Maxtor Corporation
500 McCarthy Boulevard
Milpitas, CA 95035 USA

To: **T10 SAS Protocol Working Group**
Contact: Mark Evans
             Phone: 408-894-5310
             Email: mark_evans@maxtor.com
Date: **19 December 2003**

Subject: SAS-1.1, adding the Terminate Data Transfer protocol service

Introduction

This proposal adds the new protocol service, Terminate Data Transfer, to the SSP transport layer state machines and clarifies what happens with tasks when a task management request is received by the transport layer. Terminate Data Transfer provides a mechanism for a logical unit to terminate requests that have been sent to SCSI target ports. Without the Terminate Data Transfer service, it is possible that requests for a logical unit could remain in a SCSI target port after that logical unit was reset as the result of a hard reset received on another SCSI target port. Also included in this proposal are changes to the SSP initiator state machines to clarify how initiators clear tasks from ports as the result of task management requests and other clean up of the SSP transport layer state machine descriptions. This proposal is based on SAS1r01. Revision 3 of this proposal includes input from the SAS protocol working group in Austin, November 3, 2003.

Item 1) In Figure 106 - PL_OC (port layer overall control) state machine in clause 8.2.2.1 PL_OC state machine overview: add a Cancel message going from PL_OC2:Overall_Control state to the PL_PM state machines.

Item 2) In clause 8.2.2.3.7 PL_OC2:Overall_Control state frame transmission cancellations: change the text to be as follows:

Cancel requests cause this state to cancel previous Transmit Frame requests. A Cancel request includes the following arguments:

  a) the destination SAS address; and
  b) the tag.

If this state receives a Cancel request and has not sent a Tx Frame message to a PL_PM state machine for the Transmit Frame request specified by the Cancel request, then this state shall:

  a) discard all Transmit Frame requests for the destination SAS address and tag; and
  b) send a Transmission Status (Cancel Acknowledge) confirmation to the transport layer.

If this state receives a Cancel request and a Tx Frame message has been sent to a PL_PM state machine for the Transmit Frame request specified by the Cancel request, then this state shall send a Cancel message to the PL_PM state machine to which the Tx Frame message was sent. The Cancel message includes the tag.

Item 3) In Figure 108 - PL_PM (port layer phy manager) state machine (part 2) in clause 8.2.3.1 PL_PM state machine overview: add a Cancel message coming from the PL_OC state machine going to the PL_PM3:Connected state.

Item 4) In clause 8.2.3.4.1 PL_PM3:Connected state description: add the following (possibly after the paragraph that begins, "If this state receives an ACK/NAK Timeout confirmation...").

If this state receives a Cancel message, then this state shall:

   a) discard all Tx Frame requests for the destination SAS address and tag; and
   b) send a Transmission Status (Cancel Acknowledge) confirmation to the transport layer.

Item 5) Replace clause 9.2.4 SSP transport layer error handling of link layer errors with the clause in 03-186 (though I still think that the text in this clause is redundant with text in other clauses or belongs in a different clause).

Item 6) Replace clause 9.2.5 SSP transport layer error handling with the following (though I still think that the text in this clause is redundant with text in other clauses or belongs in a different clause). References are to the clauses as numbered in this proposal.

9.2.5 SSP transport layer error processing

9.2.5.1 SSP target port transport layer error processing summary

This clause contains a summary of how an SSP target port processes transport layer errors. This summary does not include every error case. For each instance in this clause there is a cross reference to where specific behavior is defined in this standard.

If an SSP target port receives an XFER_RDY frame or an unsupported frame type, then the SSP target port discards the frame (see 9.2.6.3.2).

If an SSP target port receives a COMMAND frame, and the frame is too short to contain a LUN field or the frame is too short to contain a CDB, then the SSP target port returns a RESPONSE frame with the DATAPRES field set to RESPONSE_DATA and the RESPONSE CODE set to INVALID FRAME (see 9.2.6.3.2).

If an SSP target port receives a COMMAND frame, and the ADDITIONAL CDB LENGTH field indicates that the frame should be a different length, then the SSP target port returns a RESPONSE frame with the DATAPRES field set to RESPONSE_DATA and the RESPONSE CODE set to INVALID FRAME (see 10.2.3).

If an SSP target port receives a TASK frame that is too short, then the SSP target port returns a RESPONSE frame with the DATAPRES field set to RESPONSE_DATA and the RESPONSE CODE set to INVALID FRAME (see 9.2.6.3.2).

If an SSP target port receives a COMMAND frame with a tag that is already in use, then the SSP target port may return a CHECK CONDITION status with a sense key of ABORTED COMMAND and an additional sense code of OVERLAPPED COMMANDS DETECTED (see 9.2.6.3.2).

If an SSP target port receives a TASK frame with a tag that is already in use, then the SSP target port may return a RESPONSE frame with the DATAPRES field set to RESPONSE_DATA and the RESPONSE CODE set to INVALID FRAME (see 9.2.6.3.2).

If an SSP target port receives a DATA frame with an unknown tag, then the SSP target port discards the frame (see 9.2.6.3.2).

If an SSP target port receives a DATA frame that does not contain first burst data and for which there is no XFER_RDY frame outstanding, then the SSP target port discards the frame (see 9.2.6.3.2).

If an SSP target port receives a TASK frame with an unknown logical unit number, then the SSP target port returns a RESPONSE frame with the DATAPRES field set to RESPONSE_DATA and the RESPONSE CODE set to INVALID LOGICAL UNIT (see 10.2.3).

