

T10/06-451 revision 0

Date: October 09, 2006

To: T10 Committee (SCSI)

From: George Penokie (IBM)

Subject: SAS-2: Miscellaneous State Machine Fixes

1 Overview

There have been a errors pointed out in several state machines. This proposal fixes those errors.

2 Missing received message in the ST_IFR state

The paragraphs below from 9.2.6.2.3.3 ST_ITS2:Initiator_Send_Frame state indicate the two messages that are missing from 9.2.6.2.2.4 Processing Transmission Complete and Reception Complete messages.

If the confirmation is not Transmission Status (Frame Transmitted) or Transmission Status (I_T Nexus Loss) (see table 131 in 8.2.2.3.4), and the Transmit Frame request was for a COMMAND frame or a DATA frame, then this state shall send a **Transmission Complete (Command Failed, Connection Failed)** message to the ST_IFR state machine. The message shall include the tag.

If the confirmation is not Transmission Status (Frame Transmitted) or Transmission Status (I_T Nexus Loss) (see table 131 in 8.2.2.3.4), and the Transmit Frame request was for a TASK frame, then this state shall send a **Transmission Complete (Task Failed, Connection Failed)** message to the ST_IFR state machine. The message shall include the tag.

The correction is to add two rows to the “Confirmations sent to the SCSI application layer if a frame transmission or reception error occurs” table in section 9.2.6.2.2.4 Processing Transmission Complete and Reception Complete messages as shown below.

Table 1 — Confirmations sent to the SCSI application layer if a frame transmission or reception error occurs

Message received from ST_ITS state machine	Protocol service confirmation and Delivery Result argument sent to the SCSI application layer
Transmission Complete (Command Failed, ACK/NAK Timeout)	Command Complete Received (Service Delivery or Target Failure - ACK/NAK Timeout)
Transmission Complete (Command Failed, NAK Received)	Command Complete Received (Service Delivery or Target Failure - NAK Received)
Transmission Complete (Command Failed, Connection Failed)	Command Complete Received (Service Delivery or Target Failure - Connection Failed)
Transmission Complete (Task Failed, ACK/NAK Timeout)	Received Task Management Function - Executed (Service Delivery or Target Failure - ACK/NAK Timeout)
Transmission Complete (Task Failed, NAK Received)	Received Task Management Function - Executed (Service Delivery or Target Failure - NAK Received)
Transmission Complete (Task Failed, Connection Failed)	Received Task Management Function - Executed (Service Delivery or Target Failure - Connection Failed)
Transmission Complete (XFER_RDY Incorrect Write Data Length)	Command Complete Received (Service Delivery or Target Failure - XFER_RDY Incorrect Write Data Length)
Transmission Complete (XFER_RDY Requested Offset Error)	Command Complete Received (Service Delivery or Target Failure - XFER_RDY Requested Offset Error)
Transmission Complete (Cancel Acknowledged)	Command Complete Received (Service Delivery or Target Failure - Cancel Acknowledged)
Reception Complete (Data Offset Error)	Command Complete Received (Service Delivery or Target Failure - DATA Offset Error)
Reception Complete (Too Much Read Data)	Command Complete Received (Service Delivery or Target Failure - DATA Too Much Read Data)
Reception Complete (Information Unit Too Short)	Command Complete Received (Service Delivery or Target Failure - DATA Information Unit Too Short)
Reception Complete (Command Failed, ACK/NAK Timeout)	Command Complete Received (Service Delivery or Target Failure - ACK/NAK Timeout)

3 Misabeled variable in ST_ITS2 state description

9.2.6.2.3 ST_ITS (initiator transport server) state machine

9.2.6.2.3.1 ST_ITS state machine overview

The ST_ITS state machine performs the following functions:

- a) receives and processes messages from the ST_IFR state machine;
- b) sends messages to the ST_IFR state machine;
- c) sends request to the port layer regarding frame transmission;
- d) receives confirmations from the port layer regarding frame transmission; and
- e) receives HARD_RESET Received confirmations from the port layer.

This state machine consists of the following states:

- a) ST_ITS1:Initiator_Start state (see 9.2.6.2.3.2) (initial state);
- b) ST_ITS2:Initiator_Send_Frame state (see 9.2.6.2.3.3);
- c) ST_ITS3:Prepare_Command state (see 9.2.6.2.3.4);
- d) ST_ITS4:Prepare_Task state (see 9.2.6.2.3.5);
- e) ST_ITS5:Prepare_Data_Out state (see 9.2.6.2.3.6); and
- f) ST_ITS6:Receive_Data_In state (see 9.2.6.2.3.7).

