

Date: Printed Friday, April 29, 2005 3:42 pm

To: T10 Committee (SCSI)

From: George Penokie (IBM/Tivoli)

Subject: SAS 1.1 - Transport layer retry and argument passing fixes

## **Overview**

During letter ballot review of SAS 1.1 transport layer state machine descriptions it became apparent that the frame level retry description in the state machines was not complete and that the states in state machines that contained more than one state were not passing arguments. There appeared to be an assumption that a state would always have the information it wanted without regard as to where the information came from.

This proposal addressed both those problems. In the first half of this proposal all changes are indicated with blue underlines and red strike-through. The second half contains only change bars.

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Editor's Note 13: Note that cross-references to tables, figures, and subclauses that are to areas outside the sections in this proposal may not be accurate.

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## **Sections with all deletes and adds marked**

### **8.2.4 ST (transport layer for SSP ports) state machines**

#### **8.2.4.1 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 following confirmations between the ST state machines and the port layer:

- a) Transmission Status; and
- b) Frame Received;

include the following as arguments:

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

and are used to route the confirmations to the correct ST state machines.

#### **8.2.4.2 ST\_I (transport layer for SSP initiator ports) state machines**

##### **8.2.4.2.1 ST\_I state machines overview**

The ST\_I state machines are as follows:

- a) ST\_IFR (initiator frame router) state machine (see 8.2.4.2.2); and
- b) ST\_ITS (initiator transport server) state machine (see 8.2.4.2.3).

Figure 149 shows the ST\_I state machines.

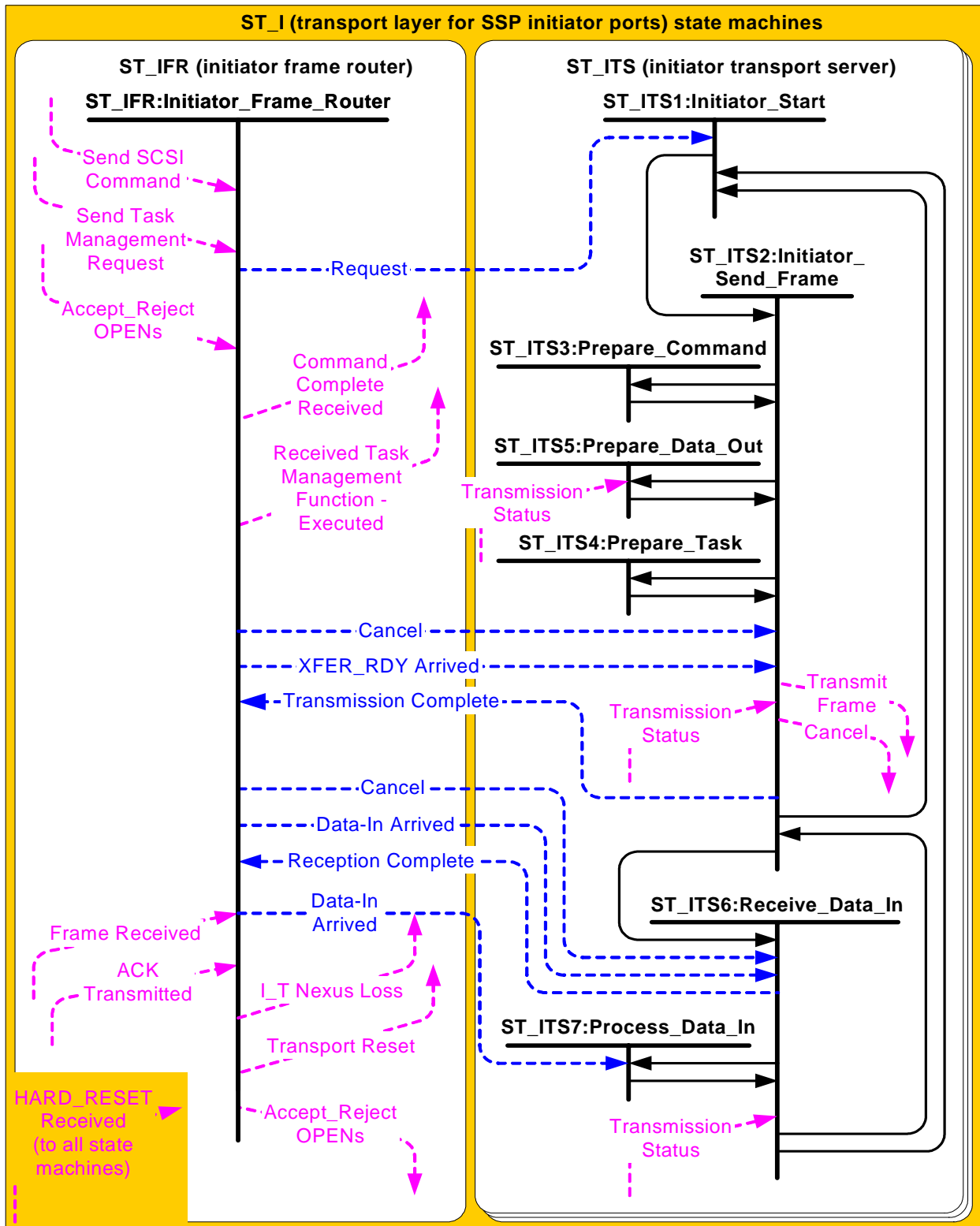


Figure 149 — ST\_I (transport layer for SSP initiator ports) state machines

Editor's Note 14: Added Data-In Arrived message into ST\_ITS7 and Transmission Status

[confirmation into ST\\_ITS5 to allow for non-interlocked DATA frame transfers.](#)

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#### 8.2.4.2.2 ST\_IFR (initiator frame router) state machine

The ST\_IFR state machine performs the following functions:

- a) receives Send SCSI Command and Send Task Management transport protocol service requests from the SCSI application layer;
- b) sends messages to the ST\_ITS state machine;
- c) receives messages from the ST\_ITS state machine;
- d) receives confirmations from the port layer;
- e) sends transport protocol service confirmations to the SCSI application layer;
- f) receives vendor specific requests from the SCSI application layer;
- g) sends vendor specific confirmations to the SCSI application layer;
- h) receives Accept\_Reject OPENs requests from the SCSI application layer;
- i) sends Accept\_Reject OPENs requests to the port layer;
- j) sends L\_T Nexus Loss event notifications to the SCSI application layer; and
- k) sends Transport Reset event notifications to the SCSI application layer.

This state machine consists of one state.

This state machine shall be started after power on.

If this state machine receives a Send SCSI Command transport protocol service request then this state machine shall send a Request (Send Command) message with the following [Command](#) arguments to the ST\_ITS1:Initiator\_Start state in an ST\_ITS state machine that does not have an active task:

- a) connection rate;
- b) initiator connection tag;
- c) destination SAS address;
- d) tag;
- e) logical unit number;
- f) enable first burst value;
- g) task priority;
- h) task attribute;
- i) additional CDB length;
- j) CDB; and
- k) additional CDB bytes, if any.

If the message is a Request (Send Command) message for a command performing write operations and first burst is enabled (see 9.2.2.1), then the message shall also include the number of bytes for the first burst size as an argument.

If this state machine receives a Send Task Management Request transport protocol service request, then this state machine shall send a Request (Send Task) message with the following [Task](#) arguments to the ST\_ITS1:Initiator\_Start state in an ST\_ITS state machine that does not have an active task:

- a) connection rate;
- b) initiator connection tag;
- c) destination SAS address;
- d) retransmit bit;
- e) tag;
- f) logical unit number;
- g) task management function; and
- h) tag of task to be managed.

If this state machine receives a Frame Received (ACK/NAK Balanced) confirmation or Frame Received (ACK/NAK Not Balanced) confirmation, then this state machine shall check the frame type [argument](#) in the frame received ~~as an argument~~ with the confirmation (see table 104 in 9.2.1). 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 machine may check that the hashed source SAS address matches the SAS address of the SAS port that transmitted the frame and that the hashed destination SAS address matches the SAS address of the SAS port that received the frame based on the connection information. If this state machine checks these SAS addresses, and they do not match, then this state machine shall discard the frame.

If the frame type is XFER\_RDY then this state machine shall check the length of the information unit. If the length of the information unit is not correct, then this state machine shall discard the frame.

If the frame type is RESPONSE then this state machine shall check the length of the information unit. If the length of the information unit is not correct and the RESPONSE frame was for a command, then this state shall discard the frame and send a Command Complete Received confirmation to the SCSI application layer with the Service Response argument set to Service Delivery or Target Failure. If the length of the information unit is not correct and the RESPONSE frame was for a task management function, then this state shall discard the frame and send a Received Task Management Function – Executed confirmation to the SCSI application layer with the Service Response argument set to Service Delivery or Target Failure.

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

If the frame type is XFER\_RDY and the tag is for a task with no write data, then this state machine shall:

- a) discard the frame;
- b) send a Command Complete Received transport protocol service confirmation with the Delivery Result argument set to Service Delivery or Target Failure - XFER\_RDY Not Expected to the SCSI application layer; and
- c) if there is an ST\_ITS state machine for the tag, send a Cancel message to that state machine.

If the frame type is RESPONSE, and this state machine has received a RESPONSE frame for the I\_T\_L\_Q nexus, then this state machine shall discard the frame.

