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To: Serial Attached SCSI Protocol Working Group
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Date: 5 August 2002

Subject: SAS SSP transport layer state machines

Introduction

This proposal is for the SAS transport layer state machines for the SSP protocol. This proposal represents a significant change in tack from previous proposals for these state machines. Earlier proposals focused on SAM objects (e.g., application client). This proposal names new objects unique to SAS, but has the goal of being consistent with the SAM layering model.

9.2.6 SSP transport layer state machines

9.2.6.1 Overview

The SSP transport layer contains state machines that perform the following functions:

- a) receive protocol service and other SAS connection management requests from the SCSI initiator application layer;
- b) send protocol service indications to the SCSI target application layer;
- c) receive data delivery service requests, other SAS connection management requests, and protocol service responses from the SCSI target application layer;
- d) send data delivery service confirmations to the SCSI target application layer;
- e) send protocol service confirmations to the SCSI initiator application layer;
- f) send requests to the SSP port layer state machines to transmit frames and manage SAS connections;
- g) receive confirmations from the SSP port layer state machines;

The SSP transport state machines are as follows:

- a) Initiator Send Frame (ISF state machines);
- b) Initiator Receive Data (IRD state machines);
- c) Initiator Process Response (IPR state machine);
- d) Initiator Frame Router (IFR state machine);
- e) Target Frame Router (TFR state machine); and
- f) Target Transport Server (TTS state machine).

9.2.6.2 SSP transport layer initiator device state machines

9.2.6.2.1 SSP transport layer initiator device state machines overview

The ISF (initiator send frame) state machine receives a protocol service request from the SCSI initiator application layer, receives an XFER_RDY Arrived parameter from the IFR state machine, and constructs SSP frames containing COMMAND, TASK, or data-out DATA information units. The service request may be to process either a command or task management function. This state machine also communicates with the initiator port layer state machine via several requests and confirmations regarding frame transmission.

The ISF state machine contains the following states:

- a) ST_ISF1:Initiator_Send_Frame state;
- b) ST_ISF2:Prepare_Command_Request state,
- c) ST_ISF3:Prepare_Send_Data_Out state;

The IRD (initiator receive data) state machine receives and processes a parameter from the IFR (initiator frame router) state machine containing an SSP frame containing a DATA information unit.

- a) ST_IRD1:Receive_Data_In state;
- b) ST_IRD2:Process_Received_Data_In state.

The IPR (initiator process response) state machine receives a parameter from the IFR (initiator frame router) state machine containing an SSP frame containing a RESPONSE information unit. The IPR process the RESPONSE information unit and sends a protocol service confirmation to the SCSI initiator application layer.

The IPR state machine contains the following state:

- a) ST_IPR1:Process_Received_Response state.

The IFR (initiator frame router) state machine receives confirmations from the initiator port layer state machine and, depending on the confirmation, may send a parameter to the ST_ISF1:Initiator_Send_Frame state, ST_IRD1:Receive_Data_In state, or the ST_IPR1:Process_Received_Response state. The IFR state machine receives connection information from the initiator port layer state machine. The IFR state machine also receives Accept_Reject OPENS requests from the SCSI initiator application layer and sends these requests to the initiator port layer state machine.

The IFR state machine contains the following state:

- a) ST_IFR1:Initiator_Frame_Router state.

The ISF state machine receives one of the following protocol service requests from the SCSI initiator application layer:

- a) Send SCSI Command; or
- b) Send Task Management Request.

The IPR state machine sends one of the following protocol service confirmations to the SCSI initiator application layer:

- a) Command Complete Received; or
- b) Received [Task Management] Function - Executed.

The IFR state machine may receive one of the following requests from the SCSI initiator application layer:

- a) Accept_Reject OPENS(Accept); or
- b) Accept_Reject OPENS(Reject).

Requests to and confirmations from the port layer state machines are described in x.x.

Figure 1 describes the SSP transport layer initiator device state machines.

