigned to the combination of machine and COM *Server*.

Each Area is the target of *HasNotifier Reference* from its parent Area. It may be the source of one or more HasNotifier *Reference*s to its child Areas. It may also be a source of a *HasEventSource Reference* to any sources in the Area.

The A&E COM *Server* may not support filtering by Areas. If this is the case then no Area *Node*s are shown in the UA *Server* address space. Some implementations could use the AREAS *Attribute* to provide filtering by Areas within the A&E COM UA Wrapper.

D.2.2 Event sources

Event Sources in the A&E COM *Server* are represented in the A&E COM UA Wrapper as *Objects* with a *TypeDefinition* of *BaseObjectType*. If the A&E COM *Server* supports source filtering then the SubscribeToEvents flag is True and the Source is a target of a HasNotifier *Reference*. If source filtering is not supported the SubscribeToEvents flag is False and the Source is a target of a HasEventSource *Reference*.

The Sources are discovered by calling BrowseOPCAreas and the GetQualifiedSourceName *Method*s. The Source name returned by BrowseOPCAreas is used as the BrowseName and DisplayName. The QualifiedSourceName is used to construct the *NodeId*. *Event* Source *Node*s are always targets of a HasEventSource *Reference* from an Area.

D.2.3 Event categories

Event Categories in the A&E COM *Server* are represented in the UA *Server* as *ObjectTypes* which are subtypes of *BaseEventType*. The *BrowseName* and *DisplayName* of the *ObjectType Node* for Simple and Tracking *Event* Types are constructed by appending the text 'EventType' to the Description of the *Event* Category. For *Condition Event* Types the text 'AlarmType' is appended to the *Condition* Name.

These *ObjectType Node*s have a super type which depends on the A&E *Event* Type, the *Event* Category Description and the *Condition* Name; however, the best mapping requires knowledge of the semantics associated with the *Event* Categories and *Condition* Names. If an A&E COM UA Wrapper does not know these semantics then Simple *Event* Types are subtypes of *BaseEventType*, Tracking *Event* Types are subtypes of *AuditEventType* and *Condition Event* Types are subtypes of the *AlarmType*. Table D.1 defines mappings for a set of "well known" Category description and *Condition* Names to a standard super type.

Table D.1 – Mapping from standard Event categories to OPC UA Event types

COM A&E Event Type	Category Description	Condition Name	OPC UA EventType
Simple	---	---	BaseEventType
Simple	Device Failure	---	DeviceFailureEventType
Simple	System Message	---	SystemEventType
Tracking	---	---	AuditEventType
Condition	---	---	AlarmType
Condition	Level	---	LimitAlarmType
Condition	Level	PVLEVEL	ExclusiveLevelAlarmType
Condition	Level	SPLEVEL	ExclusiveLevelAlarmType
Condition	Level	HI HI	NonExclusiveLevelAlarmType
Condition	Level	HI	NonExclusiveLevelAlarmType
Condition	Level	LO	NonExclusiveLevelAlarmType
Condition	Level	LO LO	NonExclusiveLevelAlarmType
Condition	Deviation	---	NonExclusiveDeviationAlarmType
Condition	Discrete	---	DiscreteAlarmType
Condition	Discrete	CFN	OffNormalAlarmType
Condition	Discrete	TRIP	TripAlarmType

There is no generic mapping defined for A&E COM sub-*Conditions*. If an *Event* Category is mapped to a *LimitAlarmType* then the sub *Condition* name in the *Event* are be used to set the state of a suitable State *Variable*. For example, if the sub-*Condition* name is "HI HI" then that means the *HighHigh* state for the *LimitAlarmType* is active

For *Condition Event* Types the *Event* Category is also used to define subtypes of *BaseConditionClassType*.

Figure D.1 illustrates how *ObjectType Nodes* created from the *Event* Categories and *Condition* Names are placed in the standard OPC UA *HasNotifier* hierarchy.

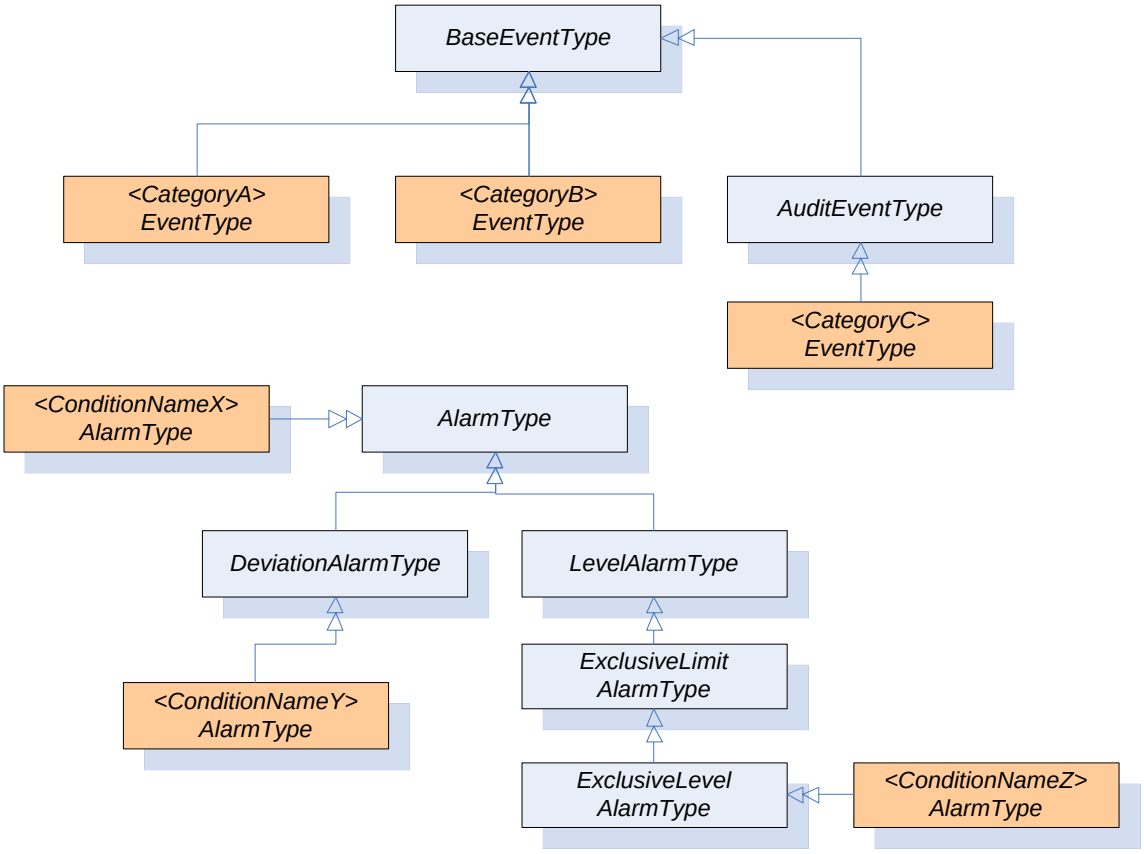


Figure D.1 – The type model of a wrapped COM AE server

D.2.4 Event attributes

*Event Attribute*s in the A&E COM *Server* are represented in the UA *Server* as *Variables* which are targets of *HasProperty References* from the *ObjectTypes* which represent the *Event* Categories. The *BrowseName* and *DisplayName* are the description for the *Event Attribute*. The data type of the *Event Attribute* is used to set *DataType* and *ValueRank*. The *NodeId* is constructed from the EventCategoryId, ConditionName and the AttributeId.

D.2.5 Event subscriptions

The A&E COM UA Wrapper creates a *Subscription* with the COM AE *Server* the first time a *MonitoredItem* is created for the *Server Object* or one of the *Node*s representing Areas. The Area filter is set based on the *Node* being monitored. No other filters are specified.

If all *MonitoredItems* for an Area are disabled then the *Subscription* will be deactivated.

The *Subscription* is deleted when the last *MonitoredItem* for the *Node* is deleted.

When filtering by Area the A&E COM UA Wrapper needs to add two Area filters: one based on the QualifiedAreaName which forms the *NodeId* and one with the text '/*' appended to it. This ensures that *Event*s from sub areas are correctly reported by the COM AE *Server*.

A simple A&E COM UA Wrapper will always request all *Attributes* for all *Event* Categories when creating the *Subscription*. A more sophisticated wrapper may look at the *EventFilter* to determine which *Attributes* are actually used and only request those.

Table D.2 lists how the fields in the ONEVENTSTRUCT that are used by the A&E COM UA Wrapper are mapped to UA BaseEventType *Variable*s.

Table D.2 – Mapping from ONEVENTSTRUCT fields to UA BaseEventType Variables

UA Event Variable	ONEVENTSTRUCT Field	Notes
EventId	szSource szConditionName ftTime ftActiveTime dwCookie	A ByteString constructed by appending the fields together.
EventType	dwEventType dwEventCategory szConditionName	The NodeId for the corresponding *ObjectType Node*. The szConditionName maybe omitted by some implementations.
SourceNode	szSource	The *NodeId* of the corresponding Source *Object Node*.
SourceName	szSource	-
Time	ftTime	-
ReceiveTime	-	Set when the *Notification* is received by the wrapper.
LocalTime	-	Set based on the clock of the machine running the wrapper.
Message	szMessage	Locale is the default locale for the COM AE *Server*.
Severity	dwSeverity	-

Table D.3 lists how the fields in the ONEVENTSTRUCT that are used by the A&E COM UA Wrapper are mapped to UA *AuditEventType Variable*s.