If the frame type is RESPONSE, the items checked in the frame are correct, and this state machine has not received a RESPONSE frame for this I\_T\_L\_Q nexus, ~~then this state machine shall send a protocol service confirmation to the SCSI application layer based on the content of the DATAPRES and RESPONSE DATA fields. If the RESPONSE frame was for a command, then the delivery result and other arguments sent with the Command Complete Received protocol service confirmation are defined in 10.2.1.5. If the RESPONSE frame was for a task management request, then the delivery result and other arguments sent with the Received Task Management Function – Executed protocol service confirmation are defined in 10.2.1.14.~~ then:

- a) this state machine shall send a protocol service confirmation to the SCSI application layer based on the content of the DATAPRES and RESPONSE DATA fields; and
- b) if there is an ST\_ITS state machine for the tag associated with the RESPONSE, then send a Cancel message to that state machine.

If the RESPONSE frame was for a command, then the delivery result and other arguments sent with the Command Complete Received protocol service confirmation are defined in 10.2.1.5. If the RESPONSE frame was for a task management request, then the delivery result and other arguments sent with the Received Task Management Function - Executed protocol service confirmation are defined in 10.2.1.14.

If the frame type is XFER\_RDY and the items checked in the frame are correct, then this state machine shall wait to receive an ACK Transmitted confirmation.

If this state machine receives an ACK Transmitted confirmation for an XFER\_RDY frame, then this state machine shall send an XFER\_RDY Arrived message to the ST\_ITS2:Initiator\_Send\_Frame state in the ST\_ITS state machine specified by the tag. The message shall include the following [Xfer\\_Rdy](#) arguments:

- a) ~~the~~ ~~retry data frames bit~~ [frames](#);
- b) ~~the~~ ~~retransmit bit~~;

- c) [retransmit](#);
- d) ~~the~~ target port transfer tag; and
- e) ~~the~~ information unit.

If the frame type is DATA and the items checked in the frame are correct, then this state machine shall send a Data-In Arrived message to the ST\_ITS6:Receive\_Data\_In state in the ST\_ITS state machine specified by the tag. The message shall include the ~~content of the SSP frame~~ [read DATA frame as an argument](#).

This state machine receives Transmission Complete messages and Reception Complete messages from the ST\_ITS state machines that may result in this state machine sending one of the following to the SCSI application layer:

- a) an I\_T Nexus Loss event notification;
- b) a Command Complete protocol service confirmation; or
- c) a Received Task\_Management Function - Executed protocol service confirmation.

If this state receives a Transmission Complete (I\_T Nexus Loss) from an ST\_ITS state machine, then this state machine shall send an I\_T Nexus Loss event notification to the SCSI application layer.

Table 103 defines other messages received from ST\_ITS state machines that require a protocol service confirmation and the Delivery Result argument sent with the corresponding service confirmation that shall be sent upon receipt of the message.

**Table 103 — Arguments sent with confirmations based on messages received**

Message received from ST_ITS state machine	Protocol service confirmation and Delivery Result argument sent to the SCSI application layer
Transmission Complete (Command Delivered)	Command Complete Received (Task Complete)
Transmission Complete (Data-Out Delivered)	Command Complete Received (Task Complete)
Transmission Complete (Command Failed, Connection Failed)	Command Complete Received (Service Delivery or Target Failure - Connection Failed)
Transmission Complete (Command Failed, NAK Received)	Command Complete Received (Service Delivery or Target Failure - NAK Received)
Transmission Complete (Task Delivered)	Received Task Management Function - Executed with the service response argument based on the content of the corresponding RESPONSE frame (see 10.2.1.14)
Transmission Complete (Task Failed, Connection Failed)	Received Task Management Function - Executed (Service Delivery or Target Failure - Connection Failed)
Transmission Complete (Task Failed, NAK Received)	Received Task Management Function - Executed (Service Delivery or Target Failure - NAK Received)
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)
Reception Complete (Data-In Received)	Command Complete Received (Task Complete)
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 (Incorrect Data Length)	Command Complete Received (Service Delivery or Target Failure - DATA Incorrect Data Length)
Reception Complete (Command Failed, Connection Failed)	Command Complete Received (Service Delivery or Target Failure - Connection Failed)

The protocol service confirmation shall include the tag as an argument.

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

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.

This state machine may receive vendor specific requests from the SCSI application layer that cause this state machine to send Cancel messages to [all the](#) ST\_ITS state machines.

### 8.2.4.2.3 ST\_ITS (initiator transport server) state machine

#### 8.2.4.2.3.1 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 8.2.4.2.3.2) (initial state);
- b) ST\_ITS2:Initiator\_Send\_Frame state (see 8.2.4.2.3.3);
- c) ST\_ITS3:Prepare\_Command state (see 8.2.4.2.3.4);
- d) ST\_ITS4:Prepare\_Task state (see 8.2.4.2.3.5);
- e) ST\_ITS5:Prepare\_Data\_Out state (see 8.2.4.2.3.6);
- f) ST\_ITS6:Receive\_Data\_In state (see 8.2.4.2.3.7); and
- g) ST\_ITS7:Process\_Data\_In state (see 8.2.4.2.3.8).

~~All ST\_ITS state machines shall be started start in the ST\_ITS1:Initiator\_Start state after power on. There shall be one ST\_ITS state machine for each possible task or task management function for the SAS initiator port.~~

If transport layer retries are enabled, this state machine shall retain the data offset for the last XFER\_RDY frame received, for use as the restart point in case of a retry for write DATA frames.

~~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 transition to the ST\_ITS1:Initiator\_Start state from any other state after receiving a HARD\_RESET Received confirmation.

#### 8.2.4.2.3.2 ST\_ITS1:Initiator\_Start state

##### 8.2.4.2.3.2.1 State description

This state is the initial state of an ST\_ITS state machine.

##### 8.2.4.2.3.2.2 Transition ST\_ITS1:Initiator\_Start to ST\_ITS2:Initiator\_Send\_Frame

This transition shall occur after this state receives a Request message from the ST\_IFR state machine.

If a Request (Send Command) message was received, then this transition shall include the Command arguments.

If a Request (Send Task) message was received, then this transition shall include the Task arguments.

#### 8.2.4.2.3.3 ST\_ITS2:Initiator\_Send\_Frame state

##### 8.2.4.2.3.3.1 State description

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~~frame performing 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\_ITS7: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.

~~The All~~ Transmit Frame ~~request~~ requests shall include the SSP frame (i.e., 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 DATA frame from the ST\_ITS7: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;
- 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 this state shall wait for 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 ~~this state machine receives a the~~ confirmation ~~that~~ is not Transmission Status (Frame Transmitted) or Transmission Status (I\_T Nexus Loss) (see ~~table 105 table xxx~~ in 8.2.2.3.4), then this state shall send ~~a the~~ Transmission Complete (~~Connection Failed~~) message indicated in table 104 to the ST\_IFR state machine. The message shall include the following arguments:

- a) any argument received with the Transmission Status confirmation; and
- b) ~~the~~ tag.

If the confirmation is Transmission Status (Frame Transmitted) and the Transmit Frame request was for a COMMAND frame not performing a read operation, a TASK frame ~~frame-frame~~, or a write DATA frame where the number of data bytes that have been transmitted equal the request byte count, 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).

NOTE 43 - If the number of data bytes ~~that have been requested to be~~ 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 write 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 write DATA frames sent for the I\_T\_L\_Q nexus.

If the confirmation is Transmission Status (NAK Received), the Transmit Frame request was for a COMMAND frame not performing a read operation or a TASK frame, and a vendor specific number of retries has not been reached, then this state shall process:

- a) the COMMAND frame as if it was received from the ST\_ITS3:Prepare\_Command state; or
- b) the TASK frame as if it was received from the ST\_ITS4:Prepare\_Task state.



Table 104 defines the confirmations received from the port layer after a Transmission Status (Frame Transmitted) and the message that shall be sent by this state to the ST\_IFR state machine upon receipt of the confirmation based on the conditions under which the confirmation was received.

**Table 104 — Messages sent to the ST\_IFR state machine based on port layer confirmations**

Confirmation received from the port layer	Conditions under which confirmation was received	Message sent to ST_IFR
Transmission Status (ACK Received)	The Transmit Frame request was for a COMMAND frame and there is no data to transfer for the command.	Transmission Complete (Command Delivered)
Transmission Status (ACK Received)	The Transmit Frame request was for a TASK frame.	Transmission Complete (Task Delivered)
Transmission Status (ACK Received)	<u>The Transmit Frame request was for a write DATA frame and:</u> <a>a) the number of data bytes transmitted equal the request byte count; and</a> <a>b) this state has received a Transmission Status (ACK Received) confirmation for each write DATA frame transmitted for the request.</a>	Transmission Complete (Data-Out Delivered)
Transmission Status (ACK/NAK Timeout) or Transmission Status (Connection Lost Without ACK/NAK)	The Transmit Frame request was for a COMMAND frame.	Transmission Complete (Command Failed, Connection Failed)
Transmission Status (NAK Received)	The Transmit Frame request was for a COMMAND frame <u>and if the vendor-specific number of retries has been reached.</u>	Transmission Complete (Command Failed, NAK Received)
Transmission Status (ACK/NAK Timeout) or Transmission Status (Connection Lost Without ACK/NAK)	The Transmit Frame request was for a TASK frame.	Transmission Complete (Task Failed, Connection Failed)
Transmission Status (NAK Received)	The Transmit Frame request was for a TASK frame <u>and if the vendor-specific number of retries has been reached.</u>	Transmission Complete (Task Failed, NAK Received)
Transmission Status (NAK Received)	<u>The Transmit Frame request was for a write DATA frame and:</u> <a>a) the RETRY DATA FRAMES bit was set to zero in the XFER_RDY frame requesting the data; or</a> <a>b) the RETRY DATA FRAMES bit was set to one in the XFER_RDY frame requesting the data, and the vendor-specific number of retries has been reached.</a>	Transmission Complete (Data Failed, NAK Received)
Transmission Status (ACK/NAK Timeout) or Transmission Status (Connection Lost Without ACK/NAK)	<u>The Transmit Frame request was for a write DATA frame and:</u> <a>a) the RETRY DATA FRAMES bit was set to zero in the XFER_RDY frame requesting the data; or</a> <a>b) the RETRY DATA FRAMES bit was set to one in the XFER_RDY frame requesting the data, and the vendor-specific number of retries has been reached.</a>	Transmission Complete (Data Failed, Connection Failed)

~~After this state sends a Transmission Complete (Command Failed, Connection Failed) for a write operation when first burst is not enabled, then this state shall wait to receive a Cancel message from the ST\_IFR state machine. If this state receives an XFER\_RDY Arrived message after this state sends the Transmission Complete (Command Failed, Connection Failed), then this state shall discard the XFER\_RDY Arrived message.~~

After this state sends a Transmission Complete (Command Failed, Connection Failed) this state shall continue processing messages and confirmations.

