

INCITS 551-2019

# American National Standard

*for Information Technology –  
SCSI RDMA Protocol-2 (SRP-2)*

---

**Developed by**



*Where IT all begins*



This is a preview of "INCITS 551-2019". [Click here to purchase the full version from the ANSI store.](#)

**INCITS 551-2019**

American National Standard  
for Information Technology –  
**SCSI RDMA Protocol-2 (SRP-2)**

Secretariat

**Information Technology Industry Council**

Approved November 7, 2019

**American National Standards Institute, Inc.**

**Abstract**

This standard describes the message format and protocol definitions required to transfer commands and data between a SCSI (Small Computer System Interface) initiator port and a SCSI target port using an RDMA communication service.

## American National Standard

Approval of an American National Standard requires review by ANSI that the requirements for due process, consensus, and other criteria for approval have been met by the standards developer.

Consensus is established when, in the judgement of the ANSI Board of Standards Review, substantial agreement has been reached by directly and materially affected interests. Substantial agreement means much more than a simple majority, but not necessarily unanimity. Consensus requires that all views and objections be considered, and that a concerted effort be made towards their resolution.

The use of American National Standards is completely voluntary; their existence does not in any respect preclude anyone, whether he has approved the standards or not, from manufacturing, marketing, purchasing, or using products, processes, or procedures not conforming to the standards.

The American National Standards Institute does not develop standards and will in no circumstances give an interpretation of any American National Standard. Moreover, no person shall have the right or authority to issue an interpretation of an American National Standard in the name of the American National Standards Institute. Requests for interpretations should be addressed to the secretariat or sponsor whose name appears on the title page of this standard.

**CAUTION NOTICE:** This American National Standard may be revised or withdrawn at any time. The procedures of the American National Standards Institute require that action be taken periodically to reaffirm, revise, or withdraw this standard. Purchasers of American National Standards may receive current information on all standards by calling or writing the American National Standards Institute.

**CAUTION:** The developers of this standard have requested that holders of patents that may be required for the implementation of the standard disclose such patents to the publisher. However, neither the developers nor the publisher have undertaken a patent search in order to identify which, if any, patents may apply to this standard. As of the date of publication of this standard, following calls for the identification of patents that may be required for the implementation of the standard, notice of one or more such claims has been received. By publication of this standard, no position is taken with respect to the validity of this claim or of any rights in connection therewith. The known patent holder(s) has (have), however, filed a statement of willingness to grant a license under these rights on reasonable and nondiscriminatory terms and conditions to applicants desiring to obtain such a license. Details may be obtained from the publisher. No further patent search is conducted by the developer or publisher in respect to any standard it processes. No representation is made or implied that this is the only license that may be required to avoid infringement in the use of this standard.

Published by

**American National Standards Institute, Inc.  
25 West 43rd Street, New York, NY 10036**

Copyright © 2019 by Information Technology Industry Council (ITI)  
All rights reserved.

No part of this publication may be reproduced in any form, in an electronic retrieval system or otherwise, without prior written permission of ITI, 700 K Street NW, Suite 600, Washington, DC 20001.

Printed in the United States of America

## Contents

	Page
1 Scope .....	1
2 Normative references .....	2
3 Definitions, symbols, abbreviations, and conventions .....	3
3.1 Definitions .....	3
3.2 Symbols and abbreviations .....	6
3.2.1 Abbreviations .....	6
3.2.2 Mathematical operators .....	6
3.3 Keywords .....	6
3.4 Editorial conventions .....	7
3.5 Numeric and character conventions .....	8
3.5.1 Numeric conventions .....	8
3.5.2 Units of measure .....	9
3.5.3 Byte encoded character strings conventions .....	10
3.6 Bit and byte ordering .....	10
3.7 Notation for procedure calls .....	12
4 RDMA communication service model .....	15
4.1 Overview .....	15
4.2 RDMA Channels .....	16
4.2.1 Introduction .....	16
4.2.2 Establishment .....	16
4.2.3 Disestablishment .....	19
4.3 Messages .....	19
4.4 RDMA operations .....	19
4.4.1 Overview .....	19
4.4.2 RDMA Read operations .....	20
4.4.3 RDMA Write operations .....	20
4.5 Ordering and Reliability .....	20
4.5.1 Ordering and reliability overview .....	20
4.5.2 Reliability .....	21
4.5.3 Ordering .....	21
5 Structure and concepts .....	22
5.1 Overview of SRP operation .....	22
5.1.1 RDMA channel establishment and login .....	22
5.1.2 Single RDMA channel operation .....	22
5.1.3 Multiple independent RDMA channel operation .....	22
5.1.4 RDMA channel disconnection .....	23
5.2 Identifiers .....	24
5.3 Alias associations .....	24
5.4 Information unit classes .....	24
5.5 SRP target port buffer management .....	24
5.5.1 Buffer management overview .....	24
5.5.2 SRP requests issued by target port .....	24
5.5.3 Requests issued by initiator port .....	25
5.6 Data buffers .....	26
5.6.1 Memory descriptors .....	26
5.6.2 Data buffer descriptors .....	27
5.6.2.1 Overview .....	27
5.6.2.2 Supported data buffer descriptor formats .....	28
5.6.2.3 No data buffer descriptor present .....	29
5.6.2.4 Direct data buffer descriptor format .....	29