Table D.3 – Mapping from ONEVENTSTRUCT fields to UA AuditEventType Variables

UA Event Variable	ONEVENTSTRUCT Field	Notes
ActionTimeStamp	ftTime	Only set for tracking *Event*s.
Status	-	Always set to True.
ServerId	-	Set to the COM AE *Server* NamespaceURI
ClientAuditEntryId	-	Not set.
ClientUserId	szActorID	-

Table D.4 lists how the fields in the ONEVENTSTRUCT that are used by the A&E COM UA Wrapper are mapped to UA AlarmType Variables.

Table D.4 – Mapping from ONEVENTSTRUCT fields to UA AlarmType Variables

UA Event Variable	ONEVENTSTRUCT Field	Notes
ConditionClassId	dwEventType	Set to the *NodeId* of the *ConditionClassType* for the *Event* Category of a *Condition Event* Type. Set to the *NodeId* of *BaseConditionClassType Node* for non-*Condition Event* Types.
ConditionClassName	dwEventType	Set to the *BrowseName* of the *ConditionClassType* for the *Event* Category of Condition *Event* Type. To set “BaseConditionClass" non-*Condition Event* Types.
ConditionName	szConditionName	-
BranchId	-	Always set to NULL.
Retain	wNewState	Set to True if the OPC_CONDITION_ACKED bit is not set or OPC_CONDITION_ACTIVE bit is set.
EnabledState	wNewState	Set to "Enabled" or "Disabled"
EnabledState.Id	wNewState	Set to True if OPC_CONDITION_ENABLED is set
EnabledState. EffectiveDisplayName	wNewState	A string constructed from the bits in the wNewState flag. The following rules are applied in order to select the string: "Disabled" if OPC_CONDITION_ENABLED is not set. "Unacknowledged" if OPC_CONDITION_ACKED is not set. "Active" if OPC_CONDITION_ACKED is set. "Enabled" if OPC_CONDITION_ENABLED is set.
Quality	wQuality	The COM DA Quality converted to a UA StatusCode.
Severity	dwSeverity	Set based on the last *Event* received for the *Condition* instance. Set to the current value if the last *Event* is not available.
Comment	-	The value of the ACK_COMMENT *Attribute*
ClientUserId	szActorID	-
AckedState	wNewState	Set to "Acknowledged" or "Unacknowledged "
AckedState.Id	wNewState	Set to True if OPC_CONDITION_ACKED is set
ActiveState	wNewState	Set to "Active" or "Inactive"
ActiveState.Id	wNewState	Set to True if OPC_CONDITION_ACTIVE is set
ActiveState.TransitionTime	ftActiveTime	This time is set when the *ActiveState* transitions from False to True. Note: Additional logic applies to exclusive limit alarms, in that the LimitState.TransitionTime also needs to be set, but this is set each time a limit is crossed (multiple limits might exist). For the initial transition to True the ftActiveTime is used for both LimitState.TransitionTime and ActiveState.TransitionTime. For subsequent transition the ActiveState.Transition time does not change, but the LimitState.TransitionTime will be updated with the new ftActiveTime. For example, if an alarm has Hi and HiHi limits, when the Hi limit is crossed and the alarm goes active the ftActiveTime is used for both times, but when the HiHi limit is later crossed, the ftActiveTime is only be used for the LimitState.TransitionTime. Note: The ftActiveTime is part of the key for identifying the unique event in the A&E server and needs to be saved for processing any commands back to the A&E Server.

The A & C *Condition* Model defines other optional *Variable*s which are not needed in the A&E COM UA Wrapper. Any additional fields associated with *Event Attributes* are also reported.

D.2.6 Condition instances

Condition instances do not appear in the UA *Server* address space. *Condition*s can be acknowledged by passing the EventId to the *Acknowledge Method* defined on the *AcknowledgeableConditionType*.

*Condition*s cannot be enabled or disabled via the COM A&E Wrapper.

D.2.7 Condition Refresh

The COM A&E Wrapper does not store the state of *Condition*s. When *ConditionRefresh* is called the *Refresh Method* is called on all COM AE *Subscription*s associated with the *ConditionRefresh* call. The wrapper needs to wait until it receives the call back with the bLastRefresh flag set to True in the OnEvent call before it can tell the UA *Client* that the *Refresh* has completed.

D.3 Alarms and Events COM UA proxy

D.3.1 General

As illustrated in the figure below, the A&E COM UA Proxy is a COM *Server* combined with a UA *Client*. It maps the *Alarms* and *Conditions* address space of UA A & C *Server* into the appropriate COM Alarms and *Event Object*s.

Subclauses D.3.2 through D.3.9 identify the design guidelines and constraints used to develop the A&E COM UA Proxy provided by the OPC Foundation. In order to maintain a high degree of consistency and interoperability, it is strongly recommended that vendors, who choose to implement their own version of the A&E COM UA Proxy, follow these same guidelines and constraints.

The A&E COM *Client* simply needs to address how to connect to the UA A & C *Server*. Connectivity approaches include the one where A&E COM *Client*s connect to a UA A & C *Server* with a CLSID just as if the target *Server* were an A&E COM *Server*. However, the CLSID can be considered virtual since it is defined to connect to intermediary components that ultimately connect to the UA A & C *Server*. Using this approach, the A&E COM *Client* calls co-create instance with a virtual CLSID as described above. This connects to the A&E COM UA Proxy components. The A&E COM UA Proxy then establishes a secure channel and session with the UA A & C *Server*. As a result, the A&E COM *Client* gets a COM *Event Server* interface pointer.

D.3.2 Server status mapping

The A&E COM UA Proxy reads the UA A & C *Server* status from the *Server Object Variable Node*. Status enumeration values that are returned in *ServerStatusDataType* structure can be mapped 1 for 1 to the A&E COM *Server* status values with the exception of UA A & C *Server* status values *Unknown* and *Communication Fault.* These both map to the A&E COM *Server* status value of *Failed*.

The VendorInfo string of the A&E COM *Server* status is mapped from *ManufacturerName*.

D.3.3 Event Type mapping

Since all *Alarms* and *Conditions Event*s belong to a subtype of *BaseEventType*, the A&E COM UA Proxy maps the subtype as received from the UA A & C *Server* to one of the three A&E *Event* types: Simple, Tracking and *Condition*. Figure D.2 shows the mapping as follows:

- Those A & C *Event*s which are of subtype *AuditEventType* are marked as A&E *Event* type Tracking.
- Those A & C *Event*s which are *ConditionType* are marked as A&E *Event* type *Condition*.
- Those A & C *Event*s which are of any subtype except *AuditEventType* or *ConditionType* are marked as A&E *Event* type Simple.

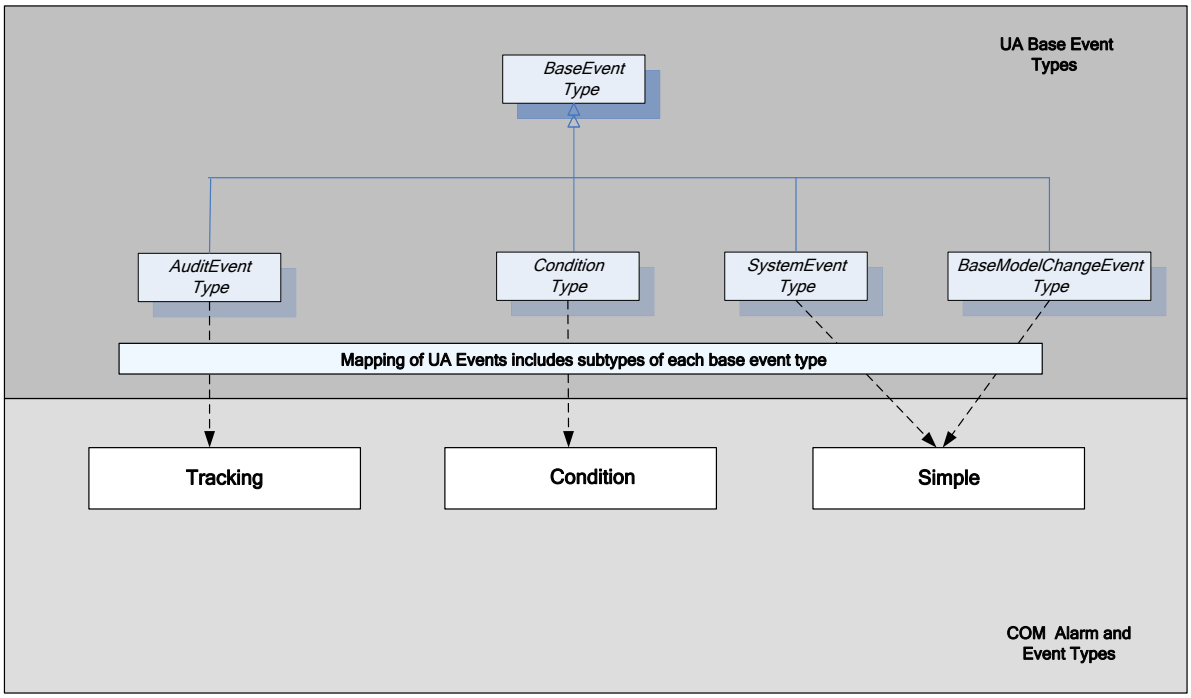


Figure D.2 – Mapping UA Event Types to COM A&E Event Types

Note that the *Event* type mapping described above also applies to the children of each subtype.