If an SSP target port receives a COMMAND frame or TASK frame with a target port transfer tag set to a value other than FFFFh, then the SSP target port may return a RESPONSE frame with the DATAPRES field set to RESPONSE_DATA and the RESPONSE CODE set to INVALID FRAME (see 9.2.6.3.2).

If an SSP target port is using target port transfer tags and it receives a DATA frame with an unknown target port transfer tag, then the SSP target port discards the frame (see 9.2.6.3.3.5.1).

If an SSP target port receives a DATA frame with a data offset that was not expected, then the SSP target port discards that frame and any subsequent DATA frames received for that command and terminates the command with a CHECK CONDITION status with a sense key of ABORTED COMMAND and an additional sense code of DATA OFFSET ERROR (see 9.2.6.3.3.5.1).

If an SSP target port receives a DATA frame with more write data than expected (i.e., the length of the DATA frame extends past the end of the expected write data length), then the SSP target port discards the frame and terminates the command with a CHECK CONDITION status with a sense key of ABORTED COMMAND and an additional sense code of TOO MUCH WRITE DATA (see 9.2.6.3.3.5.1).

If an SSP target port receives a zero length DATA frame, then the SSP target port discards the frame and terminates the command with a CHECK CONDITION status with a sense key of ABORTED COMMAND and an additional sense code of INFORMATION UNIT TOO SHORT (see 9.2.6.3.3.5.1).

9.2.5.2 SSP initiator port transport layer error processing summary

This clause contains a summary of how an SSP initiator port processes transport layer errors. This summary does not include every error case. For each instance in this clause there is a cross reference to where specific behavior is defined in this standard.

If an SSP initiator port receives a COMMAND or TASK frame or an unsupported frame type, then the SSP initiator port discards the frame (see 9.2.6.2.2).

If an SSP initiator port receives a DATA, XFER_RDY, or RESPONSE frame with an unknown TAG field value (including a tag for which it has sent a COMMAND or TASK frame but not yet received an ACK), then the SSP initiator port discards the frame (see 9.2.6.2.2). The SSP initiator port may then abort the command with that tag (see 10.2.2).

If an SSP initiator port receives an XFER_RDY frame that is not 12 bytes long, then the SSP initiator port discards the frame (see 9.2.6.2.2). The SSP initiator port may then abort the command with that tag (see 10.2.2).

If an SSP initiator port receives an XFER_RDY frame in response to a command with no write data, then the SSP initiator port discards the frame (see 9.2.6.2.2) and aborts the command (see 10.2.2).

If an SSP initiator port receives an XFER_RDY frame requesting more write data than expected, then the SSP initiator port discards the frame (see 9.2.6.2.2) and aborts the command (see 10.2.2).

If an SSP initiator port receives an XFER_RDY frame requesting zero bytes, then the SSP initiator port discards the frame (see 9.2.6.2.2) and aborts the command (see 10.2.2).

If an SSP initiator port receives an XFER_RDY frame with a requested offset that was not expected, then the SSP initiator port discards the frame (see 9.2.6.2.2) and aborts the command (see 10.2.2).

If an SSP initiator port receives a DATA frame with more read data than expected, then the SSP initiator port discards the frame (see 9.2.6.2.2) and aborts the command (see 10.2.2). The SSP initiator port may receive a RESPONSE for the command before being able to abort the command.

If an SSP initiator port receives a DATA frame with zero bytes, then the SSP initiator port discards the frame (see 9.2.6.2.2) and aborts the command (see 10.2.2). The SSP initiator port may receive a RESPONSE for the command before being able to abort the command.

If an SSP initiator port receives a DATA frame with a data offset that was not expected, then the SSP initiator port discards the frame (see 9.2.6.2.2) and aborts the command (see 10.2.2). The SSP initiator port may receive a RESPONSE for the command before being able to abort the command.

Item 7) In order for tasks to be cleared from SSP initiator ports after a task management request affecting that task has been received, it is necessary for the ST_IFR:Initiator_Frame_Router state machine to be aware of outstanding tasks and task management requests. Because of this, this proposal moves the Send SCSI Command and Send Task Management protocol service requests from being sent to the ST_ISF1:Send_Frame state machine to being sent to the ST_IFR state machine. This makes it so that the flow of the text in the draft standard is better if the ST_IFR description precedes the ST_ISF1 description. The following proposed text makes those changes along with some other editorial changes (note also that the ST_IFR state machine no longer terminates). The following begins with clause 9.2.6.1.

9.2.6.1 ST state machines overview

The ST state machines perform the following functions:

  a) receive and process transport protocol service requests and transport protocol service responses from the SCSI application layer;
  b) receive and process other SAS connection management requests from the application layer;
  c) send transport protocol service indications and transport protocol service confirmations to the SCSI application layer;
  d) send requests to the port layer to transmit frames and manage SAS connections; and
  e) receive confirmations from the port layer.

The Transmission Status and Frame Received confirmations received from the port layer include the following arguments:

  a) the tag;
  b) the destination SAS address; and
  c) the source SAS address;

These arguments are used to route the confirmations to the correct ST state machines.