This state machine shall start in the ST_ITS1:Initiator_Start state after power on.

If this state machine receives a HARD_RESET Received confirmation, then this state machine shall transition to the ST_ITS1:Initiator_Start state.

This state machine shall maintain the state machine variables defined in table 2.

Table 2 — ST_ITS state machine variables

State machine variable	Description
Data-In Buffer Offset	Current offset in the data-in buffer for read data
Data-Out Buffer Offset	Current offset in the data-out buffer for write data
Previous Requested Offset	Data offset from the last XFER_RDY frame received
Previous Write Data Length	Write data length from the last XFER_RDY frame received

This state machine shall maintain the state machine arguments defined in table 3.

Table 3 — ST_ITS state machine arguments

State machine argument	Description
Command	Consists of the Command arguments received in the Request (Send Command) message
Task	Consists of the arguments received in the Request (Send Task) message
Xfer_Rdy	Consists of the arguments received in the XFER_RDY Arrived message
Data-Out Buffer	The location of the write data buffer
Data-Out Buffer Size	The size in bytes of the write data buffer
Data-In Buffer Size	The size in bytes of the read data buffer

9.2.6.2.3.2 ST_ITS1:Initiator_Start state

9.2.6.2.3.2.1 State description

This state is the initial state of the ST_ITS state machine.

Upon entry into this state, this state shall set the Data-In Buffer Offset state machine variable to zero.

Upon entry into this state, this state shall set the Data-Out Buffer Offset state machine variable to zero.

9.2.6.2.3.2.2 Transition ST_ITS1:Initiator_Start to ST_ITS3:Prepare_Command

This transition shall occur after this state receives a Request (Send Command) message.

9.2.6.2.3.2.3 Transition ST_ITS1:Initiator_Start to ST_ITS4:Prepare_Task

This transition shall occur after this state receives a Request (Send Task) message.

9.2.6.2.3.3 ST_ITS2:Initiator_Send_Frame state

If this state is entered from the ST_ITS3:Prepare_Command state for transmission of a COMMAND frame, then this state shall send a Transmit Frame (Interlocked) request to the port layer.

If this state is entered from the ST_ITS6:Receive_Data_In state, and the vendor-specific number of retries has not been reached for the COMMAND frame requesting a read operation, then this state shall send a Transmit Frame (Interlocked) request to the port layer.

If this state is entered from the ST_ITS4:Prepare_Task state for transmission of an TASK frame, then this state shall send a Transmit Frame (Interlocked) request to the port layer.

If this state is entered from the ST_ITS5:Prepare_Data_Out state for transmission of a write DATA frame, then this state shall send a Transmit Frame (Non-Interlocked) request to the port layer if:

- a) this state has received an XFER_RDY Arrived message; or
- b) first burst is enabled and this state has received a Transmission Status (Frame Transmitted) confirmation and a Transmission Status (ACK Received) confirmation for the COMMAND frame.

A Transmit Frame request shall include the COMMAND frame from the ST_ITS3:Prepare_Command state or from the ST_ITS6:Receive_Data_In state, the TASK frame from the ST_ITS4:Prepare_Task state, or the write DATA frame from the ST_ITS5:Prepare_Data_Out state and the following arguments to be used for any OPEN address frame:

- a) initiator port bit set to one;
- b) protocol set to SSP;
- c) Connection Rate argument;
- d) Initiator Connection Tag argument;
- e) Destination SAS Address argument; and
- f) Source SAS Address argument.

After sending a Transmit Frame request this state shall wait to receive a Transmission Status confirmation.

If the confirmation is Transmission Status (I_T Nexus Loss), then this state shall send a Transmission Complete (I_T Nexus Loss) message to the ST_IFR state machine. This Transmission Complete message shall include the tag as an argument.

If the confirmation is not Transmission Status (Frame Transmitted) or Transmission Status (I_T Nexus Loss) (see table 131 in 8.2.2.3.4), and the Transmit Frame request was for a COMMAND frame or a DATA frame, then this state shall send a Transmission Complete (Command Failed, Connection Failed) message to the ST_IFR state machine. The message shall include the tag.

If the confirmation is not Transmission Status (Frame Transmitted) or Transmission Status (I_T Nexus Loss) (see table 131 in 8.2.2.3.4), and the Transmit Frame request was for a TASK frame, then this state shall send a Transmission Complete (Task Failed, Connection Failed) message to the ST_IFR state machine. The message shall include the tag.