D.3.4 Event category mapping

Each A&E *Event* type (e.g. Simple, Tracking, *Condition*) has an associated set of *Event* categories which are intended to define groupings of A&E *Event*s. For example, Level and Deviation are possible *Event* categories of the *Condition Event* type for an A&E COM *Server*. However, since A & C does not explicitly support *Event* categories, the A&E COM UA Proxy uses A & C *Event* types to return A&E *Event* categories to the A&E COM *Client*. The A&E COM UA Proxy builds the collection of supported categories by traversing the type definitions in the address space of the UA A & C *Server*. Figure D.3 shows the mapping as follows:

- A&E Tracking categories consist of the set of all *Event* types defined in the hierarchy of subtypes of AuditEventType and TransitionEventType, including AuditEventType itself and TransitionEventType itself.
- A&E *Condition* categories consist of the set of all *Event* types defined in the hierarchy of subtypes of *ConditionType*, including *ConditionType* itself.
- A&E Simple categories consist of the set of *Event* types defined in the hierarchy of subtypes of *BaseEventType* excluding *AuditEventType* and *ConditionType* and their respective subtypes.

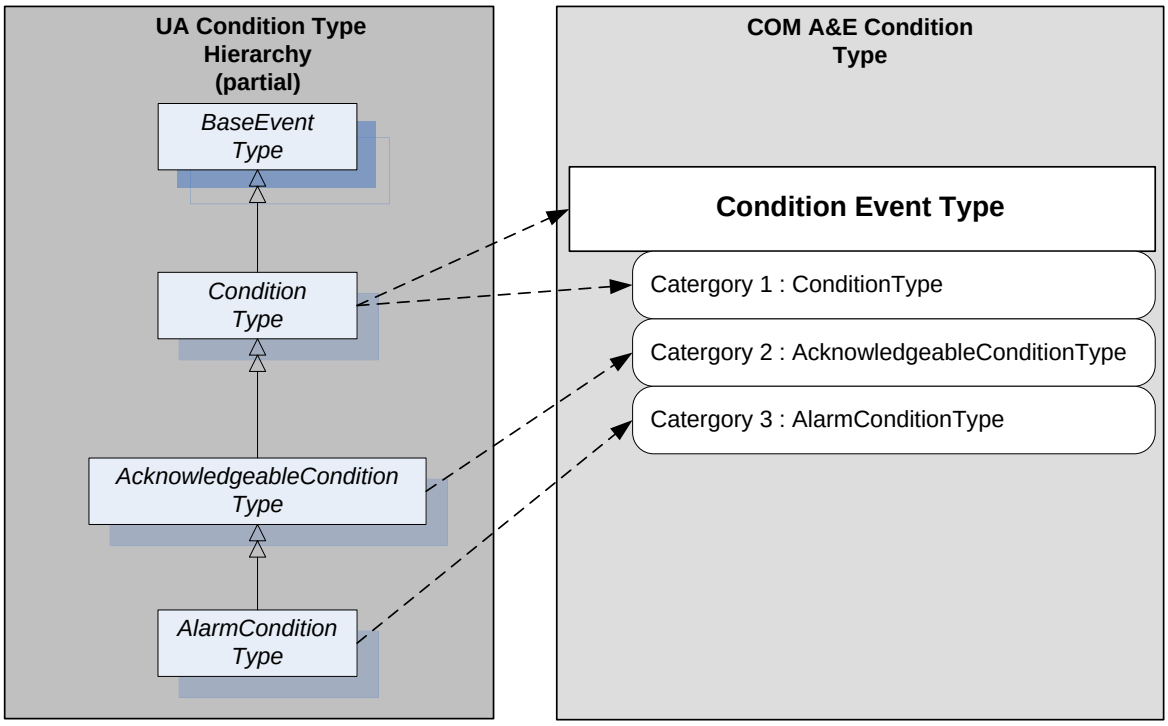


Figure D.3 – Example mapping of UA Event Types to COM A&E categories

Category name is derived from the display name *Attribute* of the *Node* type as discovered in the type hierarchy of the UA A & C *Server*.

Category description is derived from the description *Attribute* of the *Node* type as discovered in the type hierarchy of the UA A & C *Server*.

The A&E COM UA Proxy assigns Category IDs.

D.3.5 Event Category attribute mapping

The collection of *Attribute*s associated with any given A&E *Event* is encapsulated within the ONEVENTSTRUCT. Therefore, the A&E COM UA Proxy populates the *Attribute* fields within the ONEVENTSTRUCT using corresponding values from UA *Event Notification*s either directly (e.g., Source, Time, Severity) or indirectly (e.g., OPC COM *Event* category determined by way of the UA *Event* type). Table D.5 lists the *Attribute*s currently defined in the ONEVENTSTRUCT in the leftmost column. The rightmost column of Table D.5 indicates how the A&E COM UA proxy defines that *Attribute*.

Table D.5 – Event category attribute mapping table

A&E ONEVENTSTRUCT "attribute"	**A&E COM UA Proxy Mapping**
The following items are present for all A&E event types	
szSource	UA BaseEventType Property: SourceName
ftTime	UA BaseEventType Property: Time
szMessage	UA BaseEventType Property: Message
dwEventType	See Clause D.3.3
dwEventCategory	See Clause D.3.4
dwSeverity	UA BaseEventType Property: Severity
dwNumEventAttrs	Calculated within A&E COM UA Proxy
pEventAttributes	Constructed within A&E COM UA Proxy
The following items are present only for A&E Condition-Related Events	

A&E ONEVENTSTRUCT "attribute"	**A&E COM UA Proxy Mapping**
szConditionName	UA ConditionType Property: ConditionName
szSubConditionName	UA ActiveState Property: EffectiveDisplayName
wChangeMask	Calculated within Alarms and Events COM UA proxy
wNewState: OPC_CONDITION_ACTIVE	A & C AlarmConditionType Property: ActiveState Note that events mapped as non-Condition Events and those that do not derive from AlarmConditionType are set to ACTIVE by default.
wNewState: OPC_CONDITION_ENABLED	A & C ConditionType Property: EnabledState Note, Events mapped as non-Condition Events are set to ENABLED (state bit mask = 0x1) by default.
wNewState: OPC_CONDITION_ACKED	A & C AcknowledgeableConditionType Property: AckedState Note that A & C Events mapped as non-Condition Events or which do not derive from AcknowledgeableConditionType are set to UNACKNOWLEDGED and AckRequired = False by default.
wQuality	A & C ConditionType Property: Quality Note that Events mapped as non-Condition Events are set to OPC_QUALITY_GOOD by default. In general, the Severity field of the StatusCode is used to map COM status codes OPC_QUALITY_BAD, OPC_QUALITY_GOOD and OPC_QUALITY_UNCERTAIN. When possible, specific status' are mapped directly. These include (UA => COM): Bad status codes Bad_ConfigurationError => OPC_QUALITY_CONFIG_ERROR Bad_NotConnected => OPC_QUALITY_NOT_CONNECTED Bad_DeviceFailure => OPC_QUALITY_DEVICE_FAILURE Bad_SensorFailure => OPC_QUALITY_SENSOR_FAILURE Bad_NoCommunication => OPC_QUALITY_COMM_FAILURE Bad_OutOfService => OPC_QUALITY_OUT_OF_SERVICE Uncertain status codes Uncertain_NoCommunicationLastUsableValue => OPC_QUALITY_LAST_USABLE Uncertain_LastUsableValue => OPC_QUALITY_LAST_USABLE Uncertain_SensorNotAccurate => OPC_QUALITY_SENSOR_CAL Uncertain_EngineeringUnitsExceeded => OPC_QUALITY_EGU_EXCEEDED Uncertain_SubNormal => OPC_QUALITY_SUB_NORMAL Good status codes Good_LocalOverride => OPC_QUALITY_LOCAL_OVERRIDE
bAckRequired	If the ACKNOWLEDGED bit (OPC_CONDITION_ACKED) is set then the Ack Required Boolean is set to False, otherwise the Ack Required Boolean is set to True. If the *Event* is not of type *AcknowledgeableConditionType* or subtype then the AckRequired Boolean is set to False.
ftActiveTime	If the *Event* is of type *AlarmConditionType* or subtype and a transition from *ActiveState* of False to *ActiveState* to True is being processed then the *TransitionTime Property* of *ActiveState* is used. If the *Event* is not of type *AlarmConditionType* or subtype then this field is set to current time. Note: Additional logic applies to exclusive limit alarms, This value should be mapped to the LimitState.TransitionTime.
dwCookie	Generated by the A&E COM UA Proxy. These unique *Condition Event* cookies are not associated with any related identifier from the address space of the UA A & C *Server*.
The following is used only for A&E tracking events and for A&E condition-relate events which are acknowledgement notifications	
szActorID	
Vendor specific *Attributes* – ALL	