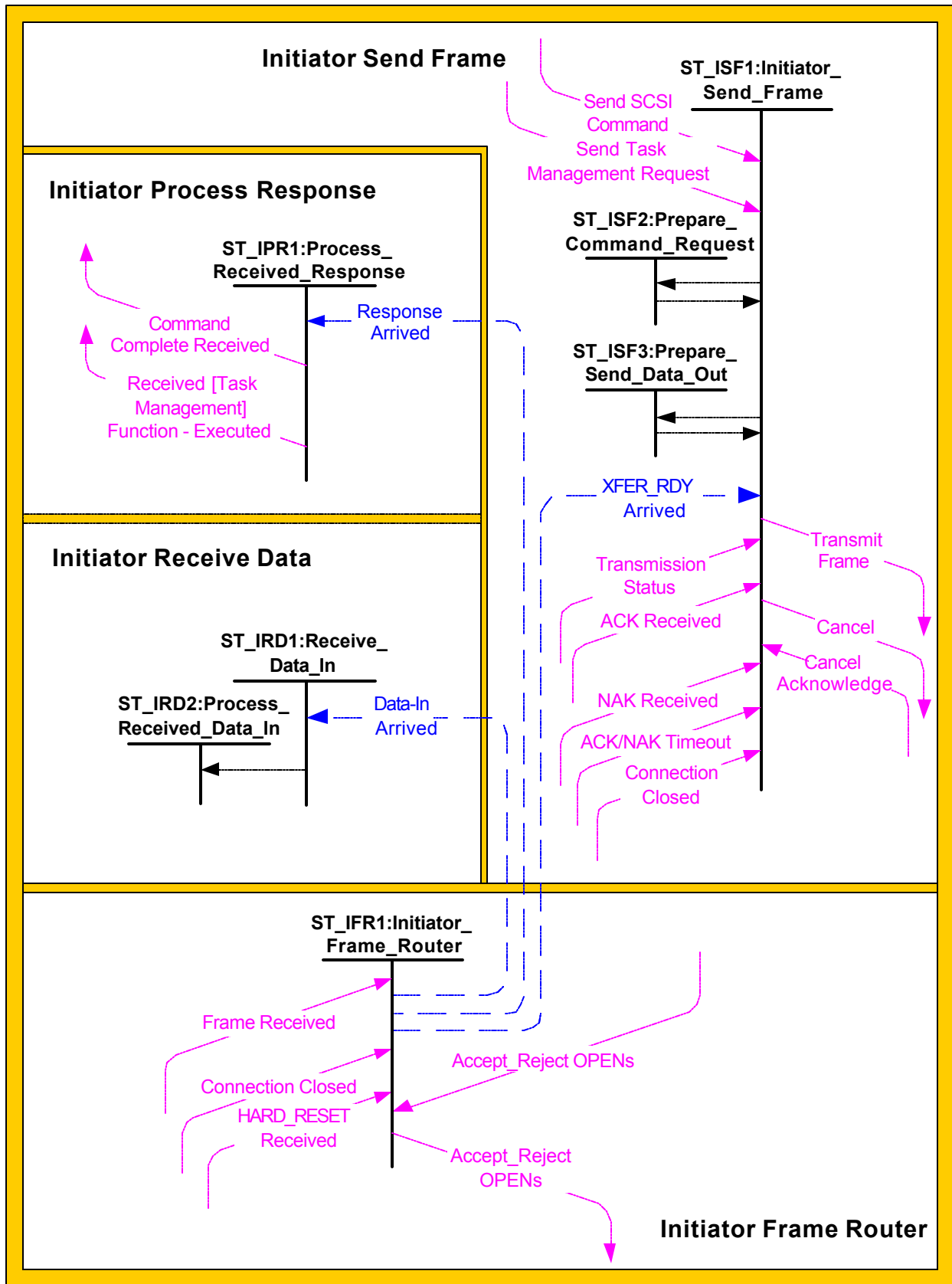


Figure 1. SSP transport layer initiator device state machines

9.2.6.2.2 ST_ISF1:Initiator_Send_Frame state

9.2.6.2.2.1 ST_ISF1:Initiator_Send_Frame state description

The ISF state machine shall be initiated when this state receives a Send SCSI Command or a Send Task Management Request protocol service request from the SCSI initiator application layer or when this state receives an XFER_RDY Arrived parameter from the IFR state machine. This state may also be entered when an SSP frame containing either a COMMAND or TASK information unit is received from the ST_ISF2:Prepare_Command_Request state, or when an SSP frame containing a DATA information unit is received from the ST_ISF3:Prepare_Send_Data_Out state.

If the ISF state machine was initiated as the result of this state receiving a Send SCSI Command or a Send Task Management Request protocol service request from the SCSI initiator application layer, then this state shall check that the request includes the values to be used in the LINK RATE, DESTINATION SAS ADDRESS, and SOURCE SAS ADDRESS fields in any OPEN address frame. If these values are not included with the request, then the ISF state machine shall terminate. The request may also contain the value to be used in the INITIATOR CONNECTION TAG field in any OPEN address frame.

If the ISF state machine was initiated as the result of this state receiving a Send SCSI Command protocol service request from the SCSI initiator application layer, then this state shall check that the request includes the values to be used in the COMMAND ID, TAG, LOGICAL UNIT NUMBER, TASK ATTRIBUTE, ADDITIONAL CDB LENGTH, CDB, and ADDITIONAL CDB BYTES fields in the SSP frame for the request. If the request is for a data-out command, then this state shall also check that the negotiated value from the FIRST BURST SIZE field in the Disconnect-Reconnect mode page for the SCSI target device is included in the request. If these values are not included with the request, then the ISF state machine shall terminate.

If the ISF state machine was initiated as the result of this state receiving a Send SCSI Send Task Management Request protocol service request from the SCSI initiator application layer, then this state shall check that the request includes the values to be used in the COMMAND ID, TAG, TASK MANAGEMENT FUNCTION, and TAG OF TASK TO BE MANAGED fields in the SSP frame for the request. If these values are not included with the request, then the ISF state machine shall terminate.

If the ISF state machine was initiated as the result of this state receiving a protocol service request and the specified values are included in the request, then this state shall transition to the ST_ISF2:Prepare_Command_Request state.

If the ISF state machine was initiated as the result of this state receiving an XFER_RDY Arrived parameter, then this state shall check that the values from the HASHED DESTINATION SAS ADDRESS, HASHED SOURCE SAS ADDRESS, COMMAND ID, TAG, TARGET PORT TRANSFER TAG, and WRITE DATA LENGTH fields from the SSP frame containing the XFER_RDY information unit received from the target are included. If these values are not included with the parameter, then the ISF state machine shall terminate.

