ISO/IEC 14776-414:2009-06 (E)

Information technology – Small computer system interface (SCSI) –
Part 414: Architecture model-4 (SAM-4)

Contents

Page
FOREWORD ... 10
INTRODUCTION ... 11
General ... 11
SCSI standards family ... 11
1 Scope ... 12
2 Normative references ... 13
3 Terms, definitions, symbols, abbreviations, and conventions ... 13
3.1 Terms and definitions ... 13
3.2 Acronyms ... 25
3.3 Keywords ... 25
3.4 Editorial conventions ... 26
3.5 Numeric conventions ... 27
3.6 Notation conventions ... 28
3.6.1 UML notation conventions ... 28
3.6.1.1 Notation conventions overview ... 28
3.6.1.2 Constraint and note conventions ... 28
3.6.1.3 Class diagram conventions ... 29
3.6.1.4 Object diagram conventions ... 33
3.6.2 Notation for procedure calls ... 34
3.6.3 Notation for state diagrams ... 34
4 SCSI architecture model ... 36
4.1 Introduction ... 36
4.2 Compliance Requirements ... 36
4.3 The SCSI distributed service model ... 37
4.4 The SCSI client-server model ... 38
4.4.1 SCSI client-server model overview ... 38
4.4.2 Synchronizing client and server states ... 39
4.4.3 Request/Response ordering ... 39
4.5 The SCSI structural model ... 39
4.6 SCSI classes ... 41
4.6.1 SCSI classes overview ... 41
4.6.2 SCSI Domain class ... 41
4.6.3 Service Delivery Subsystem class ... 42
4.6.4 SCSI Device class ... 43
4.6.4.1 SCSI Device class overview ... 43
4.6.4.2 SCSI Device Name attribute ... 43
4.6.5 SCSI Port class ... 44
4.6.5.1 SCSI Port class overview ... 44
4.6.5.2 Relative Port Identifier attribute ... 45
4.6.6 SCSI Target Port class ... 45
4.6.6.1 SCSI Target Port class overview ... 45
4.6.6.2 Target Port Identifier attribute ... 45
4.6.6.3 Target Port Name attribute ... 45
4.6.7 SCSI Initiator Port class ... 46
4.6.7.1 SCSI Initiator Port class overview ... 46
4.6.7.2 Initiator Port Identifier attribute ... 46
4.6.7.3 Initiator Port Name attribute ... 46
4.6.8 Task Router class ... 46
4.6.9 SCSI Initiator Device class ... 47
4.6.10 Application Client class ... 47
4.6.11 Application Client Task Management Function class ... 48
4.6.11.1 Application Client Task Management Function class overview ... 48
4.6.11.2 Function Identifier attribute ... 48
4.6.11.3 Nexus attribute ... 48
4.6.11.4 Service Response attribute ... 48

4.6.11.5 Additional Response Information attribute 48
4.6.12 Application Client Task Set class 48
4.6.13 Application Client Command class 49
4.6.13.1 Application Client Command class overview 49
4.6.13.2 I_T_L_Q Nexus attribute 49
4.6.13.3 CDB attribute 49
4.6.13.4 Task Attribute attribute 49
4.6.13.5 Status attribute 49
4.6.13.6 Service Response attribute 49
4.6.13.7 Data-In Buffer attribute 49
4.6.13.8 Data-In Buffer Size attribute 49
4.6.13.9 Data-Out Buffer attribute 49
4.6.13.10 Data-Out Buffer size attribute 49
4.6.13.11 CRN attribute 49
4.6.13.12 Command Priority attribute 50
4.6.13.13 First Burst Enabled attribute 50
4.6.13.14 Sense Data attribute 50
4.6.13.15 Sense Data Length attribute 50
4.6.13.16 Status Qualifier attribute 50
4.6.14 SCSI Target Device class 50
4.6.15 Level 1 Hierarchical Logical Unit class 51
4.6.16 Level 2 Hierarchical Logical Unit class 52
4.6.17 Level 3 Hierarchical Logical Unit class 52
4.6.18 Level 4 Hierarchical Logical Unit class 53
4.6.19 Logical Unit class 53
4.6.19.1 Logical Unit class overview 53
4.6.19.2 LUN attribute 55
4.6.19.3 Logical Unit Name attribute 55
4.6.19.4 Dependent Logical Unit attribute 55
4.6.20 Device Server class 56
4.6.21 Task Manager class 56
4.6.22 Task Set class 56
4.6.23 Command class 56
4.6.23.1 Command class overview 56
4.6.23.2 I_T_L_Q Nexus attribute 56
4.6.23.3 Task Attribute attribute 56
4.6.23.4 CDB attribute 57
4.6.23.5 CRN attribute 57
4.6.23.6 Command Priority attribute 57
4.6.23.7 Status attribute 57
4.6.23.8 Sense Data attribute 57
4.6.23.9 Sense Data Length attribute 57
4.6.23.10 Service Response attribute 57
4.6.23.11 Status Qualifier attribute 57
4.6.23.12 First Burst Enabled attribute 57
4.6.23.13 Device Server Buffer attribute 57
4.6.23.14 Application Client Buffer Offset attribute 57
4.6.23.15 Request Byte Count attribute 57
4.6.23.16 Delivery Result attribute 58
4.6.24 Task Management Function class 58
4.6.24.1 Task Management Function class overview 58
4.6.24.2 Function Identifier attribute 58
4.6.24.3 Nexus attribute 58
4.6.24.4 Service Response attribute 58
4.6.24.5 Additional Response Information attribute 58
4.6.25 Well Known Logical Unit class 58
4.7 Logical unit number (LUN) 59
4.7.1 Introduction 59