NOTE 44 - The application client may determine the command was received and is being processed by the device server and allow the command to complete.

NOTE 45 - The Cancel message results from a vendor specific request from the SCSI application layer after the SCSI application layer has used a task management function to determine that the SAS target port did not receive the COMMAND frame.

If this state receives a Cancel 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 shall send a Transmission Complete (Cancel Acknowledged) message to the ST\_IFR state machine.

If this state receives a Cancel 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. The Cancel request shall include the following arguments:

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

If this state receives ~~an XFER\_RDY Arrived message~~ Transmission Status (Cancel Acknowledged) confirmation, ~~and the write data length is zero or exceeds the amount of write data remaining to be transferred for the command,~~ then this state shall send a Transmission Complete (~~XFER\_RDY Incorrect Write Data Length~~ Cancel Acknowledged) message to the ~~ST\_IPR~~ ST\_IFR state machine.

If this state ~~machine~~ receives an XFER\_RDY Arrived ~~message and the requested offset is not expected~~ message, then this state shall ~~send a Transmission Complete~~ (verify the XFER\_RDY frame received

with the previous XFER\_RDY Requested Offset Error) message to frame and the write data of the ST\_IPR state machine command as specified in table 105.

**Table 105 — Reception Complete message sent on XFER\_RDY frame verification failure**

<u>Verification</u> <sup>a</sup>	<u>Message sent to ST_IFR</u>	<u>Priority</u> <sup>b</sup>
<u>The value in the WRITE DATA LENGTH field in the XFER_RDY information unit is zero.</u>	<u>Transmission Complete (XFER_RDY Incorrect Write Data Length)</u>	<u>1</u>
<u>The value in the WRITE DATA LENGTH field in the XFER_RDY information unit plus the number of bytes of write data previously transmitted for the command is greater than the number of bytes of data specified by the command.</u>	<u>Transmission Complete (XFER_RDY Incorrect Write Data Length)</u>	<u>1</u>
<u>First burst is not enabled, this is the first XFER_RDY frame for a command, and the value in the REQUESTED OFFSET field in the XFER_RDY information unit is not set to zero.</u>	<u>Transmission Complete (XFER_RDY Requested Offset Error)</u>	<u>2</u>
<u>First burst is enabled, this is the first XFER_RDY frame for a command, and the value in the REQUESTED OFFSET field in the XFER_RDY information unit is not equal to the value indicated by the first burst size field in the Disconnect-Reconnect mode page (see 10.2.6.1.5).</u>	<u>Transmission Complete (XFER_RDY Requested Offset Error)</u>	<u>2</u>
<u>The transport layer retries of write DATA frames is not supported, and the value in the REQUESTED OFFSET field in the XFER_RDY information unit is not set to the value in the REQUESTED OFFSET field in the previous XFER_RDY information unit sent for the command plus the value in the WRITE DATA LENGTH field in the previous XFER_RDY information unit.</u>	<u>Transmission Complete (XFER_RDY Requested Offset Error)</u>	<u>2</u>
<u>The transport layer retries of write DATA frames is supported, the RETRANSMIT bit set to zero, and the value in the REQUESTED OFFSET field in the XFER_RDY information unit is not set to the value in the REQUESTED OFFSET field of a previous XFER_RDY information unit sent for the command plus the value in the WRITE DATA LENGTH field in the previous XFER_RDY information unit.</u>	<u>Transmission Complete (XFER_RDY Requested Offset Error)</u>	<u>2</u>
<u>The transport layer retries of write DATA frames is supported, the RETRANSMIT bit set to one, and the value in the REQUESTED OFFSET field in the XFER_RDY information unit is not equal to the value in the REQUESTED OFFSET field of the previous XFER_RDY information unit sent for the command.</u>	<u>Transmission Complete (XFER_RDY Requested Offset Error)</u>	<u>2</u>
<sup>a</sup> <u>If the verification test fails, then the specified message is sent to ST_IFR state machine.</u> <sup>b</sup> <u>If more than one verification test fails, then the message with the highest priority shall be sent to ST_IFR state machine.</u>		

**8.2.4.2.3.3.3 Transition ST\_ITS2:Initiator\_Send\_Frame to ST\_ITS1:Initiator\_Start**

This transition shall occur after this state has sent one of the following to the ST\_IFR state machine:

- a) a Transmission Complete (Command Delivered) message;
- ~~b) a Transmission Complete (Command Failed, NAK Received) message;~~
- c) a Transmission Complete (Command Failed, NAK Received) message sent as the result of reaching the vendor-specific number of retries for a COMMAND frame;
- d) a Transmission Complete (Task Failed, NAK Received) message sent as the result of reaching the vendor-specific number of retries for a TASK frame;

- e) a Transmission Complete (Command Failed, Connection failed) message and the command was for a non-data operation;
- f) any Transmission Complete message for a TASK or write DATA frame; or
- g) a Transmission Complete (Cancel Acknowledged) ~~message~~.

#### 8.2.4.2.3.3.4 Transition ST\_ITS2:Initiator\_Send\_Frame to ST\_ITS3:Prepare\_Command

This transition shall occur ~~after-if~~ this state was entered from the ST\_ITS1:Initiator\_Start state ~~receives a Request (Send-Command) message~~ with Command arguments.

This transition shall include the Command arguments.

#### 8.2.4.2.3.3.5 Transition ST\_ITS2:Initiator\_Send\_Frame to ST\_ITS4:Prepare\_Task

This transition shall occur ~~after-if~~ this state was entered from the ST\_ITS1:Initiator\_Start state ~~receives a Request (Send-with Task message)~~ arguments.

This transition shall ~~occur after this state receives a Request (Send-~~ include the Task message) ~~arguments~~.

#### 8.2.4.2.3.3.6 Transition ST\_ITS2:Initiator\_Send\_Frame to ST\_ITS5:Prepare\_Data\_Out

This transition shall include a No-retry argument and occur after this state receives:

- a) a Transmission Status (Frame Transmitted) confirmation followed by a Transmission Status (ACK Received) confirmation for a COMMAND frame for a write operation and first burst is enabled;
- b) an XFER\_RDY Arrived message; ~~or~~
- c) a Transmission Status (Frame Transmitted) confirmation for a Transmit Frame (Non-Interlocked) request if the number of data bytes that has been transmitted for the request is less than the first burst size or the write data length specified in the XFER\_RDY;

NOTE 46 - This transition occurs even if this state has not received a Transmission Status (ACK Received) for the ~~COMMAND frame for the write operation~~ DATA frame.

- ~~d) a Transmission Status (Frame Transmitted) confirmation for a Transmit Frame (Non-Interlocked) request if the number of data bytes that has been transmitted for the request is less than the first burst size or the write data length specified in the XFER\_RDY; or~~
- ~~e) a Transmission Status (Frame Transmitted) confirmation and a confirmation other than Transmission Status (ACK Received) for a write DATA frame for which a Transmission Complete message was not sent to the ST\_IFR state machine (i.e., in order to retry transmitting the frame when the vendor-specific number of retries has not been reached).~~

This transition shall include a Retry argument and occur after:

- a) this state receives one of the following confirmations from the port layer or arguments from the ST\_ITS5:Prepare\_Data\_Out state for a write DATA frame:
  - A) Transmission Status (NAK Received);
  - B) Transmission Status (ACK/NAK Timeout); or
  - C) Transmission Status (Connection Lost without ACK/NAK);
- b) the RETRY DATA FRAMES bit set to one in the XFER\_RDY frame for the write operation; and
- c) the vendor-specific number of retries, if any, for the write DATA frame has not been reached.

This transition shall include the:

- a) Xfer\_Rdy arguments; and
- b) Command arguments.

#### 8.2.4.2.3.3.7 Transition ST\_ITS2:Initiator\_Send\_Frame to ST\_ITS6:Receive\_Data\_In

This transition shall occur after this state receives a Transmission Status (Frame Transmitted) confirmation for a COMMAND frame for a command performing a read operation.

This transition shall include the Command arguments.

NOTE 47 - This transition occurs even if this state has not received a Transmission Status (ACK Received) for the COMMAND frame.