If the ISF state machine was initiated as the result of this state receiving an XFER_RDY Arrived confirmation from the IFR state machine and the specified values are included with the confirmation, then this state shall transition to the ST_ISF3:Prepare_Send_Data_Out state.

Event Initiating ST_ISF1 State	Values to be Checked
Send SCSI Command received	LINK RATE DESTINATION SAS ADDRESS SOURCE SAS ADDRESS INITIATOR CONNECTION TAG (not mandatory) COMMAND ID TAG LOGICAL UNIT NUMBER TASK ATTRIBUTE ADDITIONAL CDB LENGTH CDB ADDITIONAL CDB BYTES FIRST BURST SIZE (data-in command only)
Send Task Management Request received	LINK RATE DESTINATION SAS ADDRESS SOURCE SAS ADDRESS INITIATOR CONNECTION TAG (not mandatory) COMMAND ID TAG TASK MANAGEMENT FUNCTION TAG OF TASK TO BE MANAGED
XFER_RDY Arrived received	HASHED DESTINATION SAS ADDRESS HASHED SOURCE SAS ADDRESS COMMAND ID TAG TARGET PORT TRANSFER TAG WRITE DATA LENGTH

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

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

A Transmit Frame request shall include the values for the LINK RATE, INITIATOR CONNECTION TAG, DESTINATION SAS ADDRESS, and SOURCE SAS ADDRESS fields received from the SCSI initiator application layer to be used for any OPEN address frame and the SSP frame constructed in either the ST_ISF2:Prepare_Command_Request state or the ST_ISF3:Prepare_Send_Data_Out state.

After sending a Transmit Frame request this state shall receive a Transmission Status confirmation from the initiator port layer state machine. If the confirmation is not Transmission Status(Frame Transmitted), then the ISF state machine shall terminate.

After receiving a Transmission Status(Frame Transmitted) confirmation, this state shall then receive one of the following confirmations from the initiator port layer state machine.

- a) ACK Received;
- b) NAK Received;
- c) ACK/NAK Timeout; or
- d) Connection Closed.

The ISF state machine shall terminate after receiving one of the above confirmations unless the confirmation is ACK Received and either of the following is true:

- a) this state has sent a Transmit Frame request for an SSP frame containing a DATA information unit and the amount of data that has been transmitted for the protocol service request is less than that specified by the FIRST BURST SIZE field in the Disconnect-Reconnect mode page received from the SCSI initiator application layer with the protocol service request; or
- b) the amount of data that has been transmitted is less than that indicated by the value in the WRITE DATA LENGTH field in a received XFER_RDY information unit.

If the confirmation is ACK Received and one of the above is true, then this state shall transition to the ST_ISF3:Prepare_Send_Data_Out state.

This state may also send a Cancel request to the initiator port layer state machine to cancel a previous Transmit Frame request. The ISF state machine shall terminate upon receipt of a Cancel Acknowledge confirmation from the initiator port layer state machine.

9.2.6.2.2 Transition ST_ISF1:Initiator_Send_Frame to ST_ISF2:Prepare_Command_Request

This transition shall occur after a Send SCSI Command or Send Task Management Request protocol service request has been received from the SCSI initiator application layer and all of the values have been verified by the ST_ISF1:Initiator_Send_Frame state.

9.2.6.2.3 Transition ST_ISF1:Initiator_Send_Frame to ST_ISF3:Prepare_Send_Data_Out

This transition shall occur after an XFER_RDY Arrived parameter has been received from the IFR state machine and all of the values have been verified by the ST_ISF1:Initiator_Send_Frame state, or after an ACK Received confirmation for a Transmit Frame(Non-interlocked) request has been received and the amount of data that has been transmitted is less than that specified by the FIRST BURST SIZE field in the Disconnect-Reconnect mode page or indicated by the value in the WRITE DATA LENGTH field in a received XFER_RDY information unit.

9.2.6.2.3 ST_ISF2:Prepare_Command_Request state

9.2.6.2.3.1 ST_ISF2:Prepare_Command_Request state description

This state shall construct an SSP frame containing either a COMMAND or TASK information unit.

If the frame to be constructed is to contain a COMMAND information unit, then this state shall use the values received from the SCSI initiator application layer for the COMMAND ID, TAG, LOGICAL UNIT NUMBER, TASK ATTRIBUTE, ADDITIONAL CDB LENGTH, CDB, and ADDITIONAL CDB BYTES fields. This state shall generate the values to be used for the INFORMATION UNIT TYPE, HASHED DESTINATION SAS ADDRESS, HASHED SOURCE SAS ADDRESS, and NUMBER OF FILL BYTES fields.

If the frame to be constructed is to contain a TASK information unit, then this state shall use the values received from the SCSI initiator application layer for the COMMAND ID, TAG, TASK MANAGEMENT FUNCTION, and TAG OF TASK TO BE MANAGED fields. This state shall generate the values to be used for the INFORMATION UNIT TYPE, HASHED DESTINATION SAS ADDRESS, HASHED SOURCE SAS ADDRESS, and NUMBER OF FILL BYTES fields.

9.2.6.2.3.2 Transition ST_ISF2:Prepare_Command_Request to ST_ISF1:Initiator_Send_Frame

This transition shall occur after the ST_ISF2:Prepare_Command_Request state has constructed an SSP frame containing either a COMMAND or TASK information unit.