4.7.2 Logical unit representation format 59
4.7.3 LUNs overview 59
4.7.4 Minimum LUN addressing requirements 59
4.7.5 Single level LUN structure 60
4.7.6 Eight byte LUN structure 62
4.7.7 Peripheral device addressing method 64
4.7.8 Flat space addressing method 65
4.7.9 Logical unit addressing method 66
4.7.10 Extended logical unit addressing 67
4.7.11 Well known logical unit addressing 70
4.7.12 Extended flat space addressing method 70
4.7.13 Logical unit not specified addressing 71
4.8 Nexus 71
4.8.1 Nexus overview 71
4.8.2 Command identifier 72
4.8.3 Nexus usage rules 72
4.9 SCSI ports 72
4.9.1 SCSI port configurations 72
4.9.2 SCSI devices with multiple ports 73
4.9.3 Multiple port SCSI target device structure 74
4.9.4 Multiple port SCSI initiator device structure 75
4.9.5 Multiple port SCSI device structure 76
4.9.6 SCSI initiator device view of a multiple port SCSI target device 77
4.9.7 SCSI target device view of a multiple port SCSI initiator device 79
4.10 The SCSI model for distributed communications 79
5 SCSI command model 84
5.1 The Execute Command procedure call 84
5.2 Command descriptor block (CDB) 85
5.3 Status 86
5.3.1 Status codes 86
5.3.2 Status qualifier 87
5.3.3 Status precedence 89
5.4 SCSI transport protocol services in support of Execute Command 90
5.4.1 Overview 90
5.4.2 Command and status SCSI transport protocol services 90
5.4.2.1 Command and status SCSI transport protocol services overview 90
5.4.2.2 Send SCSI Command SCSI transport protocol service request 91
5.4.2.3 SCSI Command Received SCSI transport protocol service indication 91
5.4.2.4 Send Command Complete SCSI transport protocol service response 92
5.4.2.5 Command Complete Received SCSI transport protocol service confirmation 92
5.4.3 Data transfer SCSI transport protocol services 93
5.4.3.1 Introduction 93
5.4.3.2 Data-In delivery service 95
5.4.3.2.1 Send Data-In SCSI transport protocol service request 95
5.4.3.2.2 Data-In Delivered SCSI transport protocol service confirmation 95
5.4.3.3 Data-Out delivery service 95
5.4.3.3.1 Receive Data-Out SCSI transport protocol service request 95
5.4.3.3.2 Data-Out Received SCSI transport protocol service confirmation 96
5.4.3.4 Terminate Data Transfer service 96
5.4.3.4.1 Terminate Data Transfer SCSI transport protocol service request 96
5.4.3.4.2 Data Transfer Terminated SCSI transport protocol service confirmation 97
5.5 Command lifetimes 97
5.6 Aborting commands 98
5.7 Command processing example 103
5.8 Commands that complete with CHECK CONDITION status 103
5.8.1 Overview 103
5.8.2 Handling commands when ACA is not in effect 104
5.8.3 Aborting commands terminated with a CHECK CONDITION status without establishing an ACA 104