9.2.6.2 ST_I (transport layer for SSP initiator ports) state machines

9.2.6.2.1 ST_I state machines overview

The ST_I state machines are as follows:

  a) ST_IFR (initiator frame router) state machine (see 9.2.6.2.2);
  b) ST_ISF (initiator send frame) state machine (see 9.2.6.2.3);
  c) ST_IPD (initiator process data) state machine (see 9.2.6.2.4); and
  d) ST_IPR (initiator process response) state machine (see 9.2.6.2.5).
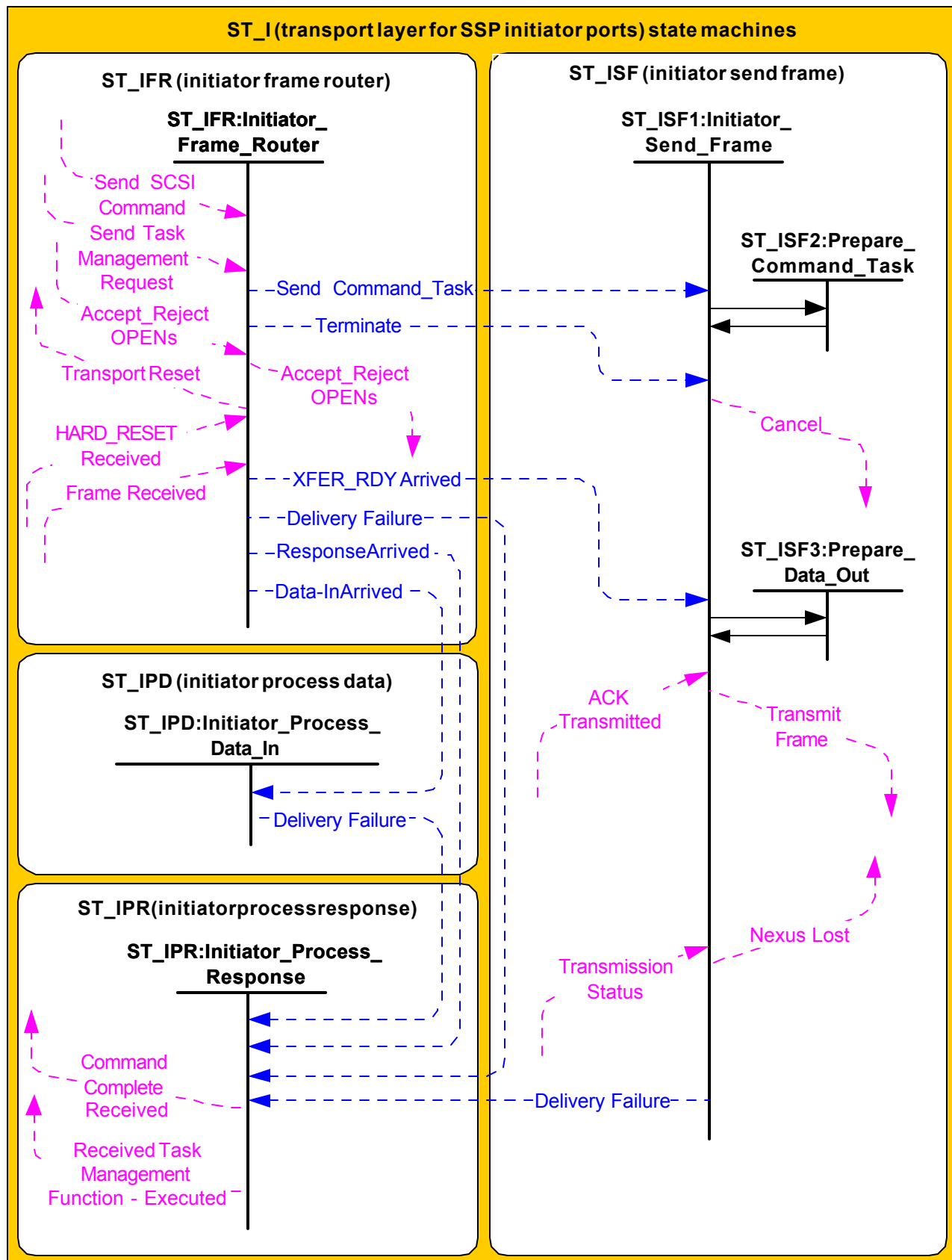
Figure 1 shows the ST_I state machines.

Figure 1 — ST_I (transport layer for SSP initiator ports) state machines

9.2.6.2.2 ST_IFR (initiator frame router) state machine

The ST_IFR state machine:

a) receives Send SCSI Command and Send Task Management transport protocol service requests from the SCSI application layer;
b) sends Send Command_Task, Terminate, and XFER_RDY Arrived messages to the ST_ISF state machine;
c) sends Data-In Arrived messages to the ST_IPD state machine;
d) sends Response Arrived messages to the ST_IPR state machine;
e) receives HARD_RESET Received confirmations from the port layer;
f) sends Transport Reset confirmations to the application layer;
g) receives Accept_Reject OPENs requests from the SCSI application layer; and
h) sends Accept_Reject OPENs requests to the port layer.

This state machine consists of one state.

This state machine shall start after power on.

If this state receives a Send SCSI Command transport protocol service request or a Send Task Management Request transport protocol service request, then this state shall send a Send Command_Task message to an ST_ISF state machine. The message includes the following to be used in any OPEN address frames required to service the request:

a) connection rate;
b) initiator connection tag; and
c) destination SAS address.