9.2.6.2.4 ST_ISF2:Prepare_Send_Data_Out state**9.2.6.2.4.1 ST_ISF2:Prepare_Send_Data_Out state description**

This state shall construct an SSP frame containing a DATA information unit. This state shall use the values received from the ST_ISF1:Initiator_Send_Frame state for the COMMAND ID, TAG, and TARGET PORT TRANSFER TAG fields. This state shall generate the values to be used for the INFORMATION UNIT TYPE, HASHED DESTINATION SAS ADDRESS, and HASHED SOURCE SAS ADDRESS.

If the amount of data to be transferred as specified by the value from the FIRST BURST SIZE field or indicated by the value in the WRITE DATA LENGTH field is greater than the maximum size of an SSP information unit, the amount of data in the DATA information unit shall be the maximum for an SSP information unit.

If the amount of data to be transferred is less than the maximum size of an SSP information unit, then all of the data shall be in the DATA information unit.

This state shall calculate the value for the NUMBER OF FILL BYTES fields and include this value in the SSP frame.

9.2.6.2.4.2 Transition ST_ISF2:Prepare_Send_Data_Out to ST_ISF1:Initiator_Send_Frame

This transition shall occur after the ST_ISF2:Prepare_Send_Data_Out state has constructed an SSP frame containing a DATA information unit.

9.2.6.2.5 ST_IRD1:Receive_Data_In state**9.2.6.2.5.1 ST_IRD1:Receive_Data_In state description**

The IRD state machine shall be initiated when this state receives a Data-In Arrived parameter from the ST_IFR:Frame_Router state.

This state shall check that the parameter includes the values from the DESTINATION SAS ADDRESS and the SOURCE SAS ADDRESS from the OPEN address frame that initiated the connection, the HASHED DESTINATION SAS ADDRESS, HASHED SOURCE SAS ADDRESS, NUMBER OF FILL BYTES, COMMAND ID, and TAG fields from the SSP frame containing the DATA information unit, and the DATA information unit.

If any of the values are not included or are incorrect, then the IRD state machine shall terminate.

If all values are correct, then this state shall transition to the ST_IRD2:Process_Received_Data_In state.

9.2.6.2.5.2 Transition ST_IRD1:Receive_Data_In to ST_IRD2:Process_Received_Data_In

This transition shall occur after the values included with the Data-In Arrived parameter have been verified by the ST_IRD1:Receive_Data_In state.

9.2.6.2.6 ST_IRD2:Process_Received_Data_In state**9.2.6.2.6.1 ST_IRD2:Process_Received_Data_In state description**

This state shall process the data-in data received by the ST_IRD1:Receive_Data_In state.

The IRD state machine shall terminate after the data-in data is processed.

9.2.6.2.7 ST_IPR1:Process_Received_Response state

9.2.6.2.7.1 ST_IPR1:Process_Received_Response state description

The IPR state machine shall be initiated when this state receives a Response Arrived parameter from the ST_IFR:Frame_Router state.

This state shall check that the parameter includes the values from the DESTINATION SAS ADDRESS and the SOURCE SAS ADDRESS from the OPEN address frame that initiated the connection, the HASHED DESTINATION SAS ADDRESS, HASHED SOURCE SAS ADDRESS, NUMBER OF FILL BYTES, COMMAND ID, and TAG fields from the SSP frame containing the RESPONSE information unit, and the RESPONSE information unit.

If any of the values are not included or are incorrect, then the IPR state machine shall terminate.

If all values are correct, then this state shall, depending on the content of the RESPONSE information unit, send either a Command Complete Received or Received [Task Management] Function – Executed protocol service confirmation to the SCSI initiator application layer.

The IPR state machine shall terminate after sending the confirmation.

9.2.6.2.8 ST_IFR1:Initiator_Frame_Router state

9.2.6.2.8.1 ST_IFR1:Initiator_Frame_Router state description

The IFR state machine shall be initiated when this state receives an Accept_Reject OPENs request from the SCSI initiator application layer or one of the following confirmations from the initiator port layer state machine:

- a) Frame Received;
- b) Connection Closed; or
- c) HARD_RESET Received.

If the IFR state machine was initiated as the result of this state receiving an Accept_Reject OPENs(Accept) or Accept_Reject OPENs(Reject) request from the SCSI initiator application layer, then this state shall send an Accept_Reject OPENs request along with the received attribute to the initiator port layer state machine. The IFR state machine shall terminate after sending an Accept_Reject OPENs request to the initiator port layer state machine.

If the IFR state machine was initiated as the result of this state receiving a Frame Received(Frame failed), Connection Closed, or HARD_RESET Received confirmation from the initiator port layer state machine, then the IFR state machine shall terminate.

If the IFR state machine was initiated as the result of this state receiving a Frame Received(ACK/NAK balanced) confirmation from the initiator port layer state machine, then this state shall check the value in the INFORMATION UNIT TYPE field in the received frame. If the information unit type is DATA, then this state shall send a Data-in parameter to the ST_IRD1:Receive_Data_In state. If the information unit type is XFER_RDY, then this state shall send a XFER_RDY Arrived parameter to the ST_ISF1:Initiator_Send_Frame state. If the information unit type is RESPONSE, then this state shall send a Response Arrived parameter to the ST_IPR1:Process_Received_Response state. If the information unit type is not DATA, XFER_RDY, or RESPONSE the IFR state machine shall terminate.