5.9 Auto contingent allegiance (ACA) ... 105
5.9.1 ACA overview ... 105
5.9.2 Establishing an ACA ... 105
5.9.3 Handling new commands received on the faulted I_T nexus when ACA is in effect ... 106
5.9.4 Handling new commands received on non-faulted I_T nexuses when ACA is in effect ... 107
5.9.4.1 Command processing permitted for commands received on non-faulted I_T nexuses during ACA ... 107
5.9.4.2 Handling new commands received on non-faulted I_T nexuses when ACA is in effect ... 107
5.9.5 Clearing an ACA condition ... 108
5.10 Overlapped commands ... 109
5.11 Incorrect logical unit ... 109
5.12 Task attribute exception conditions ... 109
5.13 Sense data ... 110
5.14 Unit attention condition ... 110
6 SCSI events and event notification model ... 114
6.1 SCSI events overview ... 114
6.2 Establishing a unit attention condition subsequent to detection of an event ... 116
6.3 Conditions resulting from SCSI events ... 117
6.3.1 Power on ... 117
6.3.2 Hard reset ... 118
6.3.3 Logical unit reset ... 118
6.3.4 I_T nexus loss ... 118
6.3.5 Power loss expected ... 119
6.4 Event notification SCSI transport protocol services ... 119
7 Task management functions ... 121
7.1 Task management function procedure calls ... 121
7.2 ABORT TASK ... 122
7.3 ABORT TASK SET ... 123
7.4 CLEAR ACA ... 123
7.5 CLEAR TASK SET ... 123
7.6 I_T NEXUS RESET ... 124
7.7 LOGICAL UNIT RESET ... 124
7.8 QUERY TASK ... 124
7.9 QUERY TASK SET ... 125
7.10 QUERY ASYNCHRONOUS EVENT ... 125
7.11 Task management function lifetime ... 126
7.12 Task management SCSI transport protocol services ... 127
7.12.1 Task management SCSI transport protocol services overview ... 127
7.12.2 Send Task Management Request SCSI transport protocol service request ... 127
7.12.3 Task Management Request Received SCSI transport protocol service indication ... 128
7.12.4 Task Management Function Executed SCSI transport protocol service response ... 128
7.12.5 Received Task Management Function Executed SCSI transport protocol service confirmation ... 129
7.13 Task management function example ... 130
8 Task set management ... 131
8.1 Introduction to task set management ... 131
8.2 Implicit head of queue ... 131
8.3 Command management model ... 131
8.4 Command management events ... 132
8.5 Command states ... 132
8.5.1 Overview ... 132
8.5.1.1 Command state nomenclature ... 132
8.5.1.2 Suspended information ... 133
8.5.2 Enabled command state ... 133
8.5.3 Blocked command state ... 133
8.5.4 Dormant command state ... 133
8.5.5 Completed command state ... 133
8.5.6 Command states and command lifetimes ... 133
8.6 Task attributes ... 134

8.6.1 Overview 134
8.6.2 Commands having the SIMPLE task attribute 134
8.6.3 Commands having the ORDERED task attribute 135
8.6.4 Commands having the HEAD OF QUEUE task attribute 135
8.6.5 Commands having the ACA task attribute 135
8.7 Command priority 135
8.8 Command state transitions 136
8.9 Task set management examples 137
8.9.1 Introduction 137
8.9.2 Commands having the HEAD OF QUEUE task attribute 138
8.9.3 Commands having the ORDERED task attribute 140
8.9.4 Commands having the ACA task attribute 141

Annex A (informative) Identifiers and names for objects 142
A.1 Identifiers and names overview 142
A.2 Identifiers and names 142

Annex B (informative) SCSI Initiator Port attributes and SCSI Target Port attributes supported by SCSI transport protocols 147

Annex C (informative) Terminology mapping to SAM-3 149

Annex D (informative) SCSI transport protocol acronyms 150
Bibliography 151

Table 1 — Numbering conventions 28
Table 2 — Constraint and note notation 28
Table 3 — Class diagram notation for classes 29
Table 4 — Multiplicity notation 30
Table 5 — Class diagram notation for associations 30
Table 6 — Class diagram notation for aggregations 31
Table 7 — Class diagram notation for generalizations 32
Table 8 — Class diagram notation for dependency 32
Table 9 — Object diagram notation for objects 33
Table 10 — Object diagram notation for link 33
Table 11 — Single level LUN structure using peripheral device addressing method 60
Table 12 — Single level LUN structure using flat space addressing method 60
Table 13 — Single level LUN structure using extended flat space addressing method 61
Table 14 — Eight byte LUN structure adjustments 62
Table 15 — Eight byte LUN structure 63
Table 16 — Format of addressing fields 63
Table 17 — ADDRESS METHOD field 64
Table 18 — Peripheral device addressing format 64
Table 19 — Flat space addressing format 66
Table 20 — Logical unit addressing format 66
Table 21 — Extended logical unit addressing format 68
Table 22 — LENGTH field and related sizes 68
Table 23 — Two byte extended logical unit addressing format 68
Table 24 — Four byte extended logical unit addressing format 69
Table 25 — Six byte extended logical unit addressing format 69
Table 26 — Eight byte extended logical unit addressing format 69
Table 27 — Logical unit extended addressing 70
Table 28 — Well known logical unit extended addressing format 70
Table 29 — Extended flat space addressing format 71
Table 30 — Logical unit not specified extended addressing format 71
Table 31 — Nexus 72
Table 32 — CONTROL byte 86
Table 33 — Status codes 86
Table 34 — Status qualifier format 87
Table 35 — SCOPE field 88
Table 36 — QUALIFIER field 89
Table 37 — SCSI device conditions that abort commands in a SCSI initiator device 98
Table 38 — SCSI device conditions that abort commands in a SCSI target device 99
Table 39 — Task management functions that abort commands 100
Table 40 — Command related conditions that abort commands 101
Table 41 — Command handling when ACA is not in effect 104
Table 42 — Aborting commands when an ACA is not established 104
Table 43 — Blocking and aborting commands when an ACA is established 106
Table 44 — Handling for new commands received on a faulted I_T nexus during ACA 107
Table 45 — Handling for new commands received on non-faulted I_T nexuses during ACA 108
Table 46 — Unit attention condition precedence level 111
Table 47 — Unit attention additional sense codes for events detected by SCSI target devices 117
Table 48 — Task Management Functions 121
Table 49 — Additional Response Information argument for QUERY ASYNCHRONOUS EVENT 126
Table 50 — UADE DEPTH field 126
Table 51 — Command management events that cause changes in command state 132
Table 52 — Command state nomenclature 132
Table 53 — Task attributes 134
Table 54 — Command priority 135
Table 55 — Task attribute and state indications in examples 137
Table 56 — Dormant command blocking boundary requirements 140
Table A.1 — Identifier attribute size and support requirements 142