A&E ONEVENTSTRUCT "attribute"	**A&E COM UA Proxy Mapping**
ACK Comment	
AREAS	All A&E Events are assumed to support the "Areas" Attribute. However, no Attribute or Property of an A & C Event is available which provides this value. Therefore, the A&E COM UA Proxy initializes the value of the Areas Attribute based on the MonitoredItem producing the Event. If the A&E COM Client has applied no area filtering to a Subscription, the corresponding A & C Subscription will contain just one MonitoredItem – that of the UA A & C Server Object. Events forwarded to the A&E COM Client on behalf of this Subscription will carry an Areas Attribute value of empty string. If the A&E COM Client has applied an area filter to a Subscription then the related UA A & C Subscription will contain one or more MonitoredItems for each notifier Node identified by the area string(s). Events forwarded to the A&E COM Client on behalf of such a Subscription will carry an areas Attribute whose value is the relative path to the notifier which produced the Event (i.e., the fully qualified area name).
Vendor specific *Attribute*s – based on category	
SubtypeProperty1 SubtypeProperty*n*	All the UA A & C subtype *Properties* that are not part of the standard set exposed by *BaseEventType* or *ConditionType*

Condition Event instance records are stored locally within the A&E COM UA Proxy. Each record holds ONEVENTSTRUCT data for each EventSource/*Condition* instance. When the *Condition* instance transitions to the state INACTIVE|ACKED, where AckRequired = True or simply INACTIVE, where AckRequired = False, the local *Condition* record is deleted. When a *Condition Event* is received from the UA A & C *Server* and a record for this *Event* (identified by source/*Condition* pair) already exists in the proxy *Condition Event* store, the existing record is simply updated to reflect the new state or other change to the *Condition*, setting the change mask accordingly and producing an OnEvent callback to any subscribing *Client*s. In the case where the *Client* application acknowledges an *Event* which is currently unacknowledged (AckRequired = True), the UA A & C *Server* Acknowledge *Method* associated with the *Condition* is called and the subsequent *Event* produced by the UA A & C *Server* indicating the transition to acknowledged will result in an update to the current state of the local *Condition* record as well as an OnEvent *Notification* to any subscribing *Client*s.

The A&E COM UA Proxy maintains the mapping of *Attribute*s on an *Event* category basis. An *Event* category inherits its *Attribute*s from the *Properties* defined on all supertypes in the UA *Event* Type hierarchy. New *Attribute*s are added for any *Properties* defined on the direct UA *Event* type to A&E category mapping. The A&E COM UA Proxy adds two *Attribute*s to each category: AckComment and Areas. Figure D.4 shows an example of this mapping.

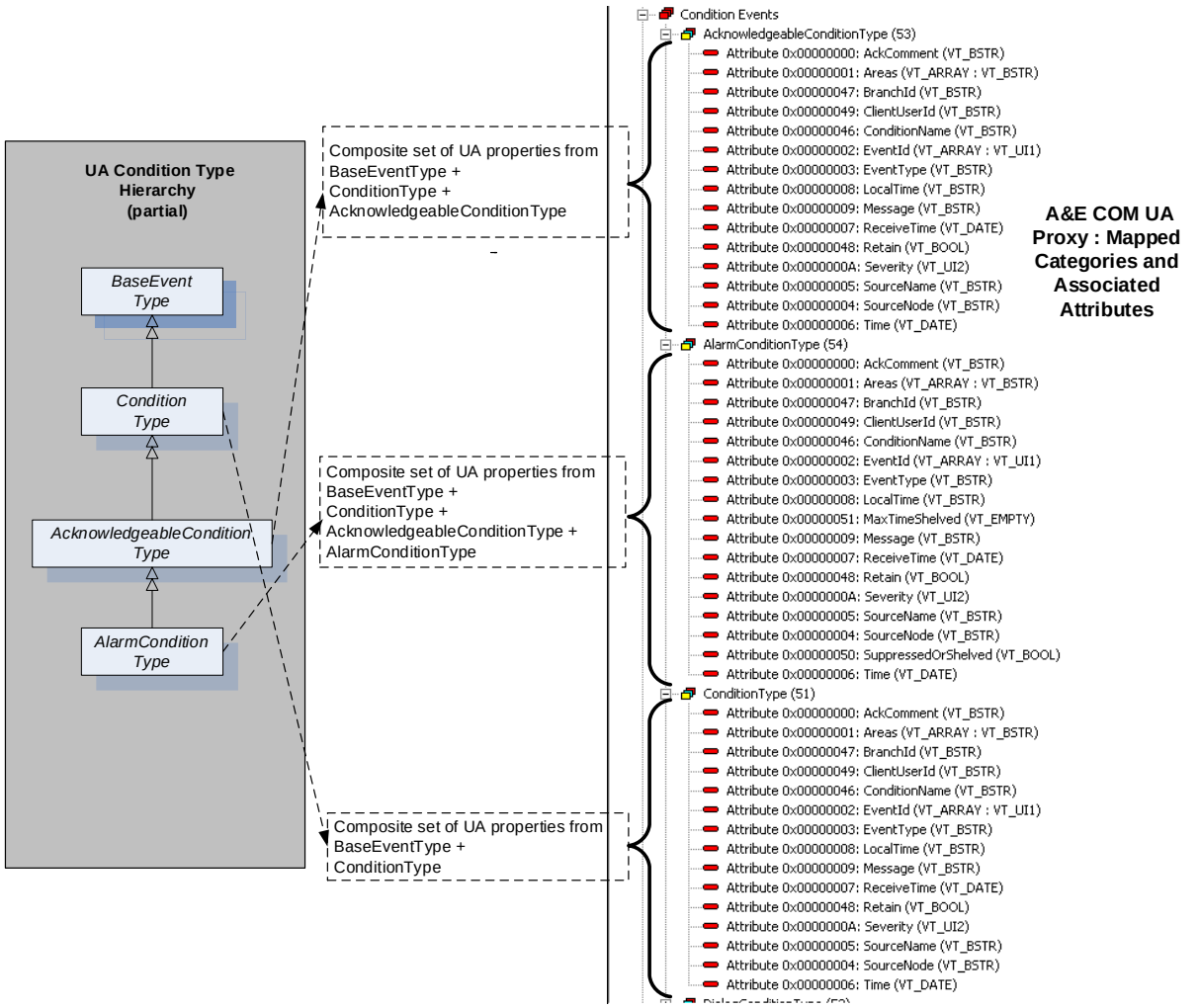


Figure D.4 – Example mapping of UA Event Types to A&E categories with attributes

D.3.6 Event Condition mapping

*Event*s of any subtype of *ConditionType* are designated COM *Condition Event*s and are subject to additional processing due to the stateful nature of *Condition Event*s. COM *Condition Event*s transition between states composed of the triplet ENABLED|ACTIVE|ACKNOWLEDGED. In UA A & C, *Event* subtypes of *ConditionType* only carry a value which can be mapped to ENABLED (DISABLED) and optionally, depending on further sub typing, may carry additional information which can be mapped to ACTIVE (INACTIVE) or ACKNOWLEDGED (UNACKNOWLEDGED). *Condition Event* processing proceeds as described in Table D.5 (see A&E ONEVENTSTRUCT "*Attribute*" rows: OPC_CONDITION_ACTIVE, OPC_CONDITION_ENABLED and OPC_CONDITION_ACKED).

D.3.7 Browse mapping

A&E COM browsing yields a hierarchy of areas and sources. Areas can contain both sources and other areas in tree fashion where areas are the branches and sources are the leaves. The A&E COM UA Proxy relies on the "HasNotifier" *Reference* to assemble a hierarchy of branches/areas such that each *Object Node* which contains a *HasNotifier Reference* and whose *EventNotifier Attribute* is set to *SubscribeToEvents* is considered an area. The root for the *HasNotifier* hierarchy is the *Server Object*. Starting at the *Server Object*, *HasNotifier Reference*s are followed and each *HasNotifier* target whose EventNotifier *Attribute* is set to SubscribeToEvents becomes a nested COM area within the hierarchy.

Note that the HasNotifier target can also be a HasNotifier source. Further, any *Node* which is a HasEventSource source and whose EventNotifier *Attribute* is set to SubscribeToEvents is also considered a COM Area. The target *Node* of any HasEventSource *Reference* is considered an A&E COM "source" or leaf in the A&E COM browse tree.

In general, *Node*s which are the source *Node*s of the HasEventSource *Reference* and/or are the source *Node*s of the HasNotifier *Reference* are always A&ECOM Areas. *Node*s which are the target *Node*s of the HasEventSource *Reference* are always A&E COM Sources. Note however that targets of HasEventSource which cannot be found by following the HasNotifier *Reference*s from the *Server Object* are ignored.

Given the above logic, the A&E COM UA Proxy browsing will have the following limitations: Only those *Node*s in the UA A & C *Server*'s address space which are connected by the HasNotifier *Reference* (with exception of those contained within the top level *Object*s folder) are considered for area designation. Only those *Node*s in the UA A & C *Server*'s address space which are connected by the HasEventSource *Reference* (with exception of those contained within the top level *Object*s folder) are considered for area or source designation. To be an area, a *Node* shall contain a HasNotifier *Reference* and its EventNotifier *Attribute* shall be set to SubscribeToEvents. To be a source, a *Node* shall be the target *Node* of a HasEventSource *Reference* and shall have been found by following HasNotifier *Reference*s from the *Server Object*.