If the IFR state machine was initiated as the result of this state receiving a Frame Received(ACK/NAK not balanced) confirmation from the initiator port layer state machine, then this state shall check the value in the INFORMATION UNIT TYPE field in the received frame. If the information unit type is DATA, then this state shall send a Data-in parameter to the ST_IRD1:Receive_Data_In state. If the information unit type is not DATA, then the IFR state machine shall terminate.

The IFR state machine shall terminate after sending a parameter to another state machine.

9.2.6.3 SSP transport layer target device state machines

9.2.6.3.1 SSP transport layer target device state machines overview

The TFR (target frame router) state machine receives confirmations from the target port layer state machine and sends a protocol service indication to the SCSI target application layer or a Data-Out Received parameter to the TTS (target transport server) state machine. The TFR state machine also receives Accept_Reject OPENS requests from the SCSI target application layer and sends these requests to the target port layer state machine.

The TFR state machine contains the following state:

- a) ST_TFR1:Target_Frame_Router state.

The TTS (target transport server) state machine performs the following functions:

- a) receives and processes data-in and data-out delivery service requests from the SCSI target application layer;
- b) processes and sends data-in and data-out delivery service confirmations to the SCSI target application layer;
- c) receives and processes protocol service responses from the SCSI target application layer; and
- d) communicates with the target port layer state machine via several requests and confirmations regarding frame transmission.

The TTS state machine contains the following states:

- a) ST_TTS1:Target_Send_Frame state;
- b) ST_TTS2:Prepare_Send_Data_In state;
- c) ST_TTS3:Receive_Data_Out;
- d) ST_TTS4:Prepare_XFER_RDY;
- e) ST_TTS5:Process_Received_Data_Out; and
- f) ST_TTS6:Prepare_Response.

The TFR state machine sends one of the following protocol service indications to the SCSI target application layer:

- a) SCSI Command Received; or
- b) Task Management Request Received.

The TFR state machine may receive one of the following requests from the SCSI target application layer:

- a) Accept_Reject OPENS(Accept); or
- b) Accept_Reject OPENS(Reject).

The TTS state machine receives one of the following protocol service responses from the SCSI target application layer:

- a) Send Data-In; or
- b) Receive Data-Out.

The TTS state machine sends one of the following protocol service confirmations to the SCSI target application layer:

- a) Data-In Delivered; or
- b) Data-Out Received.

Requests to and confirmations from the port layer state machines are described in x.x.

Figure 2 describes the SSP transport layer target device state machines.