If the request is a Send SCSI Command transport protocol service request, then the message also includes the following to be used in any SSP frame for the request:

a) logical unit number;
b) tag;
c) task attribute;
d) additional CDB length;
e) CDB; and
f) additional CDB bytes.

If the request is for a data-out command, then the message also includes the number of bytes for the first burst size for the logical unit.

If the request is a Send Task Management Request transport protocol service request, then the message includes the following to be used in the TASK frame:

a) logical unit number;
b) tag;
c) task management function; and
d) tag of task to be managed.

If the request is a Send SCSI Command transport protocol service request, and the request causes one or more outstanding tasks in the port to be cleared or aborted (e.g., PREEMPT), then this state shall send a Terminate message to any ISF state machine that is processing one of the affected tasks.

If the request is a Send Task Management Request transport protocol service request, and the request causes one or more outstanding tasks in the port to be cleared or aborted, then this state shall send a Terminate message to any ISF state machine that is processing one of the affected tasks.

If this state machine receives a Frame Received (ACK/NAK Balanced) or Frame Received (ACK/NAK Not Balanced) confirmation, then this state shall check the frame type in the received frame. If the confirmation was Frame Received (ACK/NAK Balanced) and the frame type is not XFER_RDY, RESPONSE, or DATA, then this state machine shall discard the frame. If the confirmation was Frame Received (ACK/NAK Not Balanced) and the frame type is not DATA, then this state machine shall discard the frame.

If the frame type is correct relative to the confirmation, then this state may check that the hashed source SAS address matches the SAS address of the SAS port transmitting the frame and the hashed destination SAS address in the frame matches the SAS address of the SAS port receiving the frame based on the connection. If this state checks these SAS addresses and they do not match, then this state machine shall discard the frame.

If the frame type is correct relative to the confirmation, then this state shall check the tag. If the tag does not specify a valid state machine, then this state shall discard the frame and may send a vendor-specific confirmation to the SCSI application layer to abort the command using that tag.

If the frame type is XFER_RDY, then this state shall check the length of the frame. If the length of the frame is not 12 bytes, then this state shall:

a)   discard the frame;
b)   if the frame contains fewer than 12 bytes, then send a Delivery Failure (XFER_RDY Information Unit Too Short) message to the ST_IPR state machine;
c)   if the frame contains more than 12 bytes, then send a Delivery Failure (XFER_RDY Information Unit Too Long) message to the ST_IPR state machine; and
d)   send a Terminate message to the ST_IPD state machine for the tag.

If the frame type is XFER_RDY and the tag is for a task with no write data, then this state shall;

a)   discard the frame;
b)   send a Delivery Failure (XFER_RDY Not Expected) message to the ST_IPR state machine; and
c)   if there is an ST_IPD state machine for the tag, send a Terminate message to that state machine.

If the frame type is XFER_RDY and the items checked in the frame correct, then this state shall send a XFER_RDY Arrived message to the ST_ISF1:Send_Frame state specified by the tag. The message shall include the content of the frame as an argument.

If the frame type is RESPONSE, then this state shall check the length of the frame. If the length of the frame is not 12 bytes, then this state shall:

a)   discard the frame; and
b)   if the frame contains fewer than 24 bytes, then send a Delivery Failure (XFER_RDY Information Unit Too Short) message to the ST_IPR state machine.

If the frame type is RESPONSE, then this state shall check the tag. If this state has received a RESPONSE frame for this I_T_L_Q nexus, then this state shall discard the frame.

If the frame type is RESPONSE, the items checked in the frame are correct, and this state has not received a RESPONSE frame for this I_T_L_Q nexus, then this state shall send a Response Arrived message to the ST_IPR state machine specified by the tag. The message shall include the content of the frame as an argument.

If the frame type is DATA and the items checked in the frame are correct, then this state shall send a Data-In Arrived message to the ST_IPD state machine specified by the tag.The message shall include the content of the frame as an argument.

If this state machine receives an Accept_Reject OPENs (Accept SSP) or Accept_Reject OPENs (Reject SSP) request, then this state shall send an Accept_Reject OPENs request along with the received argument to the port layer.

If this state machine receives a HARD_RESET Received confirmation, then this state shall send a Transport Reset event notification to the SCSI application layer and send a Cancel message to any ISF state machine processing a task.

9.2.6.2.3 ST_ISF (initiator send frame) state machine

9.2.6.2.3.1 ST_ISF state machine overview

The ST_ISF state machine:

  a) receives Send Command_Task and XFER_RDY Arrived messages from the ST_IFR state machine;
  b) constructs COMMAND, TASK, and data-out DATA frames;
  c) sends Transmit Frame requests to the port layer;
  d) receives Transmission Status and ACK Transmitted confirmations from the port layer;
  e) receives Terminate messages from the ST_IFR state machine;
  f) sends Cancel requests to the port layer; and
  g) communicates to the ST_IPR state machine regarding service delivery subsystem failures.

This state machine consists of the following states:

  a) ST_ISF1:Send_Frame (see 9.2.6.2.3.2)(initial state);
  b) ST_ISF2:Prepare_Command_Task (see 9.2.6.2.3.3); and
  c) ST_ISF3:Prepare_Data_Out (see 9.2.6.2.3.4).

This state machine shall be started when a Send Command Task message is received from the ST_IFR state machine.