#### 8.2.4.2.3.4 ST\_ITS3:Prepare\_Command state

##### 8.2.4.2.3.4.1 State description

This state shall construct a COMMAND frame based on the ~~values received with the Request (Send-Command) message~~[Command arguments](#):

- a) FRAME TYPE field set to 06h (i.e., COMMAND frame);
- b) HASHED DESTINATION SAS ADDRESS field set to the hashed value of the specified destination SAS address;
- c) HASHED SOURCE SAS ADDRESS field set to the hashed value of the SSP initiator port's SAS address;
- d) RETRY DATA FRAMES bit set to zero;
- e) RETRANSMIT bit set to zero;
- f) CHANGING DATA POINTER bit set to zero;
- g) NUMBER OF FILL BYTES field set zero.
- h) TAG field set to the specified tag;
- i) TARGET PORT TRANSFER TAG field set to zero;
- j) DATA OFFSET field set to zero;
- k) in the information unit, LOGICAL UNIT NUMBER field set to the specified logical unit number;
- l) in the information unit, ENABLE FIRST BURST bit set to the specified enable first burst bit;
- m) in the information unit, TASK PRIORITY field set to the specified task priority;
- n) in the information unit, TASK ATTRIBUTE field set to the specified task attribute;
- o) in the information unit, ADDITIONAL CDB LENGTH field set to the specified additional CDB length;
- p) in the information unit, CDB field set to the specified CDB; and
- q) in the information unit, ADDITIONAL CDB BYTES field set to the specified additional CDB bytes, if any.

##### 8.2.4.2.3.4.2 Transition ST\_ITS3:Prepare\_Command to ST\_ITS2:Initiator\_Send\_Frame

This transition shall occur after this state constructs a COMMAND frame.

[This transition shall include the COMMAND frame as an argument.](#)

[This transition shall include the Command arguments.](#)

#### 8.2.4.2.3.5 ST\_ITS4:Prepare\_Task state

##### 8.2.4.2.3.5.1 State description

This state shall construct a TASK frame based on ~~values received with the Request (Send-Task) message~~[Task arguments](#):

- a) FRAME TYPE field set to 16h (i.e., TASK frame);
- b) HASHED DESTINATION SAS ADDRESS field set to the hashed value of the specified destination SAS address;
- c) HASHED SOURCE SAS ADDRESS field set to the hashed value of the SSP initiator port's SAS address;
- d) RETRY DATA FRAMES bit set to zero;
- e) RETRANSMIT bit set to the specified retransmit bit;
- f) CHANGING DATA POINTER bit set to zero;
- g) NUMBER OF FILL BYTES field set zero.
- h) TAG field set to the specified tag;
- i) TARGET PORT TRANSFER TAG field set to zero;
- j) DATA OFFSET field set to zero;
- k) in the information unit, LOGICAL UNIT NUMBER field set to the specified logical unit number;
- l) in the information unit, TASK MANAGEMENT FUNCTION field set to the specified task management function; and
- m) in the information unit, TAG OF TASK TO BE MANAGED field set to the specified tag of task to be managed.

#### 8.2.4.2.3.5.2 Transition ST\_ITS4:Prepare\_Task to ST\_ITS2:Initiator\_Send\_Frame

This transition shall occur after this state constructs a TASK frame.

This transition shall include the TASK frame as an argument.

#### 8.2.4.2.3.6 ST\_ITS5:Prepare\_Data\_Out state

##### 8.2.4.2.3.6.1 State description

This state shall construct a write DATA frame using the following based on ~~values either received with the Request (Send Command) message Xfer\_Rdy arguments or, if first burst is enabled or with an XFER\_RDY-Arrived message enabled, the Command arguments:~~

- a) FRAME TYPE field set to 01h (i.e., DATA frame);
- b) HASHED DESTINATION SAS ADDRESS field set to the hashed value of the specified destination SAS address;
- c) HASHED SOURCE SAS ADDRESS field set to the hashed value of the SSP initiator port's SAS address;
- d) RETRY DATA FRAMES bit set to zero;
- e) RETRANSMIT bit set to zero;
- f) CHANGING DATA POINTER bit set ~~to zero, unless otherwise as~~ specified in this subclause;
- g) NUMBER OF FILL BYTES field set to the number of fill bytes, based on the length of the specified data;
- h) TAG field set to the specified tag;
- i) TARGET PORT TRANSFER TAG field set to the specified target port transfer tag;
- j) DATA OFFSET field set ~~to the specified data offset, unless otherwise as~~ specified in this subclause; and
- k) in the information unit, DATA field set to the specified data.
- l) fill bytes, if any.

~~If this is the first write DATA frame constructed by this state, then this state shall set the CHANGING DATA POINTER bit to zero.~~

~~If this state is entered after the ST\_ISF2:Initiator\_Send\_Frame state receives a Transmission Status (Frame Transmitted) confirmation for a write DATA frame and that state has only received confirmations of Transmission Status (Frame Transmitted) and Transmission Status (ACK Received), then this state shall:~~

If this state is entered with a No-retry argument then this state shall set the CHANGING DATA POINTER bit to ~~zero;~~ zero and;

- a) if this state was entered with Xfer\_Rdy arguments, then set the DATA OFFSET field to the value in the DATA OFFSET field in the previous write DATA frame plus the number of bytes in the previous write DATA information unit; ~~or~~

~~If this state is entered after the ST\_ISF2:Initiator\_Send\_Frame state receives a Transmission Status (Frame Transmitted) confirmation and a confirmation other than Transmission Status (ACK Received) for a write DATA frame for which a Delivery Failure message was not sent to the ST\_IFR state machine (i.e., in order to retry transmitting the frame), then this state shall:~~

- b) if this state was entered with Commands arguments, then set the DATA OFFSET field to zero.

If this state is entered with a Retry argument then this state shall set the CHANGING DATA POINTER bit in the frame to ~~one;~~ one and;

- a) if this state was entered with Xfer\_Rdy arguments, then set the DATA OFFSET field to the data offset value associated with the XFER\_RDY frame; ~~or~~
- b) if this state was entered with command arguments, then set the DATA OFFSET field to zero.

##### 8.2.4.2.3.6.2 Transition ST\_ITS5:Prepare\_Data\_Out to ST\_ITS2:Initiator\_Send\_Frame

This transition shall occur after this state constructs a write DATA frame.

This transition shall include the:

- a) Xfer\_Rdy arguments;
- b) Command arguments;

- c) [DATA frame as an argument; and](#)
- d) [received Transmission Status, if any, as an argument.](#)

**8.2.4.2.3.7 ST\_ITS6:Receive\_Data\_In state**

**8.2.4.2.3.7.1 State description**

If this state receives a Data-In Arrived message from the ST\_IFR state ~~machine~~[machine or a Data-In Arrived argument from the ST\\_ITS7:Process\\_Data\\_In state](#), then this state shall verify [the values in](#) the read DATA frame received with the message [or the argument](#) as ~~follows~~[defined in table 106](#).

- 1) ~~If the data offset was not expected (e.g., the changing data pointer bit is set to zero and the value in the data offset field is not set to the value in the data offset field in the previous DATA information unit plus the number of bytes in that information unit), then this state shall send a Reception Complete (Data Offset Error) message to the ST\_IFR state machine;~~
- 2) ~~If the length of the information unit DATA field (i.e., the length of the information unit) plus the length of read data previously received is greater than that specified by the command (i.e., by the CDB delivered in the COMMAND frame), then this state shall send a Reception Complete (Too Much Read Data) message to the ST\_IFR state machine; and~~
- 3) ~~If the length of the information unit DATA field (i.e., the length of the information unit) is zero, then this state shall send a Reception Complete (Incorrect Data Length) message to the ST\_IFR state machine.~~

**Table 106 — Reception Complete message sent on DATA frame verification failure**

<a href="#">Verification</a> <sup>a</sup>	<a href="#">Message sent to ST_IFR</a>	<a href="#">Priority</a> <sup>b</sup>
<a href="#">The transport layer retries of read DATA frames is not supported, and the value in the DATA OFFSET field in the DATA frame is not set to the value in the DATA OFFSET field in the previous DATA frame received for the command plus the number of bytes in the DATA information unit in that previous DATA frame.</a>	<a href="#">Reception Complete (Data Offset Error)</a>	<a href="#">1</a>
<a href="#">The value in the DATA OFFSET field in the DATA frame is greater than or equal to the number of bytes of data specified by the command (i.e., by the CDB delivered in the COMMAND frame).</a>	<a href="#">Reception Complete (Data Offset Error)</a>	<a href="#">1</a>
<a href="#">The number of bytes in the DATA field in the DATA information unit plus the number of bytes of read data previously received for the command is greater than the number of bytes of data specified by the command (i.e., by the CDB delivered in the COMMAND frame).</a>	<a href="#">Reception Complete (Too Much Read Data)</a>	<a href="#">2</a>
<a href="#">The number of bytes in the DATA field in the DATA information unit is zero.</a>	<a href="#">Reception Complete (Incorrect Data Length)</a>	<a href="#">3</a>
<sup>a</sup> <a href="#">If the verification test fails, then the specified message is sent to the ST_IFR state machine.</a> <sup>b</sup> <a href="#">If more than one verification test fails, then the message with the highest priority shall be sent to ST_IFR state machine.</a>		

[If:](#)

- a) [transport layer retries of read DATA frames is supported;](#)
- b) [the CHANGING DATA POINTER bit is set to zero;](#)
- c) [the value in the DATA OFFSET field is not set to the value in the DATA OFFSET FIELD in the previous DATA frame plus the number of bytes in the associated DATA information unit; and](#)
- d) [value in the DATA OFFSET field is within the range of the requested data.](#)

then this state shall discard all Data-In Arrived messages until the CHANGING DATA POINTER bit is set to one. The Data-in Arrived message with the CHANGING DATA POINTER bit set to one, and any additional Data-in Arrived messages, shall be processed by this state.

If this state receives Transmission Status (ACK/NAK Timeout) or Transmission Status (Connection Lost Without ACK/NAK), then this state shall send a Reception Complete (Command Failed, Connection Failed) to the ST\_IFR state machine.

After this state sends a Reception Complete (Command Failed, Connection Failed), ~~then this state shall wait to receive a Cancel message from the ST\_IFR state machine. If this state receives a Data-In Arrived message after this state sends the Transmission Complete (Command Failed, Connection Failed), then this state shall discard the Data-In Arrived message~~continue processing messages and confirmations.