5.6.2.5 Indirect data buffer descriptor format .....	30
5.6.2.5.1 SRP target port indirect data restrictions .....	31
5.6.2.5.2 Examples of indirect data buffers .....	31
5.6.2.6 Immediate data buffer descriptor format .....	33
6 SRP Information Units .....	34
6.1 Summary .....	34
6.2 SRP_LOGIN_REQ request .....	36
6.3 SRP_LOGIN_RSP response .....	38
6.4 SRP_LOGIN_REJ response .....	40
6.5 SRP_I_LOGOUT request .....	41
6.6 SRP_T_LOGOUT request .....	42
6.7 SRP_TSK_MGMT request .....	45
6.8 SRP_CMD request .....	47
6.9 SRP_RSP response .....	51
6.10 SRP_CRED_REQ request .....	55
6.11 SRP_CRED_RSP response .....	56
7 SCSI mode parameters .....	57
7.1 SCSI mode parameter overview and codes .....	57
7.2 Disconnect-reconnect mode page .....	57
7.3 Protocol specific LUN mode page .....	59
7.4 Protocol specific port mode page .....	59
Annex A (Normative) SRP-2 interface protocol and services .....	61
A.1 Service interface protocol .....	61
A.2 SRP services .....	63
A.3 Terminology mapping to SAM-5 .....	63
A.4 Procedure arguments .....	64
A.5 SCSI transport protocol services .....	66
A.5.1 SCSI transport protocol services overview .....	66
A.5.2 Send SCSI Command SCSI transport protocol service .....	66
A.5.3 Command processing considerations .....	67
A.5.3.1 Receive Data-Out SCSI transport protocol service .....	68
A.5.4 Send Data-In SCSI transport protocol service .....	68
A.6 Task management services .....	69
A.6.1 Task management functions overview .....	69
A.6.2 Task management functions .....	69
A.6.3 ABORT TASK .....	69
A.6.4 ABORT TASK SET .....	69
A.6.5 CLEAR ACA .....	70
A.6.6 CLEAR TASK SET .....	70
A.6.7 LOGICAL UNIT RESET .....	70
A.6.8 I_T NEXUS RESET .....	70
A.6.9 QUERY TASK .....	70
A.6.10 QUERY TASK SET .....	70
A.6.11 QUERY ASYNCHRONOUS EVENT .....	70
Annex B (Normative) SRP for the InfiniBand™ Architecture .....	71
B.1 Overview .....	71
B.2 Normative references .....	71
B.3 Definitions .....	71
B.3.1 Introduction to definitions .....	71
B.3.2 Definitions .....	71
B.4 Abbreviations .....	72
B.5 IB overview .....	73
B.6 SCSI architecture mapping .....	76

B.7 Communication management .....	77
B.7.1 Communication management overview .....	77
B.7.2 Discovering SRP target ports .....	77
B.7.3 Establishing a connection .....	78
B.7.4 Releasing a connection .....	78
B.7.5 Errors .....	78
B.7.6 Data-out and data-in operations .....	79
B.8 InfiniBand™ Architecture protocol requirements .....	79
Annex C (Informative) Bibliography .....	83