D.3.8 Qualified names

D.3.8.1 Qualified name syntax

From the root of any sub tree in the address space of the UA A & C *Server*, the A&E COM *Client* may request the list of areas and/or sources contained within that level. The resultant list of area names or source names will consist of the set of browse names belonging to those *Node*s which meet the criteria for area or source designation as described above. These names are "short" names meaning that they are not fully qualified. The A&E COM *Client* may request the fully qualified representation of any of the short area or source names. In the case of sources, the fully qualified source name returned to the A&E COM *Client* will be the string encoded value of the *NodeId* as defined in 10000-6 (e.g., “ns=10;i=859“). In the case of areas, the fully qualified area name returned to the COM *Client* will be the relative path to the notifier *Node* as defined in 10000-4 (e.g., “/6:Boiler1/6:Pipe100X/1:Input/2:Measurement“). Relative path indices refer to the namespace table described below.

D.3.8.2 Namespace table

UA *Server* Namespace table indices may vary over time. This represents a problem for those A&E COM *Client*s which cache and reuse fully qualified area names. One solution to this problem would be to use a qualified name syntax which includes the complete URIs for all referenced table indices. This however would result in fully qualified area names which are unwieldy and impractical for use by A&E COM *Client*s. As an alternative, the A&E COM UA Proxy will maintain an internal copy of the UA A & C *Server*'s namespace table together with the locally cached endpoint description. The A&E COM UA Proxy will evaluate the UA A & C *Server*'s namespace table at connect time against the cached copy and automatically handle any re-mapping of indices if required. The A&E COM *Client* can continue to present cached fully qualified area names for filter purposes and the A&E COM UA Proxy will ensure these names continue to reference the same notifier *Node* even if the *Server*'s namespace table changes over time.

To implement the relative path, the A&E COM UA Proxy maintains a stack of *INode* interfaces of all the *Node*s browsed leading to the current level. When the A&E COM *Client* calls GetQualifiedAreaName, the A&E COM UA Proxy first validates that the area name provided is a valid area at the current level. Then looping through the stack, the A&E COM UA Proxy builds the relative path. Using the browse name of each *Node*, the A&E COM UA Proxy constructs the translated name as follows:

> *QualifiedName translatedName = new QualifiedName(Name,(ushort) ServerMappingTable[NamespaceIndex])* where
>
> *Name* – the unqualified browse name of the *Node*
>
> *NamespaceIndex* – the *Server* index
>
> the *ServerMappingTable* provides the *Client* namespace index that corresponds to the *Server* index.

A '/' is appended to the translated name and the A&E COM UA Proxy continues to loop through the stack until the relative path is fully constructed.

D.3.9 Subscription filters

D.3.9.1 General

The A&E COM UA Proxy supports all of the defined A&E COM filter criteria.

D.3.9.2 Filter by Event, category or severity

These filter types are implemented using simple numeric comparisons. For *Event* filters, the received *Event* shall match the *Event* type(s) specified by the filter. For Category filters, the received *Event*'s category (as mapped from UA *Event* type) shall match the category or categories specified by the filter. For severity filters, the received *Event* severity shall be within the range specified by the *Subscription* filter.

D.3.9.3 Filter by source

In the case of source filters, the UA A & C *Server* is free to provide any appropriate, *Server*-specific value for SourceName. There is no expectation that source *Node*s discovered via browsing can be matched to the SourceName *Property* of the *Event* returned by the UA A & C Server using string comparisons. Further, the A&E COM *Client* may receive *Event*s from sources which are not discoverable by following only HasNotifier and/or HasEventSource *Reference*s. Thus, source filters will only apply if the source string can be matched to the SourceName *Property* of an *Event* as received from the target UA A & C *Server*. Source filter logic will use the pattern matching rules documented in the A&E COM specification, including the use of wildcard characters.

D.3.9.4 Filter by area

The A&E COM UA Proxy implements Area filtering by adjusting the set of *MonitoredItem*s associated with a *Subscription*. In the simple case where the *Client* selects no area filter, the A&E COM UA Proxy will create a UA *Subscription* which contains just one *MonitoredItem*, the *Server Object*. In doing so, the A&E COM UA Proxy will receive *Event*s from the entire *Server* address space – that is, all Areas. The A&E COM *Client* will discover the areas associated with the UA *Server* address space by browsing. The A&E COM *Client* will use GetQualifiedAreaName as usual in order to obtain area strings which can be used as filters. When the A&E COM *Client* applies one or more of these area strings to the COM *Subscription* filter, the A&E COM UA Proxy will create *MonitoredItem*s for each notifier *Node* identified by the area string(s). Recall that the fully qualified area name is in fact the namespace qualified relative path to the associated notifier *Node*.

The A&E COM UA Proxy calls the *TranslateBrowsePathsToNodeIds Service* to get the *Node* ids of the fully qualified area names in the filter. The *Node* ids are then added as *MonitoredItem*s to the UA *Subscription* maintained by the A&E COM UA Proxy. The A&E COM UA Proxy also maintains a reference count for each of the areas added, to handle the case of multiple A&E COM *Subscription* applying the same area filter. When the A&E COM *Subscription*s are removed or when the area name is removed from the filter, the ref count on the *MonitoredItem* corresponding to the area name is decremented. When the ref count goes to zero, the *MonitoredItem* is removed from the UA *Subscription.*

As with source filter strings, area filter strings can contain wildcard characters. Area filter strings which contain wildcard characters require more processing by the A&E COM UA Proxy. When the A&E COM *Client* specifies an area filter string containing wildcard characters, the A&E COM UA Proxy will scan the relative path for path elements that are completely specified. The partial path containing just those segments which are fully specified represents the root of the notifier sub tree of interest. From this sub tree root *Node*, the A&E COM UA Proxy will collect the list of notifier *Node*s below this point. The relative path associated with each of the collected notifier *Node*s in the sub tree will be matched against the *Client* supplied relative path containing the wildcard character. A *MonitoredItem* is created for each notifier *Node* in the sub tree whose relative path matches that of the supplied relative path using established pattern matching rules. An area filter string which contains wildcard characters may result in multiple *MonitoredItem*s added to the UA *Subscription*. By contrast, an area filter string made up of fully specified path

segments and no wildcard characters will result in one *MonitoredItem* added to the UA *Subscription*. So, the steps involved are:

1) Check if the filter string contains any of these wild card characters, '*', '?', '#', '[', ']', '!', '-'.
2) Scan the string for path elements that are completely specified by retrieving the substring up to the last occurrence of the '/' character.
3) Obtain the *Node*Id for this path using *TranslateBrowsePathsToNodeIds*
4) Browse the *Node* for all notifiers below it.
5) Using the ComUtils.Match() function match the browse names of these notifiers against the *Client* supplied string containing the wild card character.
6) Add the *Node* ids of the notifiers that match as *MonitoredItem*s to the UA *Subscription*.

Annex E – IEC 62682 Mapping

E.1 Overview

This section provides a description of how the IEC 62682 information model can be mapped to OPC UA. It highlights term differences, concepts and other functionality. IEC 62682 provides additional information about managing and limiting alarms not covered by this specification.

Note: ISA 18.2 is not discussed by this mapping, but IEC 62682 and ISA 18.2 are related and most definitions in ISA 18.2 correspond to the definitions in IEC 62682.

E.2 Terms

IEC 62682 defines a large number of terms that are covered by the OPC UA model but not used in the text. These IEC 62682 terms are listed below and include a description, mapping or relationship to OPC UA Alarms and Events:

IEC 62682	**OPC UA Mapping / Related Concept**	**IEC 62682 Definition**
		OPC UA Application of
absolute alarm	ExclusiveDeviationAlarmType NonExclusiveDeviationAlarm Type	An alarm generated when the alarm set point is exceeded.
		Both OPC UA models expose a set point and process the Alarm as an absolute Alarm requires, the only difference is the interaction between relative states (High, HighHigh...)
adaptive alarm		Alarm for which the setpoint is changed by an algorithm (e.g., rate based).
		In OPC UA adaptive alarming may be part of a vendor specific alarm application, but it would or could make use of a number of standard Alarm functions described in this specification. OPC UA provides limit, rate of change and deviation alarming. Vendors can easily develop algorithms to adjust any of the limits that are exposed.
adjustable alarm / operator-set alarm	ExclusiveLimitAlarmType NonExclusiveLimitAlarmType	An alarm for which the set point can be changed manually by the Operator.
		Both OPC UA models allow Alarm limits to be writeable and allow for an Operator to change the limit. For all changes to limits an audit event should be generated tracking the change.
advanced alarming		A collection of techniques that can help manage annunciations during specific situations.
		In OPC UA advanced alarming may be part of a vendor specific alarm application, but it would or could make use of a number of standard Alarm functions described in this specification, such as adaptive setting of a setpoint for deviation Alarm. It might also require the definition of new Alarm sub-types.
Annunciation / Alarm Annunciation	Retain	A function of the alarm system is to call the attention of the Operator to an alarm.
		OPC UA provides an Alarm model that includes concepts such as re-alarming, Alarm silence and Alarm delays, but it is up to the Client application to make use of these features to generate both audible and visual annunciation to the Operator. OPC UA does not provide visual indication but it does provide priority information on which the client can be configured to provide the appropriate visual display. A key concept for alarm display is the concept of Alarm states and a Retain bit (see Annex B for more details).
alarm attribute	Various Alarm Properties	The setting for an alarm within the process control system.
		OPC UA defines a number of Properties that reflect what would be termed alarm attributes in IEC 62682 such as Alarm setpoint which maps to the setpoint property in an ExclusiveDeviationAlarmType.
alarm class	ConditionClass, ConditionSubClass	A group of alarms with a common set of alarm management requirements (e.g., testing, training, monitoring, and audit requirements).
		OPC UA provides ConditionClasses, but also provides other groupings, like ConditionSubClass OPC UA also specifies a number of predefined classes, but it is expected that vendors, other standards group or even end users will define their own extensions to these classes. The OPC concepts allow Alarms to be categorized as needed.

