X3T9.2/92-145 R0

August 21, 1992 DRAFT 3

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Serial Storage Architecture, SCSI Mapping (informational presentation)

Document X3T9.2/92-145r0

Attached is a paper on Serial Storage Architecture, SCSI Mapping presented at the X3T9.2 ANSI meeting in Bellevue WA on Monday August 17th, 1992. This document may be sent out in the ANSI X3T9.2 mailing. The paper is for informational purposes to inform the X3T9.2 membership of the work going on in regards to Serial Storage Architecture (SSA). No action is necessary.

For more information, contact John Scheible via phone, FAX, or EMail as described on the title page.

John P. Scheible
Advisory Engineer/Scientist

JPS:jps

Attachment

To: X3T9.2 Committee

From: John Scheible, IBM

Subject: SCSI mapping on Serial SSA

Serial Storage Architecture SCSI mapping (SSA-SCSI) Version 1.1 Document number X3T9.2/92-145r0

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Version 1.1 August 92

The following changes were made based on the June/July meeting comments and comments from other sources.

1. Increase CRC bytes to 4 bytes (from 2 bytes)

2. **SCSI_Command Message**

    - Moved Channel field to make position consistent with other messages.
    - Add Vendor Unique bytes.
    - Moved *DDRM* and *Split* fields to allow for expansion of *Queue_Type* field (>2 bits).

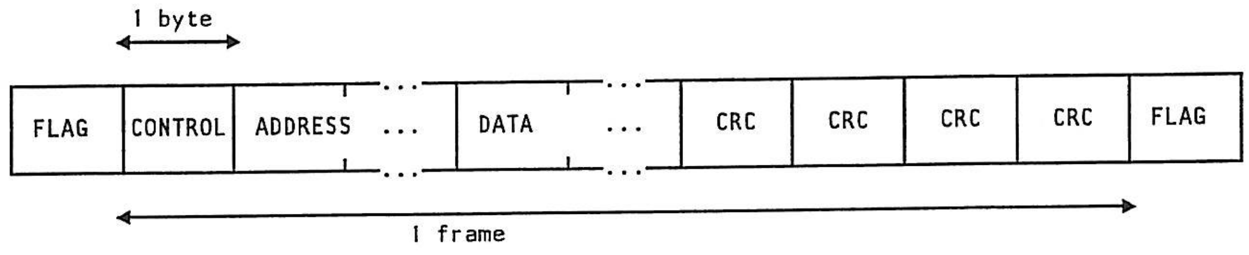
3. **SCSI_Data_Reply**

    - Moved Channel field to make position consistent with other messages.

4. Added Vendor Unique message code ranges.

5. Pad messages to a multiple of four bytes for ease in 4 byte wide data transfer, and for additional error checking.

Frame format



- FLAG (1 Protocol character)

  Frame delimiter

  Byte synchronization (Also sent when idle)

- CONTROL FIELD (1 byte)

  Frame type (Application, Privileged, Reset)

  Frame sequence number

- ADDRESS FIELD (1 - 6 bytes)

  Routes the frame to the destination node

  Then selects a channel

- DATA FIELD (0 - 128 bytes)

  Message (eg. command or status)

  Data

- CRC FIELD (4 bytes)

  Protects Control, Address and Data fields

- Each frame expects 2 responses:

  ACK indicates the frame was received OK

  RR paces the next frame

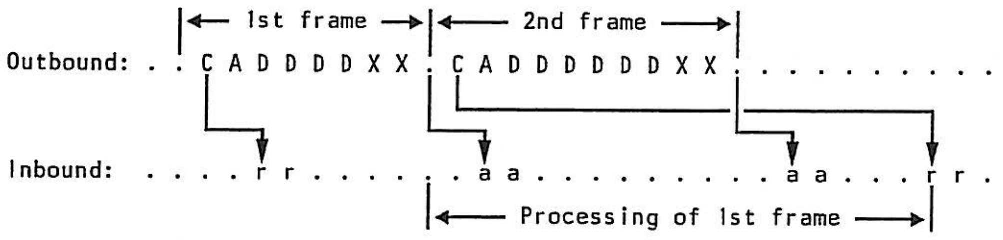
- ACK and RR are protocol characters, not frames

  Duplicated for checking

  Can be interleaved within a frame to reduce latency

- Typical transfer with A/B buffering

  NB. Half-duplex for clarity, but full-duplex is supported


1st frame
2nd frame
Outbound: . . C A D D D D X X . C A D D D D D D X X . . . .
Inbound: . . . . r r . . . . a a . . . . a a . . . . r r .
Processing of 1st frame