## Tables

	Page
Table 1 — Numbering conventions .....	9
Table 2 — Comparison of decimal prefixes and binary prefixes .....	10
Table 3 — Example of ordering of bits and bytes within a data dword .....	11
Table 4 — Example of ordering of bits and bytes within a data dword element .....	12
Table 5 — Memory descriptor .....	26
Table 6 — Data buffer descriptor format codes .....	28
Table 7 — Data buffer descriptor format (required and supported) .....	29
Table 8 — Indirect data buffer descriptor .....	30
Table 9 — Immediate data buffer descriptor .....	33
Table 10 — SRP requests sent from SRP initiator ports to SRP target ports .....	34
Table 11 — SRP responses sent from SRP target ports to SRP initiator ports .....	34
Table 12 — SRP requests sent from SRP target ports to SRP initiator ports .....	34
Table 13 — SRP responses sent from SRP initiator ports to SRP target ports .....	35
Table 14 — SRP_LOGIN_REQ request .....	36
Table 15 — MULTICHANNEL ACTION field .....	37
Table 16 — SRP_LOGIN_RSP response .....	38
Table 17 — MULTICHANNEL RESULT field .....	39
Table 18 — SRP_LOGIN_REJ response .....	40
Table 19 — REASON field .....	41
Table 20 — SRP_I_LOGOUT request .....	42
Table 21 — SRP_T_LOGOUT request .....	43
Table 22 — REASON field .....	44
Table 23 — SRP_TSK_MGMT request .....	45
Table 24 — TASK MANAGEMENT FUNCTION field .....	46
Table 25 — SRP_CMD request .....	48
Table 26 — task attribute field .....	49
Table 27 — SRP_RSP response .....	51
Table 28 — RESPONSE DATA field .....	54
Table 29 — RSP_CODE field .....	55
Table 30 — SRP_CRED_REQ request .....	55
Table 31 — SRP_CRED_RSP response .....	56
Table 32 — SRP mode page codes .....	57
Table 33 — Disconnect-Reconnect mode page for SRP .....	58
Table A.1 — Terminology mapping to SAM-5 .....	63
Table A.2 — Procedure arguments .....	65
Table A.3 — Processing of execute command procedure call for a Send SCSI Command SCSI transport protocol service .....	67
Table A.4 — Processing of execute command procedure call for a Receive Data-Out SCSI transport protocol service .....	68
Table A.5 — Processing of execute command procedure call for a Send Data-In SCSI transport protocol service .....	69
Table B.1 — IB names and addresses .....	75
Table B.2 — IB SRP initiator port identifier .....	76
Table B.3 — IB SRP target port identifier .....	77
Table B.4 — IB RDMA header fields .....	79
Table B.5 — Transport operation support requirements .....	79
Table B.6 — IOUnit attributes for SRP target ports .....	80
Table B.7 — IOControllerProfile attributes for SRP target ports .....	81
Table B.8 — ServiceEntries attribute pair for SRP target ports .....	82

## Figures

	Page
Figure 1 — SCSI document structure .....	1
Figure 2 — RDMA communication service example .....	15
Figure 3 — Example RDMA channel establishment .....	17
Figure 4 — Memory descriptor mapping .....	27
Figure 5 — Example indirect data buffer descriptor with no PARTIAL MEMORY DESCRIPTOR LIST field .....	32
Figure 6 — Example indirect data buffer descriptor with a PARTIAL MEMORY DESCRIPTOR LIST field .....	33
Figure A.1 —SRP reference model .....	61
Figure A.2 —Model for a four-step confirmed service .....	62
Figure A.3 —Model for a two-step confirmed service .....	63
Figure B.1 —IB device example .....	73
Figure B.2 —IB I/O unit example .....	74
Figure B.3 —SCSI architecture mapping .....	76

**Foreword** (This foreword is not part of American National Standard INCITS 551.)

Requests for interpretation, suggestions for improvement or addenda, or defect reports are welcome. They should be sent to InterNational Committee for Information Technology Standards (INCITS), ITI, 700 K Street, NW, Suite 600, Washington, DC 20001.

This standard was processed and approved for submittal to ANSI by INCITS. Committee approval of this standard does not necessarily imply that all committee members voted for its approval. At the time it approved this standard, INCITS had the following members:

Laura Lindsay, Chair  
 Donald Deutsch, Vice-Chair  
 Jennifer Garner, Secretary

<i>Organization Represented</i>	<i>Name of Representative</i>
Adobe Systems, Inc. ....	Scott Foshee
AIM Global, Inc. ....	Steve Halliday
	Mary Lou Bosco (Alt.)
	Chuck Evanhoe (Alt.)
Amazon Web Services, Inc. ....	Oliver Bell
	Sean Estrada (Alt.)
Apple .....	Helene Workman
	David Singer (Alt.)
	Anna Weinberg (Alt.)
CA Technologies .....	Ron Doyle
Department of Commerce - NIST.....	Michael Hogan
	Wo Chang (Alt.)
	Sal Francomacaro (Alt.)
Farance, Inc. ....	Frank Farance
	Timothy Schoechle (Alt.)
Futurewei Technologies, Inc. ....	Wael Diab
	Wilbert Adams (Alt.)
	Timothy Jeffries (Alt.)
Google .....	Catherine Nelson
	Tommy Ward (Alt.)
GS1GO.....	Steven Keddie
	Edward Merrill (Alt.)
	Dan Mullen (Alt.)
HP, Inc.....	Karen Higginbottom
	Paul Jeran (Alt.)
	Lonnie Mandigo (Alt.)
	Vanitha Venkateshlu (Alt.)
IBM Corporation .....	Steve Holbrook
	Alexander Tarpinian (Alt.)
Intel Corporation.....	Philip Wennblom
	Grace Wei (Alt.)
Microsoft Corporation .....	Laura Lindsay
	John Calhoon (Alt.)
Oracle.....	Donald Deutsch
	Anish Karmarkar (Alt.)
	Michael Kavanaugh (Alt.)
	Jim Melton (Alt.)
	Jan-Eike Michels (Alt.)
	Elaine Newton (Alt.)
Qualcomm, Inc. ....	Michael Atlass
	Mazen Chmaytelli (Alt.)
	Marta Karczewicz (Alt.)
	Farrokh Khatibi (Alt.)
Telecommunications Industry Association (TIA) .....	Florence Otieno

<i>Organization Represented</i>	<i>Name of Representative</i>
United States Dept. of Defense - Joint Artificial Intelligence Center .....	Steven Harrison
VMware, Inc. ....	Stephen Diamond Salim AbiEzzi (Alt.) Eric Betts (Alt.) Lawrence Lamers (Alt.)

Technical Committee T10 on SCSI Storage Interfaces, which reviewed this standard, had the following members:

William Martin, Chair  
Curtis Ballard, Vice-Chair  
Curtis Stevens, Secretary  
Frederick Knight, International Representative

<i>Organization Represented</i>	<i>Name of Representative</i>
Advantest .....	Danielle Romano
Amphenol Corporation .....	Gregory McSorley Brad Brubaker (Alt.) David Chan (Alt.) Paul Coddington (Alt.) Zhineng Fan (Alt.) Adrian Green (Alt.) Donald Harper (Alt.) Yifan Huang (Alt.) Martin Li (Alt.) Chris Lyon (Alt.) Alex Persaud (Alt.) Michael Scholeno (Alt.) Hu Silver (Alt.) Michael Wingard (Alt.) CN Wong (Alt.) Matt Wright (Alt.)
Anritsu Corporation .....	Tadanori Nishikobara
BizLink Technology, Inc. ....	Tristan Hsiao
Broadcom, Inc. ....	Brad Besmer Patrick Bashford (Alt.) Jim Borowiak (Alt.) Srikiran Dravida (Alt.) John Gardner (Alt.) Jeffrey Gauvin (Alt.) Rick Kutcipal (Alt.) Bernhard Laschinsky (Alt.) David Peterson (Alt.) Robert Sheffield (Alt.) James Smart (Alt.) Jason Stuhlsatz (Alt.) Steven Wilson (Alt.)
Cadence Design Systems, Inc. ....	Lana Chan Vinod Lakshman (Alt.) Deep Mehta (Alt.) Gurudatta Mewundi (Alt.)
Clearsky Data, Inc. ....	Daniel Suman
Dell, Inc. ....	Kevin Marks David Black (Alt.) George Ericson (Alt.) Christopher Goonan (Alt.) Gary Kotzur (Alt.) Bill Lynn (Alt.) Ash McCarty (Alt.) Marlon Ramroopsingh (Alt.)
Flextronics International (Taiwan), Ltd. ....	Roger Wan Istvan BakroNagy (Alt.)