9.2.6.2.3.2 ST_ISF1:Send_Frame state

9.2.6.2.3.2.1 State description

If this state machine receives an XFER_RDY Arrived message, and the write data length is zero or exceeds the amount of data remaining to be transferred for the data-out command, then this state shall:

  a) send a Delivery Failure (XFER_RDY Incorrect Write Data Length) message to the ST_IPR state machine; and
  b) terminate after sending the message.

If this state machine receives an XFER_RDY Arrived message and the requested offset is not expected, then this state shall:

  a) send a Delivery Failure (XFER_RDY Requested Offset Error) message to the ST_IPR state machine; and
  b) terminate after sending the message.

If this state is entered from the ST_ISF2:Prepare_Command_Task state, then this state shall send a Transmit Frame (Interlocked) request to the port layer.

If this state is entered from the ST_ISF3:Prepare_Data_Out state, then this state shall send a Transmit Frame (Non-Interlocked) request to the port layer.

A Transmit Frame request shall include the SSP frame and the following to be used for any OPEN address frame:

  a) the initiator port bit set to one;
  b) protocol set to SSP;
  c) connection rate;
  d) initiator connection tag;
  e) destination SAS address; and
  f) source SAS address set to the SAS address of the SSP initiator port.

After sending a Transmit Frame request to the port layer this state shall wait for a Transmission Status confirmation.

If the confirmation is not Transmission Status (Frame Transmitted), then this state shall send a Delivery Failure (Service Delivery Subsystem Failure) message to the ST_IPR state machine. The Delivery Failure message shall include:

    a)   any argument received with the Transmission Status confirmation; and
    b)   I_T_L_x nexus information (i.e., destination SAS address and tag).

If the confirmation is Transmission Status (Frame Transmitted) and the Transmit Frame request was for a COMMAND frame, TASK frame, or DATA frame where the number of data bytes that have been transmitted for the Send SCSI Command or Send Task Management transport protocol service request equal the number of bytes in the service request, then this state shall wait to receive a Transmission Status (ACK Received), Transmission Status (NAK Received), Transmission Status (ACK/NAK Timeout), or Transmission Status (Connection Lost Without ACK/NAK) confirmation.

> NOTE 1 - If the number of data bytes that have been transmitted for the Send SCSI Command or Send Task Management transport protocol service request are fewer than the number of bytes in the service request, then this state may send additional Transmit Frame requests for DATA frames for the protocol service request before receiving a Transmission Status (ACK Received), Transmission Status (NAK Received), Transmission Status (ACK/NAK Timeout), or Transmission Status (Connection Lost Without ACK/NAK) confirmation for Transmit Frame requests for previous DATA frames sent for the I_T_L_Q nexus.

If the confirmation is Transmission Status (ACK Received) and the Transmit Frame request was for a COMMAND frame, TASK frame, or DATA frame where the number of data bytes that have been transmitted for the Send SCSI Command or Send Task Management transport protocol service request equal the number of bytes in the service request, then this state shall terminate.

If the confirmation is Transmission Status (ACK Received) and the Transmit Frame request was for a COMMAND frame, TASK frame, or DATA frame where the number of data bytes that have been transmitted for the Send SCSI Command or Send Task Management transport protocol service request are fewer than the number of bytes in the service request, then this state shall send Transmit Frame requests for the DATA frames for the protocol service request.

If a Transmission Status (NAK Received) confirmation is received, then this state shall send a Delivery Failure (Service Delivery Subsystem Failure - NAK Received) message to the ST_IPR state machine.

If a Transmission Status (ACK/NAK Timeout) or Transmission Status (Connection Lost Without ACK/NAK) confirmation is received, then this state shall send a Delivery Failure (Service Delivery Subsystem Failure - Connection Failed) message to the ST_IPR state machine.

After sending a Delivery Failure message to the ST_IPR state machine, this state machine shall terminate.

If this state receives a Terminate message from the ST_IFR state machine, and this state has received confirmations for all Transmit Frame requests sent to the port layer, then this state machine shall terminate.

If this state receives a Terminate message from the ST_IFR state machine, and this state has not received confirmations for all Transmit Frame requests sent to the port layer, then this state shall send a Cancel request to the port layer. This state may also send a Cancel request to the port layer to cancel a previous Transmit Frame request. A Cancel request shall include the following arguments:

    a)   the destination SAS address; and
    b)   the tag.

This state machine shall terminate upon receipt of a Transmission Status (Cancel Acknowledge) confirmation.

9.2.6.2.3.2.2 Transition ST_ISF1:Send_Frame to ST_ISF2:Prepare_Command_Task

This transition shall occur after receiving a Send Command_Task message.

9.2.6.2.3.2.3 Transition ST_ISF1:Send_Frame to ST_ISF3:Prepare_Data_Out

[No change proposed to the text in this clause.]

9.2.6.2.3.3 ST_ISF2:Prepare_Command_Task state

[No change proposed to the text in this clause.]

9.2.6.2.3.4 ST_ISF3:Prepare_Data_Out state

[No change proposed to the text in this clause.]

9.2.6.2.4 ST_IPD (initiator process data) state machine

[No change proposed to the text in this clause.]

9.2.6.2.5 ST_IPR (initiator process response) state machine

[No change proposed to the text in this clause.]

Item 8) In Figure 114 - ST_T (transport layer for SSP target ports) state machines in clause 9.2.6.3.1 ST_T state machines overview add:

  a) a Terminate Data Transfer request from the application layer to ST_TFR:Target_Frame_Router;
  b) a Data Transfer Terminated confirmation from ST_TFR:Target_Frame_Router to the application layer;
  c) a Terminate message from ST_TFR:Target_Frame_Router to ST_TS2:Send_Frame; and
  d) a Terminate message from ST_TFR:Target_Frame_Router to ST_TTS4:Receive_Data_Out.