NOTE 48 - The application client may determine the command was received and is being processed by the device server and allow the command to complete.

NOTE 49 - The Cancel message results from a vendor specific request from the SCSI application layer after the SCSI application layer has used a task management function to determine that the SAS target port did not receive the COMMAND frame.

If this state is entered from the ST\_ITS7:Process\_Data\_In state and number of bytes moved for the data in command equals the request byte count, then this state shall send a Reception Complete (Data-In Received) message to the ~~ST\_TFR~~ST\_IFR state machine.

If this state receives a Cancel message from the ST\_IFR state machine, then this state shall send a Reception Complete (Cancel Acknowledged) message to the ST\_IFR state machine. The Reception Complete message shall include the tag as an argument.

#### 8.2.4.2.3.7.2 Transition ST\_ITS6:Receive\_Data\_In to ST\_ITS1:Initiator\_Start

This transition shall occur after this state sends one of the following to the ST\_IFR state machine:

- a) a Reception Complete (Data-In Received) message;
- b) a Reception Complete (Data Offset Error) message;
- c) a Reception Complete (Too Much Read Data) message;
- d) a Reception Complete (Incorrect Data Length) message; or
- e) a Reception Complete (Cancel Acknowledged) message.

#### 8.2.4.2.3.7.3 Transition ST\_ITS6:Receive\_Data\_In to ST\_ITS2:Initiator\_Send\_Frame

This transition shall occur after this state receives a Transmission Status (NAK Received) confirmation for a COMMAND frame for a command performing a read operation.

This transition shall include the Command arguments.

#### 8.2.4.2.3.7.4 Transition ST\_ITS6:Receive\_Data\_In to ST\_ITS7:Process\_Data\_In

This transition shall occur after this state receives and verifies ~~a~~the read DATA frame received with the Data-In Arrived message values.

This transition shall include the:

- a) Command arguments; and
- b) read DATA frame as an argument.

#### 8.2.4.2.3.8 ST\_ITS7:Process\_Data\_In state

##### 8.2.4.2.3.8.1 State description

This state shall process the data received ~~with in~~ the Data-In Arrived message read DATA frame argument.



#### 8.2.4.2.3.8.2 Transition ST\_ITS7:Process\_Data\_In to ST\_ITS6:Receive\_Data\_In

This transition shall occur after this state has processed the data received in ~~a Data-In Arrived message~~[the read DATA frame argument](#).

[This transition shall include the:](#)

- a) [Command arguments;](#)
- b) [read DATA frame as an argument; and](#)
- c) [received Data-In Arrived, if any, as an argument.](#)

#### 8.2.4.3 ST\_T (transport layer for SSP target ports) state machines

##### 8.2.4.3.1 ST\_T state machines overview

The ST\_T state machines are as follows:

- a) ST\_TFR (target frame router) state machine (see 8.2.4.3.2); and
- b) ST\_TTS (target transport server) state machine (see 8.2.4.3.3).

This state machine may maintain the timers listed in table 107.

**Table 107 — ST\_T state machine timers**

Timer	Initial value
Initiator Response Timeout	The value in the INITIATOR RESPONSE TIMEOUT field in the Protocol-Specific Port mode page (see 10.2.6.2).

Figure 150 shows the ST\_T state machines.

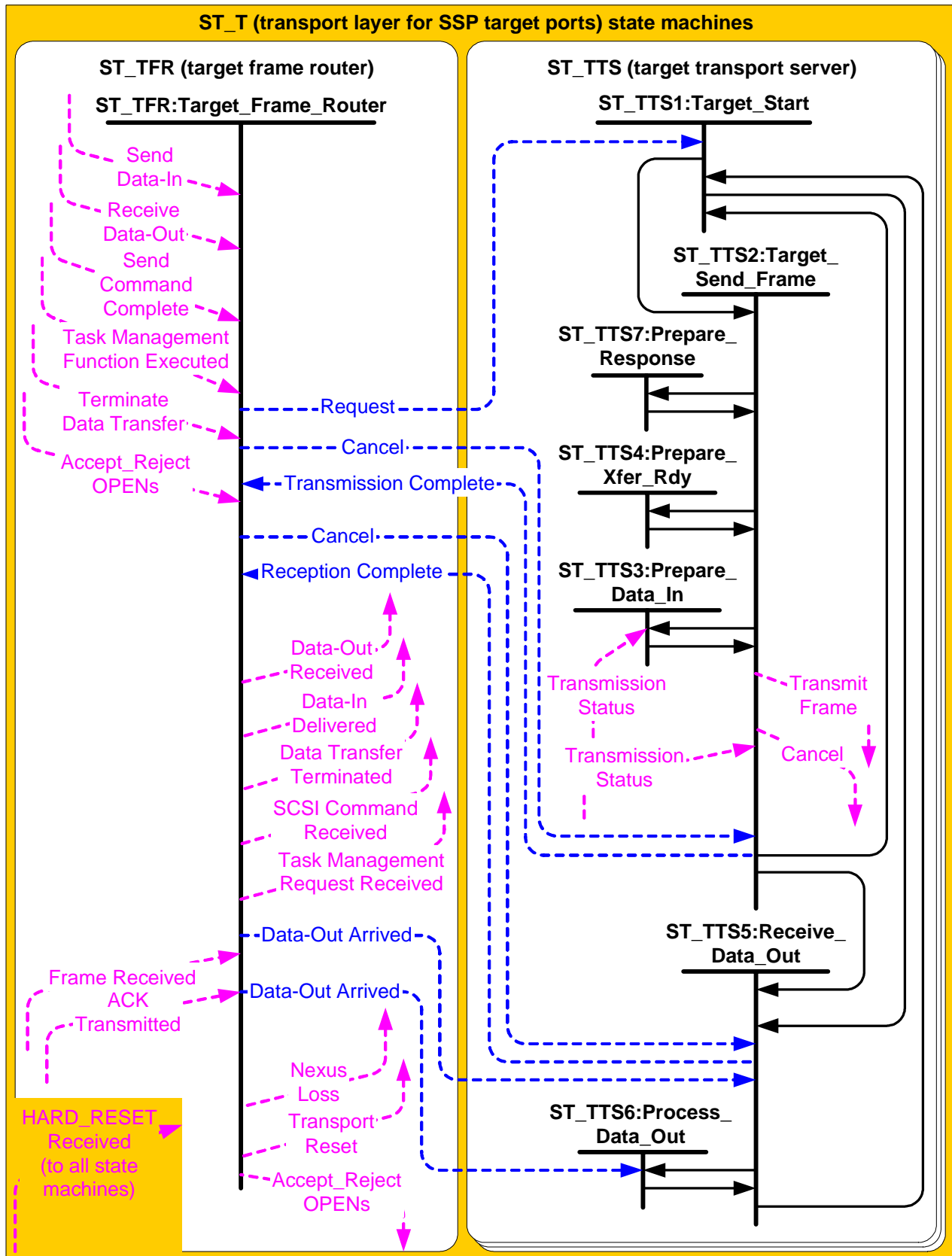


Figure 150 — ST\_T (transport layer for SSP target ports) state machines

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[Editor's Note 15: Added Data-Out Arrived message into ST\\_TTS6 and Transmission Status confirmation into ST\\_TTS3 to allow for non-interlocked DATA frame transfers. Also removed the ST\\_TTS5 to ST\\_TTS2 transition which was not defined in SAS 1.1. rev 9 and is not needed.](#)

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### 8.2.4.3.2 ST\_TFR (target frame router) state machine

The ST\_TFR state machine performs the following functions:

- 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 messages from the ST\_TTS state machine;
- f) receives Accept\_Reject OPENs requests from the SCSI application layer;
- g) sends Accept\_Reject OPENs requests to the port layer;
- h) sends Nexus Loss event notifications to the SCSI application layer; and
- i) sends Transport Reset event notifications to the SCSI application layer.

This state machine consists of one state.

This state machine shall be started after power on.

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 104 in 9.2.1). 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 received frame are zero. If any reserved fields are checked and they are not set to zero, then this state machine shall send a Request (Send Transport Response) message with an argument of Invalid Frame to the ST\_TTS1:Target\_Start state in an ST\_TTS state machine that does not have an active task. The check of reserved fields described above shall not apply to the reserved fields within the CDB in a COMMAND frame. Checking of reserved fields in a CDB is described in SPC-3.

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

If the frame type is COMMAND or TASK then this state machine shall check the length of the information unit. If the length of the information unit is not correct, then this state machine shall send a Request (Send Transport Response) message with an argument of Invalid Frame to the ST\_TTS1:Target\_Start state in an ST\_TTS state machine that does not have an active task.

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 port layer.

If the frame type is TASK and this state machine does not check tags, then this state machine shall ignore the RETRANSMIT bit.

If the frame type is COMMAND or TASK, then this state machine may check the target port transfer tag. If this state checks the target port transfer tag and the tag is set to a value other than FFFFh, then this state machine shall send a Request (Send Transport Response) message with an argument of Invalid Frame to the ST\_TTS1:Target\_Start state in an ST\_TTS state machine that does not have an active task.

If the frame type is TASK, then this state machine shall check the logical unit number. If the logical unit number is unknown, then this state machine shall send a Request (Send Transport Response) message with

an argument of Incorrect Logical Unit Number to the ST\_TTS1:Target\_Start state in an ST\_TTS state machine that does not have an active task.

If the frame type is DATA and this frame is for first burst data or this state machine did not assign a target port transfer tag for the data transfer, 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 Request (Send Transport Response) message with an argument of Invalid Frame to the ST\_TTS1:Target\_Start state in an ST\_TTS state machine that does not have an active task.