Data characters:

C – Control

A – Address

D – Data

X – CRC

Protocol characters:

. – FLAG

a – ACK

r – RR

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- Automatic (No address switches)
- All Initiators & Switches have a **Unique_ID** in EPROM

  Vendor_ID (4 bytes) + Node_ID (4 bytes)

  Detects cycles during configuration

- Each Initiator builds a **Configuration table**

  Lists every node & its Path address(es)

  Built by 'walking' network with **Query_node** message

- One Initiator is the **Master**

  Coordinates the processing of asynchronous alerts

  Issues **Configure_port** messages to all other nodes

- Each Target builds an **Initiator table**

  Lists every Initiator with its Unique_ID & Path address(es)

  Built from information in Query_node

  Used to quiesce commands after an error

- Conforms with SCSI-2 programming model:
  - Tagged queuing
  - Command descriptor blocks
  - Status byte
  - Sense bytes
- Maps the following SCSI-2 functions:
  - Bus phases
  - Initiator & Target addressing
  - Messages
- Better performance than parallel SCSI:
  - Full duplex, frame multiplexing & spatial reuse
  - No arbitration, disconnection & reselection
  - Minimum Initiator-Target exchanges
  - Concurrent I/O processes (Same or different devices)
  - Out-of-order data transfers
- Integrated spindle synchronization
- Based on the IBM 9333 adapter-controller link

- The frame address field specifies:

  1. The **Path** to the destination node

  2. A **Channel** within the destination node

- Channel 0h is predefined to receive **messages**

  eg. commands, status and initiating data transfers

- All other Channels are used to receive data

  Dynamically allocated by exchanging messages

- All messages contain a 2-byte **Tag**

  Identifies the SCSI nexus (Target, LUN and Queue tag)

  Allocated by the Initiator in the SCSI_command message

  Freed when the Target returns a SCSI_status message

  Must be unique among all active Tags from that Initiator, but no cross initiator uniqueness required.

- Logical Unit = 128 (0..127)

- Target Routine = 128 (128..255)

- Addresses = 5 1/2 bytes (capacity depends on topology)

- Simultaneous data transfers = 65535 (1..FFFFh)

- Tag Field = 2 bytes

  Tag must be unique for all outstanding commands/messages for a given initiator. No cross initiator tag uniqueness is required.

- Command Descriptor Block = Same as SCSI-2 (SCSI-3?)

  However, the LUN field can be overridden with the expanded LUN.

Allows an Initiator to send a SCSI command to a Target:

	Bit 7	6	5	4	3	2	1	0
Byte 0	Message_code = 10h							
1	LUNTAR	LUNTRN						
2	Tag							
3								
4	Return_path							
.								
7								
8	Reserved for vendor unique							
9								
10	DDRM	Split	Reserved = 0				Queue_ctl	
11	Reserved = 00h							
12	Channel							
13								
14	Command_descriptor_block (CDB)							
.								
m								

LUNTAR, LUNTRN	Addresses Logical Unit or Target routine
Tag	Allocated by Initiator
Return_path	Path address to Initiator + Channel 0h
Vendor Unique	Reserved for Vendor Unique functions
DDRM	If set, disable Data_ready message on reads
Split	If set, enables split read or split write
Queue_ctl	Unqueued, Head, Unordered or Ordered
Channel	Channel for read data if DDRM = 1
CDB	6, 10 or 12 bytes, as defined by parallel SCSI-2

Allows a Target to present SCSI status to the Initiator:

Byte	Bit 7	6	5	4	3	2	1	0
0	Message_code = 11h							
1	Reserved = 0						Flag	Link
2	Tag							
3								
4	Status							
5	Reserved = 00h							
6								
7								

Flag	Copied from SCSI_command
Link	If set, Initiator will send another SCSI_command
Tag	Identifies the nexus
Status	As defined by parallel SCSI-2

Allows a Target to request a data transfer to the Initiator:

Byte	Bit 7	6	5	4	3	2	1	0
0	Message_code = 20h							
1	Reserved = 00h							
2	Tag							
3								
4	Byte_count							
.								
7								
8	Byte_offset							
.								
11								

Tag	Identifies the nexus
Byte_count	Number of bytes currently being offered by Target
Byte_offset	Starting position, relative to first byte requested

Sent from an Initiator to a Target in reply to Data_ready:

Byte	Bit 7 6 5 4 3 2 1 0
0	Message_code = 21h
1	Reserved = 00h
2 – 3	Tag
4 . 7	Byte_count
8 . 11	Reserved = 00h
12 – 13	Channel
14 – 15	Reserved = 00h

Tag Identifies the nexus

Byte_count Number of bytes the Initiator can currently accept

Reserved A place holder for Byte_Offset in other messages to allow consistent field location.