<i>Organization Represented</i>	<i>Name of Representative</i>
Foxconn Interconnect Technology, Ltd. (FIT).....	Fred Fons Gary Hsieh (Alt.) Glenn Moore (Alt.) Miller Zhao (Alt.)
Fujitsu America, Inc. ....	Kun Katsumata Osamu Kimura (Alt.) Mark Malcolm (Alt.) Gene Owens (Alt.)
Futurewei Technologies, Inc.....	Eddy Zhou Xiaoyu Ge (Alt.) Xu Qi ming (Alt.) Jia Shi (Alt.) Fang You (Alt.)
Genesis Technology USA .....	Gray Vallely Mickey Felton (Alt.)
Google .....	Radha Ramachandran Thieu Le (Alt.)
Hewlett Packard Enterprise .....	Curtis Ballard Chris Cheng (Alt.) Robert Elliott (Alt.) Barry Olawsky (Alt.) Han Wang (Alt.) Jeff Wolford (Alt.)
IBM Corporation .....	Kevin Butt Mike Osborne (Alt.)
Intel Corporation .....	Chunfei Ye Michael Allison (Alt.) Eric Pickering (Alt.) Tzewan Wang (Alt.) Juntao Yuan (Alt.)
Lingua Data LLC.....	Joe Breher
Lotes Company, Ltd. ....	DT Dao Stephen Chiu (Alt.) John Lynch (Alt.)
LUXSHARE-ICT, Inc. ....	Scott Shuey Josue Castillo (Alt.) Jinhua Chen (Alt.) Pat Young (Alt.)
Marvell Semiconductor, Inc. ....	James Walch Craig Carlson (Alt.) Leon Krantz (Alt.) Wei Liu (Alt.) Wei Zhou (Alt.)
Micron Technology, Inc. ....	Paul Suhler Michael George (Alt.) Dan Hubbard (Alt.)
Microsemi, a Mirochip Company .....	Jermiah Tussey Sapna Devi (Alt.) Sanjay Goyal (Alt.) Vincent Hache (Alt.) David Hong (Alt.) Adnan Jiwani (Alt.) Chethen K (Alt.) Marudhu Karthikeyan (Alt.) Anil Kumar (Alt.) Nitin Kumar (Alt.) Keith Shaw (Alt.) Ariel Sibley (Alt.) Tim Symons (Alt.) Gregory Tabor (Alt.)
Microsoft Corporation .....	Lee Prewitt Vishal Jose Mannanal (Alt.) Paul Lubner (Alt.) Bryan Matthew (Alt.)

<i>Organization Represented</i>	<i>Name of Representative</i>
Molex, Inc. ....	Alexandra Haser Jay Neer (Alt.) Ed Poh (Alt.) Darian Schulz (Alt.) Scott Sommers (Alt.)
NetApp, Inc. ....	Frederick Knight Chris Fore (Alt.) Jaimon George (Alt.) John Meneghini (Alt.) Urmi Misra (Alt.) Vijay Rao (Alt.)
Nexsan Technologies.....	Andy Garrett
Oracle.....	Martin Petersen Jon Allen (Alt.) Lance Hartmann (Alt.) Phi Tran (Alt.) Lee Wan-Hui (Alt.)
QNAP Systems, Inc. ....	Ming-chih Chang CH Yang (Alt.)
Quantum Corporation.....	Darryl Torske Carsten Prigge (Alt.)
Realtek Semiconductor .....	Chien-Kuo Cheng
Samsung Semiconductor, Inc. (SSI).....	William Martin Judy Brock (Alt.) HeeChang Cho (Alt.) MiKyeong Kang (Alt.) Sung Lee (Alt.) Aishwarya Ravichandran (Alt.)
Samtec, Inc. ....	David Givens
Seagate Technology .....	Gerald Houlder Umamahesh Allenki (Alt.) Andre Boyogueno (Alt.) Alvin Cox (Alt.) Ian Davies (Alt.) John Fleming (Alt.) Jim Hatfield (Alt.) Anil Keste (Alt.) Tony Kilwein (Alt.) Judy Westby (Alt.)
ShenZhen TIGO Semiconductor Co., Ltd. ....	Jiwei Liu
Silicon Motion, Inc. ....	Amanda Huang Edward Hsieh (Alt.) Sky Hsu (Alt.)
SK Hynix, Inc. ....	Andie Choi Tom Friend (Alt.) Johnny Lam (Alt.) Suna Shin (Alt.) Neil Wanamaker (Alt.)
Socionext .....	Masaru Suzuki Toru Iwata (Alt.) Hideyuki Kabuo (Alt.) Masanori Okinoi (Alt.)
TE Connectivity .....	Nathan Tracy Dan Gorenc (Alt.) Tom Grzysiewicz (Alt.) Kyle Klinger (Alt.) Jeff Mason (Alt.) Joel Meyers (Alt.) Eric Powell (Alt.)
Teledyne LeCroy Corporation .....	Amit Bakshi Douglas Lee (Alt.)
Toshiba America Electronic Components, Inc. ....	Patrick Hery Johanna Hernandez (Alt.) Juji Katori (Alt.) Scott Wright (Alt.)