IEC 62682	OPC UA Mapping / Related Concept	IEC 62682 Definition
		OPC UA Application of
alarm Deadband	ExclusiveDeviationAlarmType NonExclusiveDeviationAlarm Type	A change in signal from the alarm setpoint necessary for the alarm to return to normal.
		In OPC UA, an alarm Deadband is optionally provided for all limit based alarms. It provides the same functionality as described in IEC 62682
filtering(alarm)	Event Subscription	A function which selects alarm records to be displayed according to a given element of the alarm record.
		In OPC UA Alarms are received by a Client according to the specific filter requested by the Client. The filtering can be very robust or very simple according to the needs of the client. It is up to the Client application to generate and provide the appropriate filter to the server. OPC UA's Alarm model is a subscription based model, not a push model that is configured on a server. The choice of filter is a client's responsibility.
alarm flood	Alarm diagnostics	A condition during which the Alarm rate is greater than the Operator can effectively manage - (e.g., more than 10 Alarms per 10 minutes).
		OPC UA does not define Alarm flooding but it does provide the capability to collect diagnostics that would allow an engineer to review overall Alarm performance.
alarm group	alarm group	A set of alarms with common association (e.g., process unit, process area, equipment set, or service). Alarm groups are primarily used for display purposes.
		OPC UA allows the definition of Alarm groups and the assignment of Alarms to these groups. In addition. OPC UA allows Alarms to also be part of a category. OPC UA also allows Alarms to be organized as a HasNotifier hierarchy (see clause 6). Groups, categories and hierarchies can be used for filtering or restricting Alarms that are being displayed.
alarm history	historical events	long term repository for alarm records.
		10000-11 describes historical Events.
alarm log		short term repository for alarm records.
		This part does not specify repositories for Alarms. Alarm logging is a Client function.
alarm management alarm system management		collection of processes and practices for determining, documenting, designing, operating, monitoring, and maintaining alarm systems.
		OPC UA provides an infrastructure to allow vendors and Operators to provide Alarm management, as such it should be an integral part of an alarm management system.
alarm message	Events	text string displayed with the alarm indication that provides additional information to the Operator (e.g., Operator action).
		OPC UA provides an Event structure that includes many different pieces of information (see 10000-5 for additional details). Clients can subscribe for as much of this information as desired and display this as an Alarm message. All typical fields that would be associated with an Alarm message are available. In addition, OPC UA provides significant additional information.
alarm priority	Priority	relative importance assigned to an alarm within the alarm system to indicate the urgency of response (e.g., seriousness of consequences and allowable response time)
		OPC UA provides a Priority Variable as part of the Alarm Object that provides the same functionality
alarm rate	Alarm diagnostics	the number of alarm annunciation, per Operator, in a specific time interval.
		OPC UA provides diagnostics allowing the collection of Alarm rate information at any level in the system.
Record (Alarm)	Events, Event filtering	a set of information which documents an alarm state change.
		In OPC UA all Alarms are generated as an Event and the Client can select the fields that are to be included in the Events. This selection can be customized for each AlarmConditionType, which allows a customized Alarm record to be generated.
alarm setpoint, alarm limit, alarm trip point	Limit Alarms, Discrete Alarms	the threshold value of a process variable or discrete state that triggers the alarm indication.
		OPC UA supports Alarm limits and setpoints for multiple Alarm types, including limit Alarms and discrete Alarms.
Sorting (alarm)		a function which orders alarm records to be displayed according to a given element of alarm record.
		OPC UA does not provide Alarm sorting as part of an event subscription. Multiple filtering options are provided, but the Client is required to perform any ordering of Alarms.
alarm summary, alarm list		a display that lists alarm annunciations with selected information (e.g., date, time, priority, and alarm type).
		In OPC UA Alarm summaries and Alarm lists are Client functionality and are not specified. Extensive filtering capabilities are provided by the Server to allow easier implementation of Alarm summaries or lists by a Client.

IEC 62682	OPC UA Mapping / Related Concept	IEC 62682 Definition
		OPC UA Application of
Alert		An audible and/or visible means of indicating to the Operator an equipment or process condition that can require evaluation when time allows.
		Alerts are items that should be attended to, but are not as urgent as Alarms. OPC UA does not differentiate between Alarms and alerts, but it does provide a full range of priorities for Alarms. It is up to the end users to determine what range of priorities are considered an alert vs an Alarm etc.
allowable response time		The maximum time between the annunciation of the alarm and when the Operator takes corrective action to avoid the consequence.
		OPC UA does not provide any specific fields for allowable response time, but it does track the times at which an Alarm occurs and when any actions are taken on the Alarm.
Annunciator		device or group of devices that call attention to changes in process conditions
		OPC UA does not define annunciators, this is Client functionality that can be implemented using OPC UA
Audit		comprehensive assessment that includes the evaluation of alarm system performance and the effectiveness of the work practices used to administer the alarm system.
		OPC UA does provide a number of features that can facilitate an audit, including diagnostics and audit events. Do not confuse OPC Audit Event with the IEC audit concept.
bad-measurement alarm		an alarm generated when the signal for a process measurement is outside the expected range (e.g., 3.8 mA for a 4 mA to 20 mA signal).
		A bad measurement Alarm is not defined in OPC UA, but limit Alarms are defined and they could be used directly to represent a bad-measurement Alarm. Alternatively, limit Alarms could be further subtyped to allow easier filtering on bad-measurement Alarms if desired.
bit-pattern alarm	Discrete alarm	an alarm that is generated when a pattern of digital signals matches a predetermined pattern.
		In OPC UA a bit pattern Alarm can be mapped to a DiscreteAlarmType.
calculated alarm		An alarm generated from a calculated value instead of a direct process measurement.
		In OPC UA any of the defined Alarm types can be applied to calculated values or to process values.
call-out alarm		alarm that notifies and informs an Operator by means other than, or in addition to, a console display (e.g., pager or telephone)
		OPC UA does not specify call-out alarms, since this is client functionality. OPC UA does provide the ability to categorize or group an Alarm such that it could be easily identified as requiring a different type of annunciation.
chattering alarm	OnDelay, OffDelay	alarm that repeatedly transitions between the alarm state and the normal state in a short period of time.
		The OPC UA features of OnDelay and OffDelay can be used to help control chattering Alarms.
Classification	ConditionClasses	the process of separating alarms into alarm classes based on common requirements (e.g. testing, training, monitoring, and auditing requirements).
		OPC defines a number of extensible ConditionClasses that can be used for this purpose.
controller-output alarm		alarm generated from the output signal of a control algorithm (e.g., PID controller) instead of a direct process measurement.
		OPC UA does not provide an Alarm type for controller-output alarm, but a type could be created or an existing type could be used, depending on the requirements.
dynamic alarming		An automatic modification of alarm attributes based on process state or conditions.
		OPC UA does not define dynamic alarming behaviour, but it allows programmatic access to limits, set points or other parameters that would be required for a dynamic alarming solution.
enforcement		enhanced alarming technique that can verify and restore alarm attributes in the control system to the values in the master alarm database.
		OPC UA does not provide enforcement, but it enables enforcement by providing an information model that includes default setting for Alarm types as well as original settings for dynamic Alarms. These features can be used by a Client application to provide enforcement.
fleeting alarm	Suppression, Shelving	An alarm that transitions between an active alarm state and an inactive alarm state in a short period of time.
		OPC UA provides Alarm Suppression and Shelving which an Operator might use to control fleeting Alarms.