Table A.2 — Name attribute size and support requirements 143
Table A.3 — Identifier attribute size for each SCSI transport protocol 143
Table A.4 — Identifier attribute format for each SCSI transport protocol 144
Table A.5 — Name attribute size for each SCSI transport protocol 145
Table A.6 — Name attribute format for each SCSI transport protocol 146
Table B.1 — SCSI Initiator Port attributes and SCSI Target Port attributes supported by SCSI transport protocols 148
Table C.1 — Terminology mapping to SAM-3 149

Figure 1 — SCSI standard structure 11
Figure 2 — Examples of association relationships in class diagrams 31
Figure 3 — Examples of aggregation relationships in class diagrams 31
Figure 4 — Example of generalization relationships in class diagrams 32
Figure 5 — Example of a dependency relationship in class diagrams 33
Figure 6 — Examples of link relationships for object diagrams 34
Figure 7 — Example state diagram 35
Figure 8 — Requirements precedence 37
Figure 9 — Client-server model 37
Figure 10 — SCSI client-server model 38
Figure 11 — SCSI I/O system and domain model 40
Figure 12 — SCSI Domain class diagram overview 41
Figure 13 — SCSI Domain class diagram 42
Figure 14 — SCSI domain object diagram 42
Figure 15 — SCSI Device class diagram 43
Figure 16 — SCSI Port class diagram 44
Figure 17 — SCSI Initiator Device class diagram 47
Figure 18 — SCSI Target Device class diagram 50
Figure 19 — Level 1 Hierarchical Logical Unit class 51
Figure 20 — Logical Unit class diagram 54
Figure 21 — Eight byte LUN structure adjustments 62
Figure 22 — Logical unit selection using the peripheral device addressing format 65
Figure 23 — Logical unit selection using the logical unit addressing format 67
Figure 24 — SCSI device functional models 73
Figure 25 — Multiple port target SCSI device structure model 74
Figure 26 — Multiple port SCSI initiator device structure model 75
Figure 27 — Multiple port SCSI device structure model 76
Figure 28 — SCSI target device configured in a single SCSI domain 77
Figure 29 — SCSI target device configured in multiple SCSI domains 78
Figure 30 — SCSI target device and SCSI initiator device configured in a single SCSI domain 78
Figure 31 — Protocol service reference model 79
Figure 32 — SCSI transport protocol service mode 80
Figure 33 — Request-Response SAL transaction and related STPL services 81
Figure 34 — SCSI transport protocol service model for data transfers 81
Figure 35 — Device server data transfer transaction and related STPL services 82
Figure 36 — SCSI transport protocol service model for Terminate Data Transfer 82
Figure 37 — Device server Terminate Data Transfer transaction and related STPL services 83
Figure 38 — Model for Data-In and Data-Out data transfers 93
Figure 39 — Command processing events 103
Figure 40 — Events and event notifications for SCSI target devices 115
Figure 41 — Events and event notifications for SCSI initiator devices 116
Figure 42 — Task management processing events 130
Figure 43 — Example of Dormant state command behavior 134
Figure 44 — Command states 136
Figure 45 — Commands having the HEAD OF QUEUE task attribute and blocking boundaries (example 1) 138
Figure 46 — Commands having the HEAD OF QUEUE task attribute and blocking boundaries (example 2) 139
Figure 47 — Commands having ORDERED task attributes and blocking boundaries 140
Figure 48 — Commands having ACA task attributes example 141