If this state machine sends a Request (Send Transport Response) message with an argument of Invalid Frame to [the ST\\_TTS1:Target\\_Start state in](#) an ST\_TTS state machine, then this state machine shall discard the frame and shall include the following [Transport Response](#) arguments in the message:

- a) connection rate;
- b) initiator connection tag;
- c) destination SAS address set to the SAS address from which the invalid frame was received;
- d) source SAS address set to the SAS address of the SAS port containing the state machine; and
- e) tag.

If the frame type is COMMAND or TASK and the items checked in the frame are correct, then this state machine shall wait to receive an ACK Transmitted confirmation.

If the frame type is COMMAND, the items checked in the frame are correct, and this state machine receives an ACK Transmitted confirmation, then this state machine shall send a SCSI Command Received transport protocol service indication with the following arguments to the SCSI application layer:

- a) source SAS address (i.e., the SAS address that transmitted the COMMAND frame);
- b) tag;
- c) logical unit number;
- d) task attribute;
- e) task priority;
- f) CDB; and
- g) additional CDB bytes, if any.

If the frame type is TASK, the items checked in the frame are correct, and this state machine receives an ACK Transmitted confirmation, then this state machine shall send a Task Management Request Received transport protocol service indication to the SCSI application layer. The indication shall include:

- a) source SAS address (i.e., the SAS address that transmitted the TASK frame);
- b) tag;
- c) logical unit number;
- d) task management function; and
- e) tag of the task to be managed.

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

If the frame type is DATA, and the tag matches a tag for an outstanding command performing write operations without first burst data enabled or for which no Transmission Complete (Xfer\_Rdy Delivered) message has been received from an ST\_TTS state machine, then this state machine shall discard the frame.

If the frame type is DATA and a target port transfer tag was assigned in an XFER\_RDY frame for the request, then this state machine shall check the target port transfer tag. If the target port transfer tag does not specify a valid state machine, then this state machine shall discard the frame.

If the frame type is DATA and the items checked in the frame are correct, and there is first burst data enabled or this state machine has received a Transmission Complete (Xfer\_Rdy Delivered) from the ST\_TTS state machine for the request, then this state machine shall send a Data-Out Arrived message to the ST\_TTS5:Receive\_Data\_Out state in the ST\_TTS state machine specified by the tag in the frame. The message shall include the content of the [SSP-write DATA](#) frame.

If this state machine receives a Send Data-In transport protocol service request from the SCSI application layer, then this state machine shall send a Request (Send Data-In) message to the ST\_TTS1:Target\_Start state in an ST\_TTS state machine that does not have an active task.

If this state machine receives a Receive Data-Out transport protocol service request from the SCSI application layer, then this state machine shall send a Request (Receive Data-Out) message to the ST\_TTS1:Target\_Start state in an ST\_TTS state machine that does not have an active task.

A Request (Send Data-In) message shall include the following Data-in arguments:

- a) connection rate;
- b) initiator connection tag;
- c) destination SAS address (i.e., the SAS address to which the read DATA frame is to be transmitted);
- d) tag;
- e) device server buffer;
- f) request byte count; and
- g) application client buffer offset.

A Request (~~Send Data-In) message or a Request (Receive Data-Out) message shall include the following Data-out arguments:~~

- a) connection rate;
- b) initiator connection tag;
- c) destination SAS address (i.e., the SAS address to which the XFER\_RDY frame ~~or read DATA frame is~~ to be transmitted);
- d) tag;
- e) device server buffer; ~~and;~~
- f) request byte count;~~;~~
- g) application client buffer offset;
- h) first burst; and
- i) ~~A Request (Receive Data-Out) message shall also include the~~ target port transfer tag.

If this state machine receives a Send Command Complete transport protocol service response from the SCSI application layer with the Service Response argument set to TASK COMPLETE or LINKED COMMAND COMPLETE, then this state machine shall send a Request (Send Application Response) message to the ST\_TTS1:Target\_Start state in the ST\_TTS state machine specified by the tag. The message shall include the following Command Complete arguments:

- a) connection rate;
- b) initiator connection tag;
- c) destination SAS address (i.e., the SAS address to which the RESPONSE frame is to be transmitted);
- d) tag;
- e) status; and
- f) sense data, if any.

If this state machine receives a Task Management Function Executed transport protocol service response from the SCSI application layer, then this state machine shall send a Request (Send Transport Response) message to the ST\_TTS1:Target\_Start state in an ST\_TTS state machine that does not have an active task with the argument specified in table 108 and the following Task Complete arguments:

- a) connection rate;
- b) initiator connection tag;
- c) destination SAS address (i.e., the SAS address to which the RESPONSE frame is to be transmitted); and
- d) tag.

Table 108 specifies which argument to send with Request (Send Transport Response) based on the Service Response argument that was received.

**Table 108 — Task Management Function Executed Service Response argument mapping**

<b>Task Management Function Executed protocol service response Service Response argument received</b>	<b>Request (Send Transport Response) argument to send</b>
FUNCTION COMPLETE	Task Management Function Complete
FUNCTION SUCCEEDED	Task Management Function Succeeded
FUNCTION REJECTED	Task Management Function Not Supported
INCORRECT LOGICAL UNIT NUMBER	Incorrect Logical Unit Number
SERVICE DELIVERY OR TARGET FAILURE - Overlapped Tag Attempted	Overlapped Tag Attempted

If this state machine receives a Terminate Data Transfer protocol service request from the SCSI application layer and this state machine has not sent a Request message to a ST\_TTS state machine for the Send Data-In or Receive Data-Out protocol service request to which the Terminate Data Transfer request applies, then this state machine shall discard the Terminate Data Transfer request and any corresponding Send Data-In or Receive Data-Out request. This state shall then send a Data Transfer Terminated protocol service confirmation to the SCSI application layer.

If this state machine receives a Terminate Data Transfer protocol service request from the SCSI application layer and this state machine has sent a Request message to a ST\_TTS state machine for the Send Data-In protocol service request to which the Terminate Data Transfer request applies, then this state machine shall send a Cancel message to the ST\_TTS2:Target\_Send\_Frame state in the ST\_TTS state machine specified by the tag and the Send Data-In protocol service request.

If this state machine receives a Terminate Data Transfer protocol service request from the SCSI application layer and this state machine has sent a Request message to a ST\_TTS state machine for the Receive Data-Out protocol service request to which the Terminate Data Transfer request applies, then this state machine shall send a Cancel message to the ST\_TTS5:Receive\_Data\_Out state in the ST\_TTS state machine specified by the tag and the Receive Data-Out protocol service request.

This state machine receives Transmission Complete and Reception Complete messages from the ST\_TTS state machines that may result in this state machine sending a Nexus Loss event notification or a protocol service confirmation to the SCSI application layer. If this state machine receives a Transmission Complete (I\_T Nexus Loss) message, then this state machine shall send a Nexus Loss event notification to the SCSI

application layer. Table 109 defines the received messages that require a protocol service confirmation and the corresponding service confirmations that shall be sent upon receipt of the message.

**Table 109 — Confirmations sent to the SCSI application layer**

Message received from ST_TTS state machine	Protocol service confirmation sent to SCSI application layer
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, Connection Failed)	Data-Out Received with the Delivery Result argument set to DELIVERY FAILURE - CONNECTION FAILED
Transmission Complete (Data Failed, NAK Received)	Data-In Delivered with the Delivery Result argument set to DELIVERY FAILURE - NAK RECEIVED
Transmission Complete (Data Failed, Connection Failed)	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
Transmission Complete (Data Transfer Terminated)	Data Transfer Terminated
Reception Complete (Data Transfer Terminated)	Data Transfer Terminated

Each protocol service confirmation shall include the tag as an argument.

If this state machine receives an Accept\_Reject OPENS (Accept SSP) or Accept\_Reject OPENS (Reject SSP) request, then this state machine shall send a corresponding Accept\_Reject OPENS request 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.

### 8.2.4.3.3 ST\_TTS (target transport server) state machine

#### 8.2.4.3.3.1 ST\_TTS state machine overview

The ST\_TTS state machine performs the following functions:

- a) receives and processes messages from the ST\_TFR state machine;
- b) sends messages to the ST\_TFR state machine;
- c) communicates with the port layer using requests and confirmations regarding frame transmission; and
- d) receives HARD\_RESET Received confirmations from the port layer.

This state machine consists of the following states:

- a) ST\_TTS1:Target\_Start (see 8.2.4.3.3.2) (initial state);
- b) ST\_TTS2:Target\_Send\_Frame (see 8.2.4.3.3.3);
- c) ST\_TTS3:Prepare\_Data\_In (see 8.2.4.3.3.4);
- d) ST\_TTS4:Prepare\_Xfer\_Rdy (see 8.2.4.3.3.5);
- e) ST\_TTS5:Receive\_Data\_Out (see 8.2.4.3.3.6);
- f) ST\_TTS6:Process\_Data\_Out (see 8.2.4.3.3.7); and
- g) ST\_TTS7:Prepare\_Response (see 8.2.4.3.3.8).

~~Each ST\_TTS-This state machines-machine shall be started-start~~ in the ST\_TTS1:Target\_Start state after power on. There shall be one ST\_TTS state machine for each possible task that may be accepted by the SAS target port.