Channel Channel address for data frames

Allows a Target to request a data transfer from the Initiator:

	Bit 7	6	5	4	3	2	1	0
Byte 0	Message_code = 21h							
1	Reserved = 00h							
2	Tag							
3								
4	Byte_count							
.								
7								
8	Byte_Offset							
.								
11								
12	Channel							
13								
14	Reserved = 00h							
15								

Tag	Identifies the nexus
Byte_count	Number of bytes currently being requested
Byte_offset	Starting position relative to first byte requested
Channel	Channel address for data frames

INITIATOR	**TARGET**
Initialize DMA channel	
SCSI_command message —>	
	Queue command
	Execute command
<—	**Data** frames
	.
	.
	.
<—	**SCSI_status** message

Read scenario (DDRM=0) X3T9.2/92-145r0

<u>**INITIATOR**</u> <u>**TARGET**</u>

SCSI_command message —>

Queue command

Execute command

<— **Data_ready** message

Initialize DMA channel

Data_reply message ———>

<— **Data** frames

.

.

.

<— **SCSI_status** message

- There can be several Data_ready messages

  eg. a split read

- Each Data_ready can have several Data_reply messages

  eg. Initiator has limited buffer space

Write scenario

INITIATOR	TARGET
SCSI_command message ——>	
	Queue command
	Execute command
	<—— **Data_request** message
Initialize DMA channel	
Data frames ———————>	
.	
.	
.	
	<—— **SCSI_status** message

- There can be several Data_request messages, eg.

  RAID-5

  Target has limited buffer space

Other messages

- **Abort_tag** (Tag, Return_path, Tag_2)

  Aborts the command specified by Tag_2 only

- **Abort** (LUNTAR, LUNTRN, Tag, Return_path)

  Aborts all commands from this Initiator on specified LUN/TRN

- **Clear_queue** (LUNTAR, LUNTRN, Tag, Return_path)

  Aborts all commands from all Initiators on specified LUN/TRN

- **Reset** (Tag, Return_path)

  Aborts all commands from all Initiators on all LUN/TRN's

- **Quiesce** (Tag, Return_path, Unique_ID)

  Aborts all commands for specified Initiator on all LUN/TRN's

- **Response** (Return_code, Tag)

  Confirms receipt of any message above

A Target handles invalid messages as follows:

1. If the Return_path is known:

   Send Response with Return_code = FFh to the Initiator

2. If the Return_path is not known:

   Send Link_alert specifying 'Message reject' to the Master

   Master sends Master_alert to all other Initiators

SCSI-2	SSA-SCSI
No Operation	n/a
Simple Queue Tag	SCSI_command(Queue_ctl=11, Tag)
Head of Queue Tag	SCSI_command(Queue_ctl=01, Tag)
Ordered Queue Tag	SCSI_command(Queue_ctl=10, Tag)
Identify (Out)	SCSI_command(LUNTAR, LUNTRN)
Identify (In)	Data_ready(Tag)
"	Data_request(Tag)
"	SCSI_status(Tag)
Command Complete	SCSI_status
Linked Command Complete	SCSI_status(Link=1)
Linked Command Complete with Flag	SCSI_status(Link=1, Flag=1)
Disconnect	n/a
Save Data Pointer	n/a
Restore Pointers	n/a
Modify Data Pointer	Data_request(Byte_offset)
"	Data_ready(Byte_offset)
Initiate Recovery	TBD
Release Recovery	TBD
Abort	Abort
Abort Tag	Abort_tag
Clear Queue	Clear_queue
Bus Device Reset	Reset
Message Reject	Response
"	Link_alert & Master_alert
Initiator Detected Error	n/a
Message Parity Error	n/a
Synchronous Transfer Request	n/a
Wide Data Transfer Request	n/a
Ignore Wide Residue	n/a

Unit Attention

- Allows a Target to present asynchronous state changes:

  Resets

  Aborts by another Initiator

  Mode Select changes by another Initiator

- Target functions in SSA:

  If UA generated set flag in each Initiator table entry

  (Table is built by SSA-PH during configuration)

  For each SCSI_command, search table with Return_path

  If flag set, present CC, generate sense & reset the flag

- To minimize command processing overhead:

  Search the Initiator table by hashing Return_path

  Keep a count of outstanding Unit Attentions

  Bypass search if count = 0

Spindle synchronization

- Spindle synchronization can improve performance

  Arrays (Particularly RAID-3)

  Mirrored disks

  Rotational Position Knowledge (Allows queue optimization)

- SSA-SCSI defines a **SYNC** character

  K28.0 (A User-defined character in SSA-PH)

  Originated by one node, once per revolution

  Can be interleaved within frames

  Propagated by dual-port nodes & switches

  (Except for one port in each cyclic path)

  Decoded by disk drives & used like an index pulse

  Replaces separate synchronization cable in parallel SCSI

- Controlled by Mode_select disk geometry page, 4h

  No Sync, Slave Sync or Master Sync

  Rotational_offset (eg. 180 degrees for a mirrored pair)

X3T9.2/92-146

U.S. Design

U.S. DESIGN MEANS QUALITY & SERVICE

X3 Secretariat
311 First Street, NW
Washington, DC 20001-2178
Attention: Lynn Barra

Wed, Jul 1, 1992

Dear Ms. Barra:

I am writing in response to the X3 Committee's public review and comment period on X3.131-199x, the Small Computer System Interface (SCSI-II). I have spoken with John Lohmeyer about our concern, and here want to state U.S. Design's comment for the record.

In the Message System Specification of SCSI-II, the extended message code 02h, which previously was used for the EXTENDED IDENTIFY message, has been removed. It is now a reserved code. This decision adversely impacts our product offering.

U.S. Design has a product that uses the EXTENDED IDENTIFY message to address individual platter surfaces within an optical medium-changer device. We provide both the target and initiator interfaces, and our system uses the extended message service to support concurrent threads to each platter surface in the jukebox. The target interface looks like a standard write-once or optical memory device, while our own jukebox control logic decides when to execute the actual changer commands.

With the EXTENDED IDENTIFY message code gone from SCSI-II, we know of no way under this specification to address more than 8 logical units at a single bus address. This is a limitation that is hardly befitting to SCSI. We surmount it in our product line, but would ask the SCSI committee to address it in a formal manner in a future specification.

Sincerely,

[illegible]

Chuck Duquette

cc.: American National Standards Institute (1)
John Lohmeyer, NCR Corporation (1)

Accredited Standards Committee*
X3, Information Processing Systems

Doc. No.:	X3T9.2/92-147
Date:	October 16, 1992
Project:	375-R
Ref. Doc.:	X3T9.2/92-146
Reply to:	Mr. Del Shoemaker Digital Equipment Corp. 1331 Pennsylvania Ave NW Suite 600, MS: WNP Washington, DC 20004 (202) 383-5622

Draft

Mr. Chuck Duquette
U.S. Design Corp.
9075 Guilford Road
Columbia, MD 21046

Dear Mr. Duquette:

Thank you for your interest in the draft revision to the SCSI-2 standard, X3.131-199x. Your comment points out that the SCSI-1 (X3.131-1986) EXTENDED IDENTIFY message was removed from SCSI-2 and the message code was changed to RESERVED.

The action to remove the EXTENDED IDENTIFY message occurred at the December 1988 meeting of X3T9.2 and was based on a recommendation of an ad hoc group that the EXTENDED IDENTIFY message should either be documented properly or removed. The documentation problems were in defining the exact relationship of the IDENTIFY message and the EXTENDED IDENTIFY message. There were also significant concerns about the relationship of the EXTENDED IDENTIFY message and the queue tag messages.

The people present at the plenary meeting did not know of any existing usage of the EXTENDED IDENTIFY message. With no identified interest in this feature, the committee could not justify delaying the standard to document it.

The only application of the EXTENDED IDENTIFY message that the group could identify was for a communications device which might have more than eight communications streams. The group instead elected to add a Stream Selection field to the appropriate fields of the Communications Device command set to permit up to 65,536 streams.

One of the new command sets in SCSI-2 is the Medium Changer command set. It supports up to 65,536 pieces of media whereas the EXTENDED IDENTIFY message would only permit 256 pieces of media.

Your letter asks that X3T9.2 address your request in a future specification. Some work on the SCSI-3 family of standards has already begun. A proposal for the SCSI-3 Architecture Model (SAM) project would permit significantly more logical units (presently 32,768), depending on the capabilities of the physical transport interface used. The working document for the SCSI-3 Parallel Interface (SPI) project has

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