These changes are shown in the following figure.

Figure 2 — ST_T (transport layer for SSP target ports) state machines
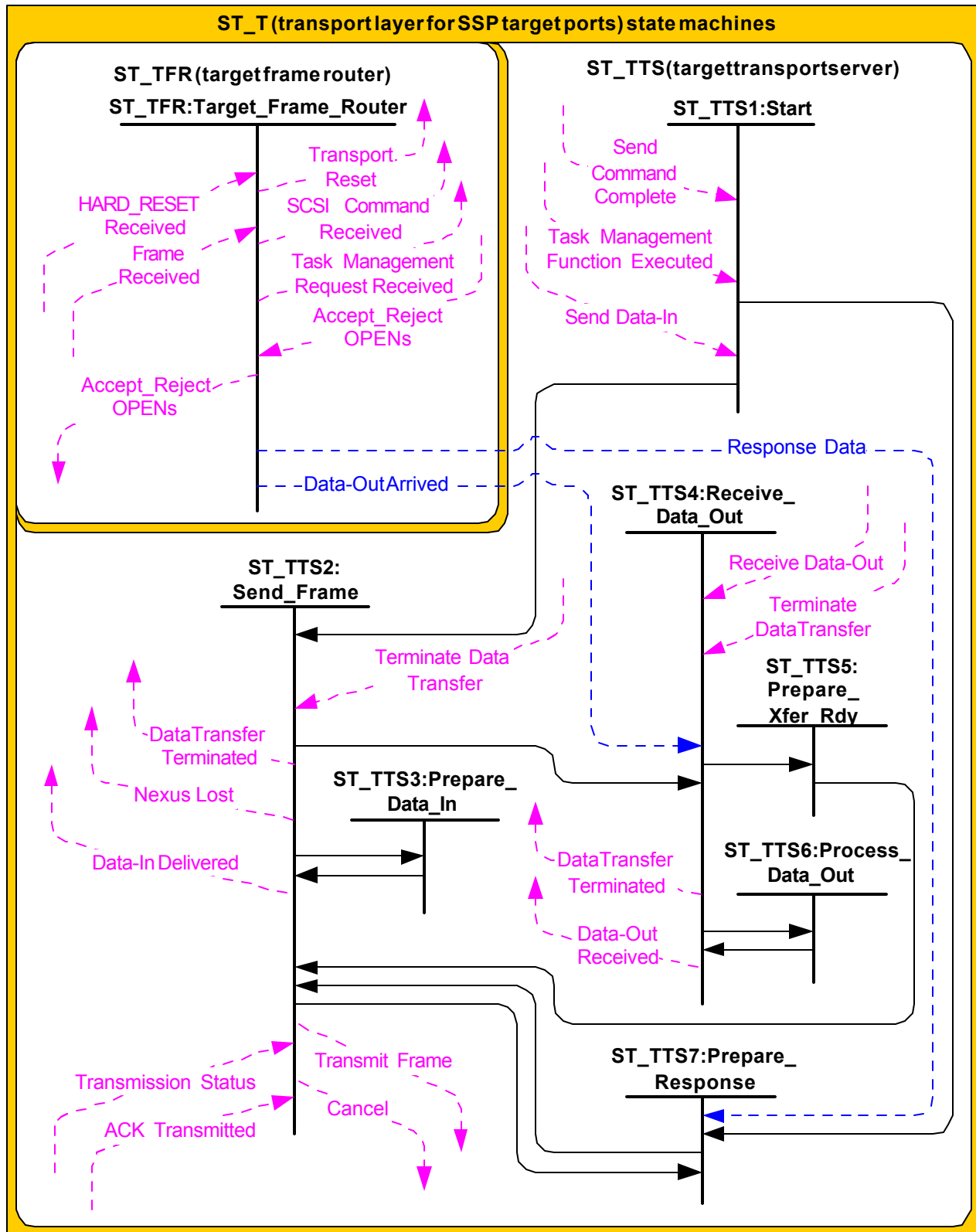
Item 9) For clause 9.2.6.3.2 ST_TFR (target frame router) state machine: change the text to be as follows [note also that this state machine no longer terminates].

The ST_TFR state machine:

    a) receives confirmations from the port layer;
    b) receives transport protocol service requests from the SCSI application layer;
    c) sends transport protocol service indications to the SCSI application layer;
    d) sends messages to the ST_TTS state machine
    e) receives Accept_Reject OPENs requests from the application layer; and
    f) sends Accept_Reject OPENs requests to the port layer.

This state machine consists of one state.

This state machine shall start after power on.

If this state machine receives an Accept_Reject OPENs (Accept SSP) or Accept_Reject OPENs (Reject SSP) request, then this state shall send an Accept_Reject OPENs request to the port layer.

If this state machine receives a Frame Received (ACK/NAK Balanced) or Frame Received (ACK/NAK Not Balanced) confirmation, then this state machine shall check the frame type in the received frame (see table 93). If the frame type is not COMMAND, TASK, or DATA, then this state machine shall discard the frame. If the confirmation was Frame Received (ACK/NAK Not Balanced) and the frame type is not DATA, then this state machine shall discard the frame.