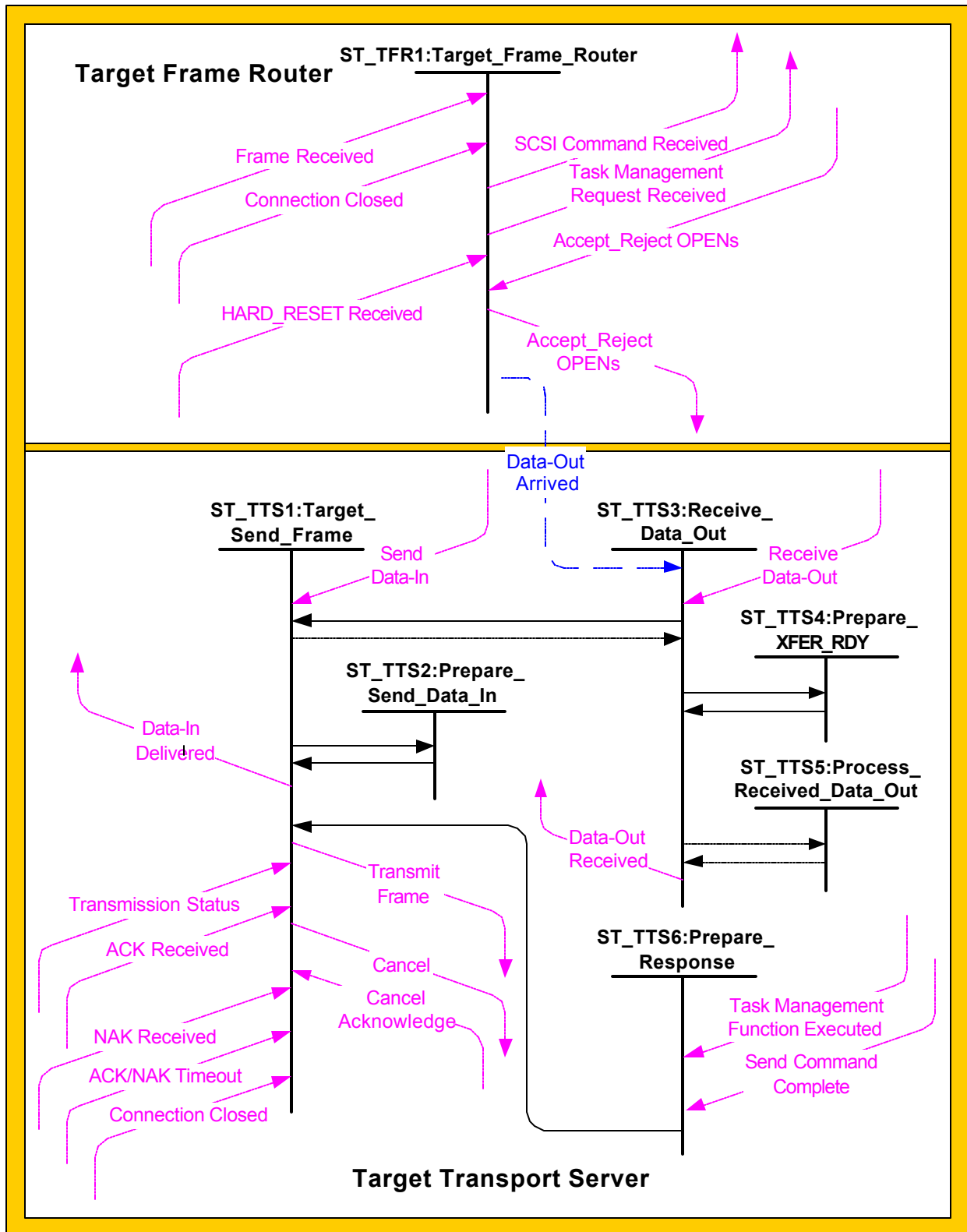


Figure 2. SSP transport layer target device state machines

9.2.6.3.2 ST_TFR1:Target_Frame_Router state

9.2.6.3.2.1 ST_TFR1:Target_Frame_Router state description

The TFR state machine shall be initiated when this state receives an Accept_Reject OPENs request from the SCSI target application layer or one of the following confirmations is received from the target port layer state machine:

- a) Frame Received;
- b) Connection Closed; or
- c) HARD_RESET Received.

If the TFR state machine was initiated as the result of this state receiving an Accept_Reject OPENs(Accept) or Accept_Reject OPENs(Reject) request from the SCSI target application layer, then this state shall send an Accept_Reject OPENs request along with the received attribute to the target port layer state machine. The TFR state machine shall terminate after sending an Accept_Reject OPENs request to the target port layer state machine.

If the TFR state machine was initiated as the result of this state receiving a Frame Received(Frame failed), Connection Closed, or HARD_RESET Received confirmation from the target port layer state machine, then the TFR state machine shall terminate.

If the TFR state machine was initiated as the result of this state receiving a Frame Received(ACK/NAK balanced) confirmation from the target port layer state machine, then this state shall check the value in the INFORMATION UNIT TYPE field in the received frame. If the information unit type is DATA, then this state shall send a Data-Out Arrived parameter to the ST_TTS3:Receive_Data_Out state. If the information unit type is COMMAND, then this state shall send a SCSI Command Received protocol service indication to the SCSI target application layer. If the information unit type is TASK, then this state shall send a Task Management Request Received protocol service indication to the SCSI target application layer. If the information unit type is not DATA, COMMAND, or TASK the TFR state machine shall terminate.

If the TFR state machine was initiated as the result of this state receiving a Frame Received(ACK/NAK not balanced) confirmation from the target port layer state machine, then this state shall check the value in the INFORMATION UNIT TYPE field in the received frame. If the information unit type is DATA, then this state shall send a Data-Out Arrived parameter to the ST_TTS3:Receive_Data_Out state. If the information unit type is not DATA, then the TFR state machine shall terminate.

The TFR state machine shall terminate after sending a Data-Out Arrived parameter or protocol service indication.

9.2.6.3.3 ST_TTS1:Target_Send_Frame state

9.2.6.3.3.1 ST_TTS1:Target_Send_Frame state description

The TTS state machine shall be initiated when this state receives a Send Data-In data-in delivery service request from the SCSI target application layer. This state may also be entered when an SSP frame containing a DATA information unit is received from the ST_TTS2:Prepare_Send_Data_In state, when an SSP frame containing an XFER_RDY information unit is received from the ST_TTS3:Receive_Data_Out state, or when an SSP frame containing a RESPONSE information unit is received from the ST_TTS6:Prepare_Response state.

If the TTS state machine was initiated as the result of this state receiving a Send Data-In data-in delivery service request, then this state shall check that the request includes:

- a) the values to be used in the LINK RATE, INITIATOR CONNECTION TAG, DESTINATION SAS ADDRESS, and SOURCE SAS ADDRESS fields in any OPEN address frame;

- b) the values to be used in the COMMAND ID, TAG, TARGET PORT TRANSFER TAG, and WRITE DATA LENGTH fields in the SSP frame containing the data-in DATA information unit;
- c) the Device Server Buffer from which the data is to be transferred; and
- d) The Request Byte Count (i.e., the number of bytes to be moved by this request).

If these values are not included with the request, then the TTS state machine shall terminate.

If the TTS state machine was initiated as the result of this state receiving a Send Data-In data-in delivery service request and the specified values are included with the request, then this state shall transition to the ST_TTS2:Prepare_Send_Data_In state.

If this state is entered by receipt of an SSP frame containing a DATA information unit, then this state shall send a Transmit Frame(Non-interlocked) request to the target port layer state machine.

If this state is entered by receipt of an SSP frame containing an XFER_RDY information unit, then this state shall send a Transmit Frame(Interlocked) request to the target port layer state machine.

A Transmit Frame request shall include the values for the LINK RATE, INITIATOR CONNECTION TAG, DESTINATION SAS ADDRESS, and SOURCE SAS ADDRESS fields and the SSP frame.