<i>Organization Represented</i>	<i>Name of Representative</i>
Toshiba Memory Corporation .....	Curtis Stevens Mark Carlson (Alt.) John Geldman (Alt.) Don Harwood (Alt.) Koichi Nagai (Alt.) Tatsuya Tanaka (Alt.)
Unisys Corporation .....	Jeffrey Dremann Phil Shelton (Alt.)
Viavi Solutions, Inc. ....	Jason Rusch George Bullis (Alt.) Dominic Coupal (Alt.) Paul Gentieu (Alt.) Jason Mann (Alt.) Francisco Roy (Alt.) Yamini Shastry (Alt.)
VMware, Inc.....	Neil MacLean Wenchao Cui (Alt.) Patrick Dirks (Alt.) Wenhua Liu (Alt.) Mike Panas (Alt.) Murali Rajagopal (Alt.) Ahmad Tawil (Alt.)
Western Digital Corporation .....	Dave Landsman David Brewer (Alt.) Jorge Campello (Alt.) Frank Chu (Alt.) Marvin DeForest (Alt.) Kirill Dimitrov (Alt.) Jason Gao (Alt.) Michael Koffman (Alt.) Larry McMillian (Alt.) Chet Mercardo (Alt.) Nadesan Narenthiran (Alt.) Nathan Obr (Alt.) Christopher Reed (Alt.) Yoni Shternhell (Alt.) Ralph Weber (Alt.)

*Emeritus*

William Ham  
John Lohmeyer

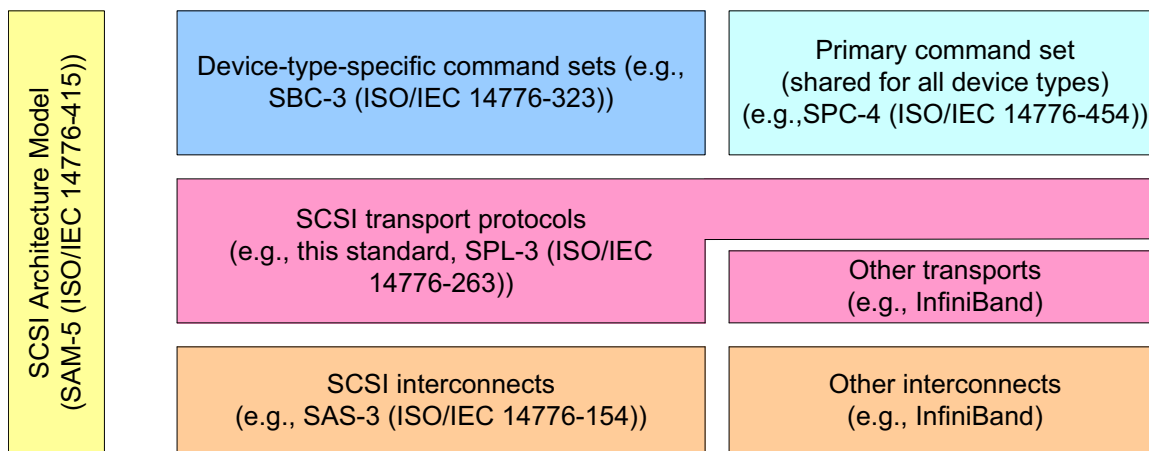
**American National Standard  
for Information Technology -**

# SCSI RDMA Protocol-2 (SRP-2)

## 1 Scope

The SCSI family of standards provides for many different transport protocols that define the rules for exchanging information between different SCSI devices. This standard defines the rules for exchanging information between SCSI devices using RDMA (Remote Direct Memory Access). Other SCSI transport protocol standards define the rules for exchanging information between SCSI devices using other interconnects.

Figure 1 shows the relationship of this standard to the other standards and related projects in the SCSI family of standards as of the publication of this standard.



**Figure 1 — SCSI document structure**

Figure 1 shows the general relationship of the documents to one another, and do not imply any hierarchy, protocol stack, or system architecture relationship.

These standards specify the interfaces, functions and operations necessary to ensure interoperability between conforming implementations. This standard is a functional description. Conforming implementations may employ any design technique that does not violate interoperability.

This standard has made obsolete the following:

- a) SRP\_AER\_REQ request;
- b) SRP\_AER\_RSP response;
- c) asynchronous event solicited notification (AESOLNT) bit;
- d) the MAXIMUM BURST SIZE field of the Disconnect-Reconnect mode page; and
- e) the EMDP bit of the Disconnect-Reconnect mode page.