If the confirmation is Transmission Status (Frame Transmitted), and the Transmit Frame request was for a COMMAND frame not requesting a read operation, a COMMAND frame not requesting a write operation, a TASK frame, or a write DATA frame where the number of data bytes that have been transmitted equal the ~~request byte count~~ [Data-Out Buffer Size](#), then this state shall wait to receive one of the following confirmations:

- a) Transmission Status (ACK Received);
- b) Transmission Status (NAK Received);
- c) Transmission Status (ACK/NAK Timeout); or
- d) Transmission Status (Connection Lost Without ACK/NAK).

If the confirmation is Transmission Status (Frame Transmitted), and the Transmit Frame request was for a COMMAND frame requesting a write operation, or a write DATA frame where the number of data bytes that

have been transmitted is less than the ~~request byte count~~ [Data-Out Buffer Size](#) and the write data length from the previous XFER_RDY frame, then this state shall wait to receive one of the following confirmations:

- a) Transmission Status (ACK Received);
- b) Transmission Status (NAK Received);
- c) Transmission Status (ACK/NAK Timeout);
- d) Transmission Status (Connection Lost Without ACK/NAK); or
- e) XFER_RDY Arrived message.

4 Change in error conditions in the SL_RA state machine

In the text in section 7.14.3 there is an interpretation by some that an EOF is required before the frame is discarded after more than eight Dwords are received. The wording below makes it clear that the frame is discarded on the ninth Dword if that Dword is not an EOF.

7.14.3 SL_RA (receive OPEN address frame) state machine

The SL_RA state machine's function is to receive address frames and determine if the received address frame is an OPEN address frame and whether or not it was received successfully. This state machine consists of one state.

This state machine receives SOAFs, dwords of an OPEN address frames, and EOFs.

This state machine shall ignore all messages except SOAF Received, Data Dword Received, and EOF Received.

If this state machine receives a subsequent SOAF Received message after receiving an SOAF Received message but before receiving an EOF Received message, then this state machine shall discard the Data Dword Received messages received before the subsequent SOAF Received message.

If this state machine receives more than eight Data Dword Received messages after an SOAF Received message ~~and before an EOF Received message~~ [\(i.e., the ninth Data Dword is not an EOF Received message\)](#), then this state machine shall discard the address frame.

If this state machine receives an Invalid Dword Received message or an ERROR Received message after an SOAF Received message and before an EOF Received message, then this state machine shall:

- a) ignore the invalid dword or ERROR; or
- b) discard the address frame.

After receiving an EOF Received message, this state machine shall check if the address frame is a valid OPEN address frame.

This state machine shall accept an address frame if:

- a) the ADDRESS FRAME TYPE field is set to Open;
- b) the number of data dwords between the SOAF and EOF is 8; and
- c) the CRC field contains a valid CRC.

Otherwise, this state machine shall discard the address frame. If the frame is not discarded then this state machine shall send a OPEN Address Frame Received message to the SL_CC0:Idle state and the SL_CC1:ArbSel state with an argument that contains all the data dwords received in the OPEN address frame.

5 Confirmation sent to wrong layer in ST_TFR state machine

In section 9.2.6.3.2.2 Processing Frame Received confirmations the following paragraph references the port layer when it should be referencing the SCSI application layer. See below for correction:

If the frame type is TASK, this state machine checks tags, the RETRANSMIT bit in the new TASK frame is set to one, and the tag for the new TASK frame is the same as the tag for a previous TASK frame where the task management function for the previous TASK frame is not complete, then this state machine shall discard the

new TASK frame and not send a Task Management Request Received confirmation to the [SCSI application](#) ~~port~~-layer.

6 SAS Source address not passed between link layer and port layer

The SAS source address that is received in an open address frame is not passed to the port layer. This is an error as the port layer needs to be passed the SAS source address to the transport layer whenever a frame is received. The transport layer uses the SAS source address to determine if the frame came from the right source by comparing that address against the hashed SAS source address contained within the received frame, if that checking is enabled. To resolve this the following change needs to be made.

In addition I discovered that there was no message going to PL_OC to indicate that an open was received.

To resolve these the following changes need to be made.

7.14.4.4.3 Transition SL_CC2:Selected to SL_CC3:Connected

This transition shall occur after sending a Connection Opened confirmation.