This state machine may check that reserved fields in the frame are zero. If any reserved fields are not zero, then this state machine may send a Response Data (Invalid Frame) message to the ST_TTS7:Prepare_Response state including the logical unit number and tag.

> NOTE 30 - The check of reserved fields described above does not apply to the reserved fields within the CDB in a COMMAND frame. Checking of reserved fields in a CDB is described in SAM-3.

If the frame type is correct relative to the confirmation, then this state may check that the hashed source SAS address matches the SAS address of the SAS port transmitting the frame and the hashed destination SAS address in the frame matches the SAS address of the SAS port receiving the frame based on the connection. If this state checks these SAS addresses and they do not match, then this state machine shall discard the frame.

If the frame type is COMMAND, then this state machine shall check the length of the information unit. If the length of the information unit is not correct (see 9.2.2.1), then this state machine shall send a Response Data (Invalid Frame) message to the ST_TTS7:Prepare_Response state. The message shall include the logical unit number and tag.

If the frame type is TASK, then this state machine shall check the length of the information unit. If the length of the information unit is not correct (see 9.2.2.2), then this state machine shall send a Response Data (Invalid Frame) message to the ST_TTS7:Prepare_Response state. The message shall include the logical unit number and tag.

If the frame type is COMMAND or TASK, then this state machine may check if the tag conflicts with an existing tag (i.e., an existing command or task management function). If this state machine checks the tag, and the tag conflicts with an existing tag, then this state machine shall send a Response Data (Invalid Frame) message to the ST_TTS7:Prepare_Response state. The message shall include the logical unit number and tag.

If the frame type is COMMAND or TASK, then this state machine may check the target port transfer tag. If target port transfer tag is set to a value other than FFFFh, then this state machine may send a Response Data (Invalid Frame) message to the ST_TTS7:Prepare_Response state. The message shall include the logical unit number and tag.

If the frame type is TASK, then this state machine shall check the logical unit number. If there is no logical unit at the specified logical unit number, then this state machine shall send a Response Data (Invalid Logical Unit Number) message to the ST_TTS7:Prepare_Response state. The message shall include the logical unit number and tag.

If the frame type is COMMAND and the items checked in the frame are correct, then this state machine shall send a SCSI Command Received transport protocol service indication to the SCSI application layer. The indication shall include:

    a) the source SAS address;
    b) the tag;
    c) the logical unit number;
    d) the task attribute;
    e) the CDB; and
    f) any additional CDB bytes.

If the frame type is TASK and the items checked in the frame are correct, then this state machine shall send a Task Management Request Received transport protocol service indication to the SCSI application layer. If the frame type is DATA, then this state machine shall send a Data-Out Arrived message to the ST_TTS4:Receive_Data_Out state. The indication shall contain the content of the SAS frame.

If the frame type is DATA, and the tag does not match a tag for an outstanding data-out command, then this state machine shall discard the frame.

If the frame type is DATA, and the tag matches a tag for an outstanding data-out command without first burst data for which no XFER_RDY frame is outstanding, then this state machine shall discard the frame.

If the frame type is DATA, then this state machine may check the target port transfer tag. If this state machine checks the target port transfer tag and it does not specify a valid state machine, then this state shall discard the frame.

If the frame type is DATA and the items checked in the frame are correct, then this state machine shall send a Data-Out Arrived message to the ST_TTS4:Receive_Data_Out state. The message shall include the content of the SAS frame.

If this state machine receives a HARD_RESET Received confirmation, then this state machine shall send a Transport Reset event notification to the SCSI application layer.

Item 10) For clause 9.2.6.3.3.3.1 [ST_TTS2:Send_Frame] State description: change the text to be as follows.

If this state is entered from the ST_TTS3:Prepare_Data_In state for transmission of a DATA frame, then this state shall send a Transmit Frame (Non-Interlocked) request to the port layer.

If this state is entered from the ST_TTS5:Prepare_Xfer_Rdy state for transmission of an XFER_RDY frame, then this state shall send a Transmit Frame (Interlocked) request to the port layer.

If this state is entered from the ST_TTS7:Prepare_Response state for transmission of a RESPONSE frame and this state has received an ACK Transmitted confirmation for each DATA frame previously received (i.e., received by this state machine with a Data-Out Arrived message), then this state shall send a Transmit Frame (Interlocked) request to the port layer.

> NOTE 2 - The interlocked frame transmission rules ensure that wide ports do not send an XFER_RDY or RESPONSE frame for an I_T_L_Q nexus on a phy until all the ACKs have been received for write DATA frames for the nexus on a different phy. In a narrow port, the link layer ensures that there is ACK/NAK balance before transmitting an interlocked frame.

A Transmit Frame request from this state shall include the SSP frame and the following to be used for any OPEN address frame:

    a) the initiator port bit set to zero;
    b) protocol set to SSP;
    c) connection rate;
    d) initiator connection tag;
    e) destination SAS address; and
    f) source SAS address set to the SAS address of the SSP target port.

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), this state shall send a Nexus Lost confirmation to the SCSI application layer.

If the confirmation is Transmission Status (Frame Transmitted) and the Transmit Frame request was for a RESPONSE frame or an XFER_RDY frame or DATA frame where the number of data bytes that have been transmitted for the Send Data-In transport protocol service request equal the number of bytes in the service request, then this state shall wait to receive a Transmission Status (ACK Received), Transmission Status (NAK Received), Transmission Status (ACK/NAK Timeout), or Transmission Status (Connection Lost Without ACK/NAK) confirmation.