After sending a Transmit Frame request this state shall receive a Transmission Status confirmation from the target port layer state machine. If the confirmation is not Transmission Status(Frame Transmitted), then the TTS state machine shall terminate.

After receiving a Transmission Status(Frame Transmitted) confirmation, this state shall receive one of the following confirmations from the target port layer state machine.

- a) ACK Received;
- b) NAK Received;
- c) ACK/NAK Timeout; or
- d) Connection Closed.

If the confirmation is not ACK Received, then the TTS state machine shall terminate.

If the confirmation is ACK Received, the transmitted SSP frame contained a DATA information unit, and the number of bytes moved for the Send Data-In data-in delivery service request is equal to the Request Byte Count, then this state shall send a Data-In Delivered data-in delivery service confirmation to the SCSI target application layer. The TTS state machine shall terminate after sending the confirmation.

If the confirmation is ACK Received, the transmitted SSP frame contained a DATA information unit, and the number of bytes moved for the Send Data-In data-in delivery service request is less than the Request Byte Count, then this state shall transition to the ST_TTS2:Prepare_Send_Data_In state.

If the confirmation is ACK Received and the transmitted SSP frame contained an XFER_RDY information unit, then this state shall transition to the ST_TTS3:Receive_Data_Out state.

If the confirmation is ACK Received and the transmitted SSP frame contained a RESPONSE information unit, then the TTS state machine shall terminate.

This state may also send a Cancel request to the target port layer state machine to cancel a previous Transmit Frame request. The TTS state machine terminates upon receipt of a Cancel Acknowledge confirmation from the target port layer state machine.

9.2.6.3.3.2 Transition ST_TTS1:Target_Send_Frame to ST_TTS2:Prepare_Send_Data_In

This transition shall occur after either a Send Data-In data-in delivery service request is received by the ST_TTS1:Target_Send_Frame state from the SCSI target application layer and all of the values have been verified, or the ST_TTS1:Target_Send_Frame state has received a Transmission Status(Frame Transmitted) confirmation and an ACK Received confirmation for an SAS frame containing a DATA information unit and the number of bytes moved for the Send Data-In data-in delivery service request is less than the Request Byte Count.

9.2.6.3.3.3 Transition ST_TTS1:Target_Send_Frame to ST_TTS3:Receive_Data_Out

This transition shall occur after the ST_TTS1:Target_Send_Frame state has received a Transmission Status(Frame Transmitted) confirmation and an ACK Received confirmation for an SAS frame containing and XFER_RDY information unit.

9.2.6.3.4 ST_TTS2:Prepare_Send_Data_In state**9.2.6.3.4.1 ST_TTS2:Prepare_Send_Data_In state description**

This state fetches the data from the Device Server Buffer and constructs an SSP frame containing a DATA information unit. This state shall use the values received from the ST_TTS1:Target_Send_Frame state for the COMMAND ID, TAG, and TARGET PORT TRANSFER TAG fields. This state shall generate the values to be used for the INFORMATION UNIT TYPE, HASHED DESTINATION SAS ADDRESS, and HASHED SOURCE SAS ADDRESS.

This state shall calculate the value for the NUMBER OF FILL BYTES fields and include this in the SSP frame.

9.2.6.3.4.2 Transition ST_TTS2:Prepare_Send_Data_In to ST_TTS1:Target_Send_Frame

This transition shall occur after the ST_TTS2:Prepare_Send_Data_In state has constructed an SSP frame containing a DATA information unit.

9.2.6.3.5 ST_TTS3:Receive_Data_Out state**9.2.6.3.5.1 ST_TTS3:Receive_Data_Out state description**

The TTS state machine shall be initiated when this state receives a Receive Data-Out protocol service request from the SCSI target application layer. This state may also be entered after the ST_TTS1:Target_Send_Frame state has received an ACK Received confirmation from the target port layer state machine for an SSP frame containing an XFER_RDY information unit, or when this state receives an SSP frame containing an XFER_RDY information unit from the ST_TTS4:Prepare_XFER_RDY state, or when data-out data has been processed by the ST_TTS5:Process_Received_Data_Out state.

If the TTS state machine was initiated as the result of this state receiving a Receive Data-Out data-out delivery service request, then this state shall check that the request includes:

- a) the values to be used in the LINK RATE, INITIATOR CONNECTION TAG, DESTINATION SAS ADDRESS, and SOURCE SAS ADDRESS fields in any OPEN address frame;
- b) the values to be used in the COMMAND ID, TAG, TARGET PORT TRANSFER TAG, and WRITE DATA LENGTH fields in the SSP frame containing the XFER_RDY information unit;
- c) the Device Server Buffer to which the data is to be transferred; and
- d) the Request Byte Count (i.e., the number of bytes to be transferred, this value should be equal to the value in the WRITE DATA LENGTH field).

If these values are not included with the request, then the TTS state machine shall terminate.

If the TTS state was initiated as the result of this state receiving a Receive Data-out data-out delivery service request and the specified values are included with the request, then this state shall transition to the ST_TTS4:Prepare_XFER_RDY state.

If this state is entered as the result of receiving an SSP frame containing an XFER_RDY information unit from the ST_TTS4:Prepare_XFER_RDY state, then this state shall transition to the ST_TTS1:Target_Send_Frame state

If this state is entered as the result of the ST_TTS1:Target_Send_Frame state receiving an ACK Received confirmation from the target port layer state machine for an SSP frame containing an XFER_RDY information unit, then this state shall wait for a Data-Out Arrived parameter from the ST_TFR1:Target_Frame_Router state.