If transport layer retries are enabled, this state ~~machine~~machine shall:

- a) ~~shall~~retain the data offset for a read DATA frame transmitted for which ACK/NAK Balance was achieved (i.e., when the number of read DATA frames sent matches the number of ACK Received confirmations received) for use as the restart point in case of a retry for read DATA frames; and
- b) ~~shall~~retain the data offset for the last XFER\_RDY frame transmitted, for use in ~~these~~the following cases:
  - A) ~~if this state machine retries the XFER\_RDY frame, to retransmit the XFER\_RDY frame; or~~
  - B) if this state machine retries the XFER\_RDY frame, then this state machine shall place the retained data offset into the DATA OFFSET field of the retransmitted XFER\_RDY frame; or
  - C) if the SSP initiator port retries write DATA frames, then this state machine shall use the retained data offset to helpreestablish the write data context.

~~If this state machine receives a HARD\_RESET Received confirmation, then this state machine shall transition to the ST\_TTS4:Target\_Start state.~~

This state machine shall transition to the ST\_TTS1:Target\_Start state from any other state after receiving a HARD\_RESET Received confirmation.

#### 8.2.4.3.3.2 ST\_TTS1:Target\_Start state

##### 8.2.4.3.3.2.1 State description

This state is the initial state of an ST\_TTS state machine.

##### 8.2.4.3.3.2.2 Transition ST\_TTS1:Target\_Start to ST\_TTS2:Target\_Send\_Frame

This transition shall occur after this state receives a Request message from the ST\_TFR state machine other than a Request (Receive Data-Out) message if first burst is enabled.

If a Request (Send Transport Response) message was received, then this transition shall include the Transport Response arguments.

If a Request (Send Data-in) message was received, then this transition shall include the Data-in arguments.

If a Request (Send Data-out) message was received, then this transition shall include the Data-out arguments.



If a Request (Send Application Response) was received, then this transition shall include the received arguments (i.e., the Command Complete arguments or the Task Complete arguments).

#### 8.2.4.3.3.2.3 Transition ST\_TTS1:Target\_Start to ST\_TTS5:Receive\_Data\_Out

This transition shall occur after this state receives a Request (Receive Data-Out) message from the ST\_TFR state machine and first burst is enabled.

This transition shall include the Data-out arguments.

#### 8.2.4.3.3.3 ST\_TTS2:Target\_Send\_Frame state

##### 8.2.4.3.3.3.1 State description

If this state is entered from the ST\_TTS3:Prepare\_Data\_In state for transmission of a read 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\_TTS4: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, then this state shall send a Transmit Frame (Interlocked) request to the port layer.

NOTE 50 - The XFER\_RDY and RESPONSE frame rules ensure that wide ports do not send an XFER\_RDY or RESPONSE frame on a phy until all the ACKs have been transmitted for write DATA frames on a different phy. In a narrow port, the link layer ensures that ACK/NAKs are balanced before transmitting an interlocked frame.

A-All Transmit Frame request-requests from this state shall include the SSP frame (i.e., the DATA frame from the ST\_TTS3:Prepare\_Data\_In state, the XFER\_RDY frame from the ST\_TTS4:Prepare\_Xfer\_Rdy state, or the RESPONSE frame from the ST\_TTS7:Prepare\_Response state) and the following arguments to be used for any OPEN address frame:

- a) 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), then this state shall send a Transmission Complete (I\_T Nexus Loss) message to the ST\_TFR state machine. The 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), ~~and the Transmit Frame request was for an XFER\_RDY, DATA, or RESPONSE frame,~~ then this state shall send ~~a~~ the Transmission Complete (~~Connection Failed~~) message defined in table 110 to the ST\_TFR state machine. The message shall include the following arguments:

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

If the confirmation is Transmission Status (Frame Transmitted) and the Transmit Frame request was for an XFER\_RDY frame, a RESPONSE frame, or a read DATA frame where the number of bytes that have been transmitted equal the request byte count (i.e., all data has been transferred for the request), 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).

NOTE 51 - If the number of data bytes that have been transmitted for the Request (Send Data-In) message are fewer than the request byte count, then this state transitions to the ST\_TTS3:Prepare\_Data\_In state to construct the additional read DATA frames for the 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 read DATA frames sent for the I\_T\_L\_Q nexus (see 8.2.4.3.3.4).

Table 110 defines the confirmations to be received from the port layer after a Transmission Status (Frame Transmitted) and the message that shall be sent by this state to the ST\_TFR state machine upon receipt of the confirmation based on the conditions under which the confirmation was received.

**Table 110 — Messages sent to the ST\_TFR state machine based on port layer confirmations**

Confirmation received from the port layer	Conditions under which confirmation was received	Message sent to the ST_TFR state machine
Transmission Status (ACK Received)	The Transmit Frame request was for an XFER_RDY frame.	Transmission Complete (Xfer_Rdy Delivered) with the target port transfer tag argument
Transmission Status (ACK Received)	Transmit Frame request was for a RESPONSE frame	Transmission Complete (Response Delivered)
Transmission Status (ACK Received)	<u>The Transmit Frame request was for a read DATA frame and:</u> a) <u>the number of data bytes transmitted equal the request byte count; and</u> b) <u>this state has received a Transmission Status (ACK Received) confirmation for each read DATA frame transmitted for the request.</u>	Transmission Complete (Data-In Delivered)
Transmission Status (NAK Received), Transmission Status (ACK/NAK Timeout), or Transmission Status (Connection Lost Without ACK/NAK)	<u>The Transmit Frame request was for a RESPONSE frame and the vendor-specific number of retries has been reached.</u>	Transmission Complete (Response Delivery Failed)
Transmission Status (NAK Received)	<u>The Transmit Frame request was for an XFER_RDY frame and:</u> a) <u>the TRANSPORT LAYERS RETRIES bit is set to zero in the Protocol-Specific Logical Unit mode page (see x.x.x); or</u> b) <u>the vendor-specific number of retries has been reached.</u>	Transmission Complete (Xfer_Rdy Failed, NAK Received)
Transmission Status (ACK/NAK Timeout) or Transmission Status (Connection Lost Without ACK/NAK)		Transmission Complete (Xfer_Rdy Failed, Connection Failed)
Transmission Status (NAK Received)	<u>The Transmit Frame request was for a read DATA frame and:</u> a) <u>the TRANSPORT LAYERS RETRIES bit is set to zero in the Protocol-Specific Logical Unit mode page (see x.x.x); or</u> b) <u>the vendor-specific number of retries has been reached.</u>	Transmission Complete (Data Failed, NAK Received)
Transmission Status (ACK/NAK Timeout) or Transmission Status (Connection Lost Without ACK/NAK)		Transmission Complete (Data Failed, Connection Failed)

If this state receives a Cancel message from the ST\_TFR state machine and this state has received confirmations for all Transmit Frame requests sent to the port layer, then this state shall send a Transmission Complete (Cancel Acknowledged) message to the ST\_TFR state machine.

If this state receives a Cancel message from the ST\_TFR 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 to cancel previous Transmit Frame requests. The Cancel request shall include the following arguments:

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

Upon receipt of a Transmission Status (Cancel Acknowledged) confirmation this state shall send a Transmission Complete (Cancel Acknowledged) message to the ST\_TFR state machine.

A Transmission Complete message to the ST\_TFR state machine shall include the following arguments:

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

#### 8.2.4.3.3.3.3 Transition ST\_TTS2:Target\_Send\_Frame to ST\_TTS1:Target\_Start

This transition shall occur after this state has sent a Transmission Complete message other than Transmission Complete (Xfer\_Rdy Delivered) to the ST\_TFR state machine.

#### 8.2.4.3.3.3.4 Transition ST\_TTS2:Target\_Send\_Frame to ST\_TTS3:Prepare\_Data\_In

This transition shall include a No-retry argument and occur:

- a) if this state was entered from the ST\_TTS1:Target\_Start state with Data-in arguments; or
- b) after this state receives a Transmission Status (Frame Transmitted) confirmation for a read DATA frame and the number of bytes moved for a Request (Send Data-In) message is less than the requested byte count.

This transition shall include a Retry argument and occur ~~after this state~~after:

- a) this state receives one of the following confirmations from the port layer or arguments from the ST\_TTS3:Prepare\_Data\_In state for a read DATA frame:
  - A) Transmission Status (NAK Received);
  - B) Transmission Status (ACK/NAK Timeout); or
  - C) ~~receives a~~Transmission Status (~~ACK Received~~) confirmation for an XFER\_RDY frame ~~Con-~~nection Lost without ACK/NAK);
- b) ~~receives a~~Transmission Status (~~Frame Transmitted~~) confirmation for a read DATA frame and the number of bytes moved for a Request (Send Data-In) message is less than the requested byte count; or
- c) ~~receives a~~Transmission Status (~~Frame Transmitted~~) confirmation and a confirmation other than Transmission Status (~~ACK Received~~) for a read DATA frame for which a Transmission Complete message was not sent to the ST\_TFR state machine (i.e., in order to retry transmitting the frame when the vendor-specific number of retries has not been reached);
- d) the TRANSPORT LAYERS RETRIES bit is set to one in the Protocol-Specific Logical Unit mode page (see x.x.x); and
- e) the vendor-specific number of retries, if any, for the read DATA frame has not been reached.

This transition shall include the Data-in arguments.

If this state was entered from the ST\_TTS1:Target\_Start state, then this transition shall include the First Frame argument.

If this state receives a Transmission Status from the port layer or from the ST\_TTS3:Prepare\_Data\_In state, then this transition shall include the Next Frame argument.