> NOTE 3 - If the number of data bytes that have been transmitted for the Send Data-In transport protocol service request are fewer than the number of bytes in the service request, then this state may send additional Transmit Frame requests for DATA frames for the protocol service request before receiving a Transmission Status (ACK Received), Transmission Status (NAK Received), Transmission Status (ACK/NAK Timeout), or Transmission Status (Connection Lost Without ACK/NAK) confirmation for Transmit Frame requests for previous DATA frames sent for the I_T_L_Q nexus.

If the confirmation is Transmission Status (ACK Received) and the Transmit Frame request was for a RESPONSE frame, then this state shall send a Data-In Delivered (Delivery Result = DELIVERY SUCCESSFUL) transport protocol service confirmation to the SCSI application layer.

If the confirmation is Transmission Status (ACK Received) and the Transmit Frame request was for an XFER_RDY frame or a DATA frame where the number of data bytes that have been transmitted for the Send Data-In transport protocol service request are fewer than the number of bytes in the service request, then this state shall send Transmit Frame requests for the DATA frames for the protocol service request.

If the confirmation is Transmission Status (ACK Received), the Transmit Frame request was for a DATA frame where the number of data bytes that have been transmitted for the Send Data-In transport protocol service request equal the number of bytes in the service request, and this state has received a Transmission Status (ACK Received) confirmation for each of the DATA frames transmitted for the Send Data-In transport protocol service request, then this state shall send a Data-In Delivered (Delivery Result = DELIVERY SUCCESSFUL) transport protocol service confirmation to the SCSI application layer.

If the confirmation is Transmission Status (NAK Received), the Transmit Frame request was for a RESPONSE frame, and the vendor specific number of retries has been reached, then this state shall send a Data-In Delivered (Delivery Result = DELIVERY FAILURE - NAK RECEIVED) transport protocol service confirmation to the SCSI application layer.

If the confirmation is Transmission Status (ACK/NAK Timeout), the Transmit Frame request was for a RESPONSE frame, and the vendor specific number of retries has been reached, then this state shall send a Data-In Delivered (Delivery Result = DELIVERY FAILURE - ACK/NAK TIMEOUT) transport protocol service confirmation to the SCSI application layer.

If the confirmation is Transmission Status (NAK Received) and the Transmit Frame request was for an XFER_RDY frame or a DATA frame then this state shall send a Data-In Delivered (Delivery Result = DELIVERY FAILURE - NAK RECEIVED) transport protocol service confirmation to the SCSI application layer.

If the confirmation is Transmission Status (ACK/NAK Timeout) and the Transmit Frame request was for an XFER_RDY frame or a DATA frame then this state shall send a Data-In Delivered (Delivery Result = DELIVERY FAILURE - ACK/NAK TIMEOUT) transport protocol service confirmation to the SCSI application layer.

A Data-In Delivered transport protocol service confirmation to the SCSI application layer shall include the following:

   a) any argument received from the port layer (e.g., Transmission Status (ACK Received) or Service Delivery Subsystem Failure); and
   b) I_T_L_x nexus information (i.e., destination SAS address and tag).

This state machine shall terminate after sending a Data-In Delivered protocol service confirmation.

If this state receives a Terminate Data Transfer request and this state has received confirmations for all Transmit Frame requests sent to the port layer, then this state shall send a Data Transfer Terminated confirmation to the application layer. After sending the confirmation, this state machine shall terminate.

If this state receives a Terminate Data Transfer request and this state has not received confirmations for all Transmit Frame requests sent to the port layer, then this state shall send a Cancel request to the port layer to cancel previous Transmit Frame requests. A Cancel request shall include the following arguments:

a) the destination SAS address; and
b) the tag.

Upon receipt of a Transmission Status (Cancel Acknowledge) confirmation. this state shall:

a) send a Transmission Status (Cancel Acknowledge) confirmation; and
b) terminate.

Item 11) For clause 9.2.6.3.3.3.4 Transition ST_TTS2:Send_Frame to ST_TTS7:Prepare_Response: change it to be as follows.

This transition shall occur after receiving a Transmission Status (Frame Transmitted) and a Transmission Status confirmation with an argument other than (ACK Received) for a RESPONSE frame.

Item 12) In clause 9.2.6.3.3.5.1 [ST_TTS4:Receive_Data_Out state] State description, add the following sentence at the end of the clause:

If this state receives a Terminate Data Transfer request, then this state shall terminate.

[If more data is received for this tag, it will be discarded by the ST_TFR:Target_Frame_Router state machine because no target transport server state machine associated with the tag exists].

Item 13) In clause 9.2.6.3.3.8.1 [ST_TTS7:Prepare_Response state] State description, change the last two paragraphs in the clause as follows:

.....

If this state was entered as the result of the ST_TTS2:Send_Frame state receiving something other than a Transmission Status (Frame Transmitted) confirmation followed by a Transmission Status (ACK Received) confirmation for a RESPONSE frame (i.e., the frame transmission was unsuccessful) and the retransmit bit was set to zero in the frame, or the vendor specific number of retries has not been exceeded then this state shall:

a) generate a RESPONSE frame using all of the values from the previous RESPONSE frame, except the retransmit bit;
b) set the retransmit bit to one; and
c) send the new RESPONSE frame.