This transition shall include:

- a) an Open SSP Connection, Open STP Connection, or Open SMP Connection argument based on the requested protocol; [and](#)
- a) [the received OPEN address frame.](#)

8.2.3.2.3 Transition PL_PM1:Idle to PL_PM3:Connected

This transition shall occur after a Connection Opened confirmation is received. This transition shall include [the received OPEN address frame.](#)

8.2.3.4.1 PL_PM3:Connected state description

[If this state was entered from the PL_PM1:Idle state, then this state shall send a Connection Opened message to the PL_OC state machine that includes as an argument the received OPEN address frame.](#)

[Editor's Note 1: This message also needs to be added into the PL_PM state machine figure.](#)

7 Missing responses to Transmission status confirmations in ST_TTS2

None of the Transmission status confirmations relating to a abandoned open attempts or to a break are defined in the target transport layer. The following changes needs to be added to fix that.

9.2.6.3.2.3 Processing transport protocol service requests and responses

Table 4 — Confirmations sent to the SCSI application layer

Message received from ST_TTS state machine	Protocol service confirmation sent to SCSI application layer
Transmission Complete (Xfer_Rdy Delivered)	None
Transmission Complete (Response Delivered)	None
Transmission Complete (Response Failed) ^a	None
Transmission Complete (Connection Failed)	Data-In Delivered with the Delivery Result argument set to DELIVERY FAILURE - CONNECTION FAILED
Transmission Complete (Connection Failed)	Data-Out Delivered with the Delivery Result argument set to DELIVERY FAILURE - CONNECTION FAILED
Transmission Complete (Data Transfer Terminated)	Data Transfer Terminated
Transmission Complete (Data-In Delivered)	Data-In Delivered with the Delivery Result argument set to DELIVERY SUCCESSFUL
Transmission Complete (Xfer_Rdy Failed, NAK Received)	Data-Out Received with the Delivery Result argument set to DELIVERY FAILURE - NAK RECEIVED
Transmission Complete (Xfer_Rdy Failed, ACK/NAK Timeout)	Data-Out Received with the Delivery Result argument set to DELIVERY FAILURE - CONNECTION FAILED
Transmission Complete (Data-In Failed, NAK Received)	Data-In Delivered with the Delivery Result argument set to DELIVERY FAILURE - NAK RECEIVED
Transmission Complete (Data-In Failed, ACK/NAK Timeout)	Data-In Delivered with the Delivery Result argument set to DELIVERY FAILURE - CONNECTION FAILED
Reception Complete (Data-Out Received)	Data-Out Received with the Delivery Result argument set to DELIVERY SUCCESSFUL
Reception Complete (Data Offset Error)	Data-Out Received with the Delivery Result argument set to DELIVERY FAILURE - DATA OFFSET ERROR
Reception Complete (Too Much Write Data)	Data-Out Received with the Delivery Result argument set to DELIVERY FAILURE - TOO MUCH WRITE DATA
Reception Complete (Information Unit Too Short)	Data-Out Received with the Delivery Result argument set to DELIVERY FAILURE - INFORMATION UNIT TOO SHORT.
Reception Complete (Initiator Response Timeout)	Data-Out Received with the Delivery Result argument set to DELIVERY FAILURE - INITIATOR RESPONSE TIMEOUT
Reception Complete (Data Transfer Terminated)	Data Transfer Terminated
^a SAM-4 does not define a mechanism for the device server to determine the result of its Send Command Complete and Task Management Function Executed transport protocol service response calls.	

9.2.6.3.3.3 ST_TTS2:Target_Send_Frame state

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If the confirmation or argument is not Transmission Status (Frame Transmitted) or Transmission Status (I_T Nexus Loss), then this state shall send the Transmission Complete message defined in table 158 [or table 5](#) to the ST_TFR state machine. The message shall include the following arguments:

- a) tag; and
- b) arguments received with the Transmission Status confirmation.

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[Table 5 defines the messages that this state shall send to the ST_TFR state machine upon receipt of the listed confirmations.](#)

Table 5 — Additional messages sent to ST_TFR state machine

<u>Confirmation received</u>	<u>Message to be sent to ST_TFR</u>
Transmission Status (Bad Destination)	Transmission Complete (Connection Failed)
Transmission Status (Connection Rate Not Supported)	Transmission Complete (Connection Failed)
Transmission Status (Protocol Not Supported)	Transmission Complete (Connection Failed)
Transmission Status (STP Resources Busy)	Transmission Complete (Connection Failed)
Transmission Status (Wrong Destination)	Transmission Complete (Connection Failed)
Transmission Status (Break Received)	Transmission Complete (Data Transfer Terminated)

9.2.6.3.3.6.1 State description

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[If this state receives Transmission Status \(Break Received\) confirmation, then this state shall send a Reception Complete \(Data Transfer Terminated\) to the ST_TFR state machine.](#)

Editor's Note 2: There needs to be a Transmission Status confirmation arrow added to the ST_TTS5: Receive_Data_Out state in the ST_T state machine figure.