IEC 62682	OPC UA Mapping / Related Concept	IEC 62682 Definition
		OPC UA Application of
first-out alarm first-up alarm	FirstInGroup FirstInGroupFlag	An alarm determined (i.e., by first-out logic) to be the first, in a multiple-alarm scenario.
		OPC UA can support first-up/first-out Alarms as part of the Alarm information model, including definition of the group of Alarms.
instrument diagnostic alarm	InstrumentDiagnosticAlarmType	An alarm generated by a field device to indicate a fault (e.g., sensor failure).
		OPC UA provides support for InstrumentDiagnostic Alarms that can be used to represent a failed sensor or an instrument diagnostic.
monitoring	Alarm Diagnostics	measurement and reporting of quantitative (objective) aspects of alarm system performance.
		OPC UA provides diagnostic collection capabilities that can be used to measure and reports quantitative information related to alarm system performance.
nuisance alarm	Alarm Diagnostics	An alarm that annunciates excessively, unnecessarily, or does not return to normal after the Operator response is taken. EXAMPLE: Chattering alarm, fleeting alarm, or stale alarm.
		The OPC UA model provides Alarm Diagnostics for tracking the information needed to identify if an Alarm is a nuisance Alarm (i.e. has been in an Alarm state excessively or does not return to normal).
plant state plant mode	StateMachines	defined set of operational conditions for a process plant.
		OPC UA provides an example StateMachine (see Annex F) that can be customized or adapted to provide process information. This StateMachine could also be used to affect alarming.
process area	Event Hierarchies Object References (Part 5)	physical, geographical or logical grouping of resources determined by the site.
		OPC UA provides multiple manners in which an information model can be displayed, this includes grouping objects into process areas or any other desired grouping. This is an inherent part of the OPC UA information model.
re-alarming alarm, re-triggering alarm	ReAlarmTime ReAlarmRepeatCount	alarm that is automatically re-annunciated to the Operator under certain conditions.
		OPC UA supports re-alarming as part of its base AlarmConditionType.
recipe-driven alarm	StateMachines Alarm Limits	alarm with setpoints that depend on the recipe that is currently being executed.
		OPC UA provides support for adjustable Alarm limits. It also provides support for programs and other functionality that could be used to drive recipes. Annex F provides an example of a StateMachine and how it could be used to adjust Alarm settings.
Reset	LatchedState / Reset	Operator action that unlatches a latched alarm.
		OPC UA provides an optional StateMachine to indicate an Alarm is capable of being latched and is in a latched state. It also provides a Reset Method for clearing the latched state.
safety related alarm safety alarm	SafetyConditionClassType	an alarm that is classified as critical to process safety for the protection of human life or the environment.
		OPC UA defines a safety ConditionClass for grouping safety related alarms.
stale alarm	Alarm Diagnostics	alarm that remains annunciated for an extended period of time (e.g., 24 hours).
		OPC UA Alarm Diagnostics can track the length of time an Alarm is active.
state-based alarm - mode-based alarms	StateMachine	alarm that has attributes modified or is suppressed based on operating states or process conditions.
		OPC UA can provide a system state StateMachine to support process, device or system states (see Annex F). With this StateMachine Servers can adjust Alarm attributes or just Suppress or Disable Alarms based on the StateMachine. The StateMachine can be applied at multiple levels in the system.
statistical alarm	StatisticalConditionClassType	alarm generated based on statistical processing of a process variable or variables.
		OPC UA provides an Alarm Condition class that any of the existing AlarmConditionTypes can be assigned to. This allows any Alarm types, such as limit Alarms, to be generated by statistical analysis.
Suppress	SuppressedOrShelved	Any mechanism to prevent the indication of the alarm to the Operator when the base alarm condition is present (i.e., shelving, suppressed by design, out-of-service).
		OPC UA provides a flag SuppressedOrShelved that matches this functionality.
suppressed by design	SuppressedState	alarm annunciation to the Operator prevented based on plant state or other conditions.
		OPC UA provides a SuppressedState that matches this functionality.
system diagnostic alarm	SystemDiagnosticAlarmType	alarm generated by the control system to indicate a fault within the system hardware, software or components.
		OPC UA defines a system diagnostic Alarm that can be used to represent faults with system hardware, software or components.
	Disable/Enable	

IEC 62682	OPC UA Mapping / Related Concept	IEC 62682 Definition
		OPC UA Application of
		OPC UA supports enable / Disable of Alarms, which was supported in older version of 18.2 and IEC 62682, but these options are no longer supported and used in either 18.2 or IEC 62682. Servers that wish to be compliant to 18.2 and IEC 62682 should not use Disable / Enable methods defined in this specification.

The following terms in IEC 62682 match the terms/concepts defined in the OPC UA specification and do not need any addition mapping or discussion:

- Acknowledge
- Active
- Alarm
- Alarm OffDelay
- Alarm OnDelay
- Alarm Type
- Deviation Alarm
- Discrepancy Alarm
- Event
- Highly Managed Alarm
- LatchingAlarm
- OutofService
- Rateofchange alarms
- Return to normal
- Shelve
- Silence
- Unacknowledged

E.3 Alarm records & State Indications

OPC UA provides all of the items listed as both required and recommended as part of its alarm definitions, but it is up to the client to subscribe for the information. In OPC UA the Client controls what alarm information is requested and obtained from the *Server*. The *Server* does not define visual aspects of the alarm system, but does provide priority information from which the visual aspect can be set on the client side.

OPC UA also supports all of the states described in IEC 62682. This includes tracking the process states, system states and individual alarm states. OPC UA also provides a StateMachine model that can be used in conjunction with an alarm system to alter alarm behaviour based on the state of a system or process. For example, during start-up or shutdown of a process or a system some alarms might be suppressed.

The behaviour of an OPC UA alarm system also mimics that required by IEC 62682. All behaviour described in IEC 62682 can easily be mapped to functionality define in OPC UA Alarm & Conditions.

Annex F System State (Informative)

F.1 Overview

The state of alarms is affected by the state of the process, equipment, system or plant. For example, when a tank is taken out of service, the level alarms associated with the tank would be no longer used, until the tank is returned to service. This section describes a *StateMachine* that can be deployed as part of a system designed and used to reflect the current state of the system, process, equipment or item. Customized version of this model can be implemented for any system, this sample is just an illustration.

The current state from the *StateMachine* is applied to all items in the *HasNotifier* hierarchy below the object with which the *StateMachine* is associated. The *SystemState StateMachine* can be used to automatically disable, enable, suppress or un-suppress *Alarms* related to the Object (with in the hierarchy of alarms from the given object). The *StateMachine* can also be used by advanced alarming software to adjust the setpoint, limits or other items related to the *Alarms* in the hierarchy.

Optionally, multiple SystemState *StateMachines* can be deployed.

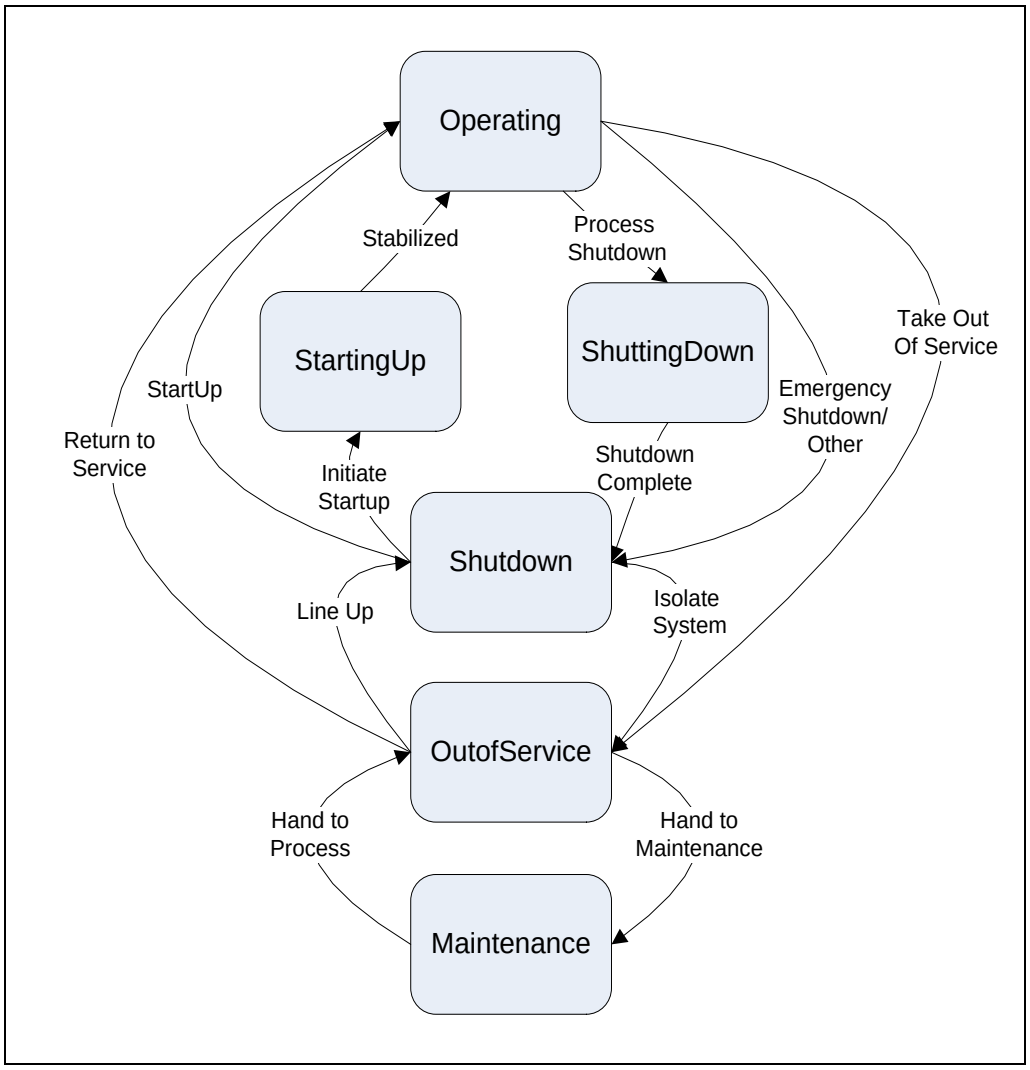


Figure F.1 – SystemState transitions

F.2 SystemStateStateMachineType

The *SystemStateStateMachineType* includes a hierarchy of sub-states. It supports multiple transitions between Operating, StartingUp, ShuttingDown, Shutdown, OutOfService and Maintenance.