If this state is entered from the ST_TTS5:Process_Received_Data_Out state and the number of bytes moved for the Receive Data-Out data-out delivery service request is less than the Request Byte Count, then this state shall wait for a Data-Out Arrived parameter from the ST_TFR1:Target_Frame_Router state.

If this state receives a Data-out Arrived parameter from the ST_TFR1:Target_Frame_Router state, then this state shall check that the parameter includes the values from the DESTINATION SAS ADDRESS and the SOURCE SAS ADDRESS from the OPEN address frame that initiated the connection, the HASHED DESTINATION SAS ADDRESS, HASHED SOURCE SAS ADDRESS, NUMBER OF FILL BYTES, COMMAND ID, and TAG fields from the SSP frame containing the DATA information unit, and the DATA information unit. If any of the values are not included or are incorrect, then the TTS state machine shall terminate. If all values are correct, then this state shall transition to the ST_TTS5:Process_Received_Data_Out state.

If this state is entered from the ST_TTS5:Process_Received_Data_Out state and number of bytes moved for the Receive Data-Out data-out delivery service request is equal to the Request Byte Count, then this state shall send a Data-Out Received data-out delivery service confirmation to the SCSI target application layer. The TTS state machine shall terminate after sending the confirmation.

9.2.6.3.5.2 Transition ST_TTS3:Receive_Data_Out to ST_TTS4:Prepare_XFER_RDY

This transition shall occur after a Receive Data-Out data-out delivery service request has been received by the ST_TTS3:Receive_Data_Out state from the SCSI target application layer and all of the values have been verified.

9.2.6.3.5.3 Transition ST_TTS3:Receive_Data_Out to ST_TTS1:Target_Send_Frame

This transition shall occur after an SSP frame containing an XFER_RDY information unit has been received from the ST_TTS4:Prepare_XFER_RDY state.

9.2.6.3.5.4 Transition ST_TTS3:Receive_Data_Out to ST_TTS5:Process_Received_Data_Out

This transition shall occur after the values included with the Data-Out Arrived parameter have been verified by the ST_TTS3:Receive_Data_Out state.

9.2.6.3.6 ST_TTS4:Prepare_XFER_RDY state

9.2.6.3.6.1 ST_TTS4:Prepare_XFER_RDY state description

This state shall construct an SSP frame containing an XFER_RDY information unit.

This state shall use the values received from the SCSI target application layer for the COMMAND ID, TAG, TARGET TRANSPORT TAG, and WRITE DATA LENGTH fields. This state shall generate the values to be used for the INFORMATION UNIT TYPE, HASHED DESTINATION SAS ADDRESS, HASHED SOURCE SAS ADDRESS, and NUMBER OF FILL BYTES fields.

9.2.6.3.6.2 Transition ST_TTS4:Prepare_XFER_RDY to ST_TTS3:Receive_Data_Out

This transition shall occur after the ST_TTS4:Prepare_XFER_RDY state has constructed an SSP frame containing an XFER_RDY information unit

9.2.6.3.7 ST_TTS5:Process_Received_Data_Out state**9.2.6.3.7.1 ST_TTS5:Process_Received_Data_Out state description**

This state shall process the data received in a Data-Out parameter using the Device Server Buffer to which the data is to be transferred.

9.2.6.3.7.2 Transition ST_TTS5:Process_Received_Data_Out to ST_TTS3:Receive_Data_Out

This transition shall occur after data received in a Data-Out parameter has been processed.

9.2.6.3.8 ST_TTS6:Prepare_Response state**9.2.6.3.8.1 ST_TTS6:Prepare_Response state description**

The TTS state machine shall be initiated when this state receives either a Task Management Function Executed or Send Command Complete protocol service response from the SCSI target application layer.

This state shall check that the response includes:

- a) the values to be used in the LINK RATE, INITIATOR CONNECTION TAG, DESTINATION SAS ADDRESS, and SOURCE SAS ADDRESS fields in any OPEN address frame;
- b) the values to be used in the COMMAND ID, TAG, TARGET PORT TRANSFER TAG, DATAPRES, STATUS, SENSE DATA LIST LENGTH, RESPONSE DATA LIST LENGTH, RESPONSE DATA, and SENSE DATA fields in the SSP frame containing the RESPONSE information unit;

If these values are not included with the request, then the TTS state machine shall terminate.

If these values are included, then this state shall construct an SSP frame containing a RESPONSE information unit. This state shall use the values received with the request for the COMMAND ID, TAG, and TARGET PORT TRANSFER TAG fields. This state shall generate the values to be used for the COMMAND ID, TAG, TARGET PORT TRANSFER TAG, DATAPRES, STATUS, SENSE DATA LIST LENGTH, RESPONSE DATA LIST LENGTH, RESPONSE DATA, and SENSE DATA fields. This state shall calculate the value for the NUMBER OF FILL BYTES fields and include this in the SSP frame.

9.2.6.3.8.2 Transition ST_TTS6:Prepare_Response to ST_TTS1:Target_Send_Frame

This transition shall occur after the ST_TTS6:Prepare_Response state has constructed an SSP frame containing a RESPONSE information unit.