The state machine is illustrated in Figure F.2 and formally defined in Table F.1.

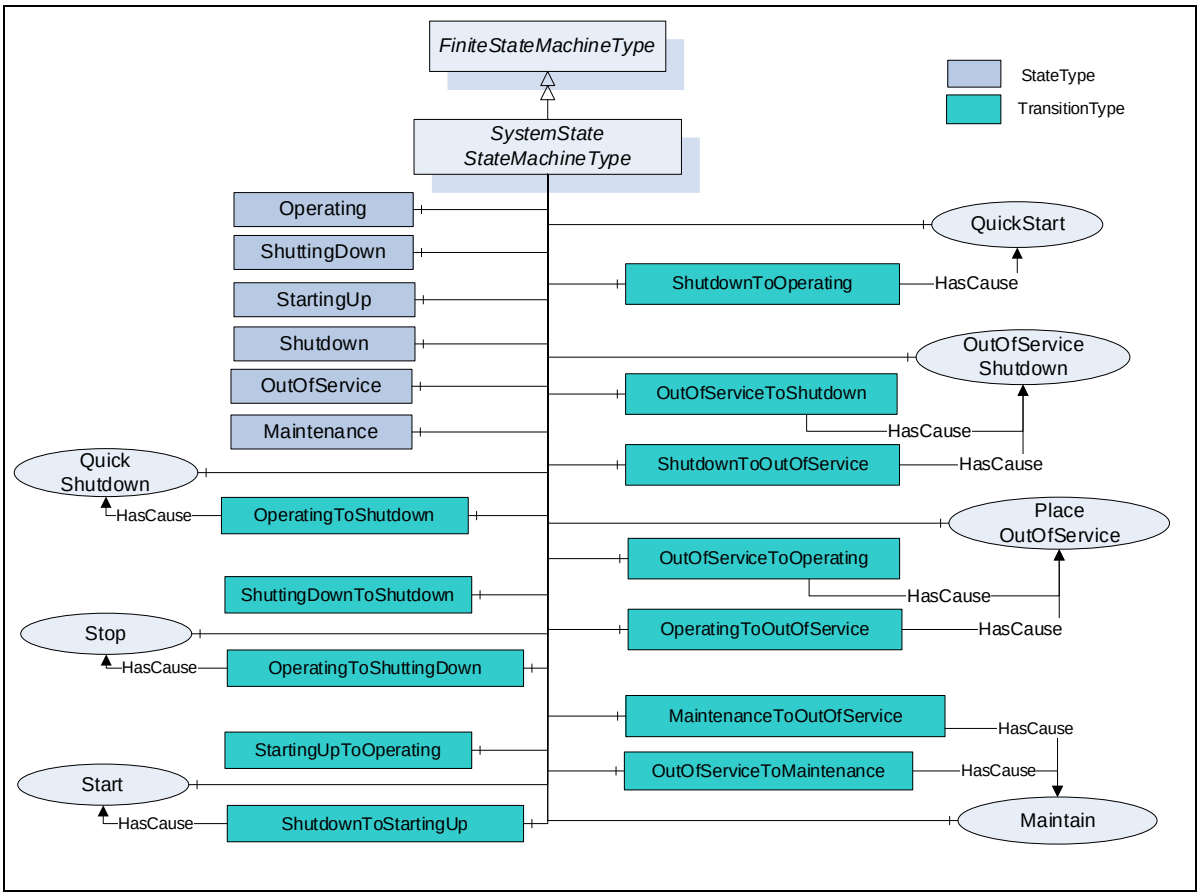


Figure F.2 – SystemStateStateMachineType Model

Table F.1 – SystemStateStateMachineType definition

Attribute	**Value**				
BrowseName	SystemStateStateMachineType				
IsAbstract	False				
References	**Node Class**	**BrowseName**	**DataType**	**TypeDefinition**	**Modelling Rule**
Subtype of the Finite*StateMachineType* defined in 10000-16					
HasComponent	Object	Operating		StateType	
HasComponent	Object	ShuttingDown		StateType	
HasComponent	Object	StartingUp		StateType	
HasComponent	Object	Shutdown		StateType	
HasComponent	Object	OutOfService		StateType	
HasComponent	Object	Maintenance		StateType	
HasComponent	Object	ShutdownToOperating		TransitionType	
HasComponent	Object	OperatingToShutdown		TransitionType	
HasComponent	Object	ShuttingdownToShutdown		TransitionType	
HasComponent	Object	OperatingToShuttingdown		TransitionType	
HasComponent	Object	StartingUpToOperating		TransitionType	
HasComponent	Object	ShutdownToStartingUp		TransitionType	
HasComponent	Object	OutOfServiceToShutdown		TransitionType	
HasComponent	Object	ShutdownToOutOfService		TransitionType	
HasComponent	Object	OutOfServiceToOperating		TransitionType	
HasComponent	Object	OperatingToOutOfService		TransitionType	
HasComponent	Object	MaintenanceToOutOfService		TransitionType	
HasComponent	Object	OutOfServiceToMaintenance		TransitionType	
HasComponent	Method	Start	Defined in Clause XXX		Optional
HasComponent	Method	Maintain	Defined in Clause XXX		Optional
HasComponent	Method	Stop	Defined in Clause XXX		Optional
HasComponent	Method	PlaceOutOfService	Defined in Clause XXX		Optional
HasComponent	Method	QuickShutdown	Defined in Clause XXX		Optional
HasComponent	Method	QuickStart	Defined in Clause XXX		Optional
HasComponent	Method	OutOfServiceShutdown	Defined in Clause XXX		Optional

The actual selection of *States* and *Transitions* would depend on the deployment of the *StateMachine*. If the *StateMachine* were being applied to a tank or other part of a process it might have a different set of *States* then if it was applied to a meter or instrument. The meter may only have Operating, OutOfService and Maintenance, while the tank may have all of the described *States* and *Transitions*. The transitions are defined in Table F.2.

The *StateMachine* supports six possible states including: *Operating*, *ShuttingDown*, *StartingUp*, *Shutdown*, *OutOfService*, *Maintenance*. It supports 12 possible *Transitions* and 7 possible *Methods*.

Table F.2 – SystemStateStateMachineType additional references

SourceBrowsePath	References	IsForward	TargetBrowsePath
ShutdownToOperating	FromState	True	Shutdown
	ToState	True	Operating
	HasCause	True	QuickStart
OperatingToShutdown	FromState	True	Operating
	ToState	True	Shutdown
	HasCause	True	QuickShutdown
ShuttingDownToShutdown	FromState	True	ShuttingDown
	ToState	True	Shutdown
OperatingToShuttingDown	FromState	True	Operating
	ToState	True	ShuttingDown
	HasCause	True	Stop
StartingUpToOperating	FromState	True	StartingUp
	ToState	True	Operating
ShutdownToStartingUp	FromState	True	Shutdown
	ToState	True	StartingUp
	HasCause	True	Start
OutOfServiceToShutdown	FromState	True	OutOfService
	ToState	True	Shutdown
	HasCause	True	OutOfServiceShutdown
ShutdownToOutOfService	FromState	True	Shutdown
	ToState	True	OutOfService
	HasCause	True	OutOfServiceShutdown
OutOfServiceToOperating	FromState	True	OutOfService
	ToState	True	Operating
	HasCause	True	PlaceOutOfService
OperatingToOutOfService	FromState	True	Operating
	ToState	True	OutOfService
	HasCause	True	PlaceOutOfService
MaintenanceToOutOfService	FromState	True	Maintenance
	ToState	True	OutOfService
	HasCause	True	Maintain
OutOfServiceToMaintenance	FromState	True	OutOfService
	ToState	True	Maintenance
	HasCause	True	Maintain

The component *Variables* of the SystemStateStateMachineType have additional *Attributes* defined inTable 149.

Table 149 – SystemStateStateMachineType Attribute values for child Nodes

BrowsePath	Value Attribute
Operating 0:StateNumber	1
ShuttingDown 0:StateNumber	2
StartingUp 0:StateNumber	3
Shutdown 0:StateNumber	4
OutOfService 0:StateNumber	5
Maintenance 0:StateNumber	6
ShutdownToOperating 0:TransitionNumber	41
OperatingToShutdown 0:TransitionNumber	14
ShuttingDownToShutdown 0:TransitionNumber	24
OperatingToShuttingDown 0:TransitionNumber	12
StartingUpToOperating 0:TransitionNumber	31
ShutdownToStartingUp 0:TransitionNumber	42
OutOfServiceToShutdown 0:TransitionNumber	54
ShutdownToOutOfService 0:TransitionNumber	45
OutOfServiceToOperating 0:TransitionNumber	51
OperatingToOutOfService 0:TransitionNumber	15
MaintenanceToOutOfService 0:TransitionNumber	65
OutOfServiceToMaintenance 0:TransitionNumber	56

The system can always generate additional *HasCause References*, such as internal code. No *HasEffect References* are defined, but an implementation might define *HasEffect References* (such as *HasEffectDisable*) for disabling or enabling *Alarms*, suppressing *Alarms* or adjusting setpoints or limits of *Alarms*. The targets of the reference might be an individual *Alarm* or portion of a plant or piece of equipment. See section 7 for a list of *HasEffect References* that could be used.

_____