#### 8.2.4.3.3.3.5 Transition ST\_TTS2:Target\_Send\_Frame to ST\_TTS4:Prepare\_Xfer\_Rdy

This transition shall include a No-retry argument and occur ~~after if~~ this state was entered from the ST\_TTS1:Target\_Start state ~~machine has received a Request (Receive with Data-Out) message out arguments~~ and:

- a) first burst is enabled, all first burst data has been received, and there is more data associated with the Data-out arguments to ~~transfer for the message~~transfer;
- b) first burst is not enabled and no XFER\_RDY has been transmitted ~~for~~associated with the ~~message;Data-out arguments; or~~
- c) all data for a previous XFER\_RDY has been received and there is more data associated with the Data-out arguments to ~~transfer for the message; or~~transfer.
- ~~d) this state receives a Transmission Status (Frame Transmitted) confirmation for an XFER\_RDY frame followed by a Transmission Status (NAK Received), Transmission Status (ACK/NAK Timeout), or Transmission Status (Connection Lost Without ACK/NAK) confirmation for the frame, and the vendor-specific number of retries has not been reached.~~

This transition shall include a Retry argument and occur after:

- a) this state receives one of the following confirmations for a XFER\_RDY frame:
  - A) Transmission Status (NAK Received);
  - B) Transmission Status (ACK/NAK Timeout); or
  - C) Transmission Status (Connection Lost without ACK/NAK);
- b) the TRANSPORT LAYERS RETRIES bit is set to one in the Protocol-Specific Logical Unit mode page (see x.x.x); and
- c) the vendor-specific number of retries, if any, for the XFER\_RDY frame has not been reached.

This transition shall include the Data-out arguments.

If this state was entered from the ST\_TTS1:Target\_Start state, then this transition shall include the First Xfer\_Rdy argument.

If this receives a Transmission Status, then this transition shall include the Next Xfer\_Rdy argument.

#### 8.2.4.3.3.3.6 Transition ST\_TTS2:Target\_Send\_Frame to ST\_TTS5:Receive\_Data\_Out

This transition shall occur after this state receives a Transmission Status (Frame Transmitted) confirmation for an XFER\_RDY frame followed by a Transmission Status (ACK Received) confirmation for the frame.

This transition shall include the Data-out arguments.

#### 8.2.4.3.3.3.7 Transition ST\_TTS2:Target\_Send\_Frame to ST\_TTS7:Prepare\_Response

This transition shall include a No-retry argument and occur if this state:

- a) was entered from the ST\_TTS1:Target\_Start state with Command Complete arguments; or
- b) was entered from the ST\_TTS1:Target\_Start state with Task Complete arguments.

This transition shall include a Retry argument and the previous RESPONSE frame, and occur if this state:

- a) receives one of the following confirmations for a RESPONSE frame:
  - A) Transmission Status (NAK Received);
  - B) Transmission Status (ACK/NAK Timeout); or
  - C) Transmission Status (Connection Lost without ACK/NAK); and
- b) the vendor-specific number of retries for the RESPONSE frame has not been reached. The number of retries for a RESPONSE frame shall be greater than or equal to one.

This transition shall ~~occur after~~include the:

- ~~a) this state machine receives a Request (Send Transport Response) message from the ST\_TFR state machine;~~
- ~~b) this state machine receives a Request (Send Application Response) message from the ST\_TFR state machine; or~~

~~e) this state receives a Transmission Status (Frame Transmitted) confirmation for a RESPONSE frame followed by a Transmission Status (NAK Received), Transmission Status (ACK/NAK Timeout), or Transmission Status (Connection Lost Without ACK/NAK) confirmation for the frame, and the vendor-specific number of retries has not been reached. The number of retries for a RESPONSE frame shall be greater than or equal to one.~~

a) [Command Compete arguments; or](#)

b) [Task Compete arguments.](#)

#### 8.2.4.3.3.4 ST\_TTS3:Prepare\_Data\_In state

##### 8.2.4.3.3.4.1 State description

This state retrieves the data from the Device Server Buffer and constructs a read DATA frame. This state shall use ~~arguments received in the Request (Send Data In) message in arguments~~ to construct the frame (see 8.2.4.3.2).

This state shall generate the following values when constructing the [read DATA](#) frame:

- a) FRAME TYPE field set to 01h (i.e., DATA frame);
- b) HASHED DESTINATION SAS ADDRESS field set to the hashed value of the specified destination SAS address;
- c) HASHED SOURCE SAS ADDRESS field set to the hashed value of the SSP target port's SAS address;
- d) RETRY DATA FRAMES bit set to zero;
- e) RETRANSMIT bit set to zero;
- f) CHANGING DATA POINTER ~~bit set to zero, unless otherwise as~~ [specified in this subclause](#);
- g) NUMBER OF FILL BYTES field set to the number of fill bytes needed for the specified data;
- h) TAG field set to the specified tag;
- i) TARGET PORT TRANSFER TAG field set to zero;
- j) DATA OFFSET field set as specified in this subclause; and
- k) in the information unit, DATA field set to the specified data; and
- l) fill bytes, if any.

~~If this is the first read DATA frame constructed by this state, then this state shall set the CHANGING DATA POINTER bit and the DATA OFFSET field in the read DATA frame to zero.~~

If this state is entered ~~after the ST\_TTS2:Target\_Send\_Frame state received with a Transmission Status (Frame Transmitted) confirmation and ST\_TTS2:Target\_Send\_Frame state has only received confirmations of Transmission Status (Frame Transmitted) and Transmission Status (ACK Received),~~ [No-retry argument](#) then this state shall generate the following values when constructing the frame:

- a) set the CHANGING DATA POINTER bit set to zero; and
- b) [if this state is entered with the:](#)
  - A) [First Frame argument, then set the DATA OFFSET field to the specified application client buffer offset; or](#)
  - B) [Next Frame argument, then](#) set the DATA OFFSET field ~~set~~ to the value in the DATA OFFSET field in the previous read DATA frame plus the number of bytes in the previous [read DATA](#) information unit.

If this state is entered ~~after the ST\_TTS2:Target\_Send\_Frame state received with a Transmission Status (Frame Transmitted) confirmation and a confirmation other than Transmission Status (ACK Received) for which a Transmission Complete message was not sent to the ST\_TFR state machine (i.e., to retry-transmitting a frame),~~ [Retry argument](#) then this state shall generate the following values when constructing the frame:

- a) set the CHANGING DATA POINTER bit in the frame to one; and
- b) set the DATA OFFSET field to a data offset value associated with a previous ACK/NAK balance.

##### 8.2.4.3.3.4.2 Transition ST\_TTS3:Prepare\_Data\_In to ST\_TTS2:Target\_Send\_Frame

This transition shall occur after this state constructs a read DATA frame.

[This transition shall include the:](#)

- a) [Data-in arguments; and](#)
- b) [read DATA frame as an argument; and](#)
- c) [received Transmission Status, if any, as an argument.](#)

#### 8.2.4.3.3.5 ST\_TTS4:Prepare\_Xfer\_Rdy state

##### 8.2.4.3.3.5.1 State description

This state shall construct an XFER\_RDY frame using ~~arguments received in the Request (Receive-Data-Out)-message-out arguments~~ (see 8.2.4.3.2):

- a) FRAME TYPE field set to 05h (i.e., XFER\_RDY frame);
- b) HASHED DESTINATION SAS ADDRESS field set to the hashed value of the specified destination SAS address;
- c) HASHED SOURCE SAS ADDRESS field set to the hashed value of the SSP target port's SAS address;
- d) RETRY DATA FRAMES bit set to the value of the TRANSPORT LAYER RETRIES bit in the Protocol-Specific Logical Unit mode page (see 10.2.6.3);
- e) RETRANSMIT bit set ~~to zero, unless otherwise as~~ specified in this subclause;
- f) CHANGING DATA POINTER bit set to zero;
- g) NUMBER OF FILL BYTES field set to zero;
- h) TAG field set to the specified tag;
- i) TARGET PORT TRANSFER TAG field set to a vendor-specific value, unless otherwise specified in this subclause;
- j) DATA OFFSET field set to zero; and
- k) in the information unit, REQUESTED OFFSET field set ~~to the as~~ specified ~~data offset~~ [in this subclause](#); and
- l) in the information unit, WRITE DATA LENGTH field set to the specified write data length.

If first burst is enabled, this state shall adjust the write data length to reflect the amount of first burst data.

~~If this state is entered after the ST\_TTS2:Target\_Send\_Frame state received a Transmission Status (Frame Transmitted) confirmation and a confirmation other than Transmission Status (ACK Received) for which a Transmission Complete message was not sent to the ST\_TFR state machine (i.e., to retry transmitting a frame), then this state shall construct a new XFER\_RDY frame using the values from the previous XFER\_RDY frame except:~~

[If this state is entered with a No-retry argument then this state shall generate the following values when constructing the XFER\\_RDY frame:](#)

- a) [set the RETRANSMIT bit set to zero;](#)
- b) [if the TRANSPORT LAYER RETRIES bit is set to one in the Protocol-Specific Logical Unit mode page \(see x.x.x\), then the value in the TARGET PORT TRANSFER TAG field shall be set to a value that is different than the target port transfer tag in the previous XFER\\_RDY frame associated with the Data-out arguments. The new target port transfer tag shall also be different than any other target port transfer tag currently in use. If write data is received for a subsequent XFER\\_RDY frame for a command, then all target port transfer tags used for previous XFER\\_RDY frames for the command are no longer in use; and](#)
- c) [if this state is entered with the:](#)
  - A) [First Xfer\\_Rdy argument, then set the REQUESTED OFFSET field to the specified application client buffer offset; or](#)
  - B) [Next Xfer\\_Rdy argument, then set the REQUESTED OFFSET field to the value in the REQUESTED OFFSET field in the previous XFER\\_RDY information unit plus the WRITE DATA LENGTH field of the previous XFER\\_RDY information unit.](#)

[If this state is entered with a Retry argument then this state shall generate the following values when constructing the frame:](#)

- a) [set the RETRANSMIT bit ~~shall be set in the frame~~ to one; and;](#)
- b) [set the value in the TARGET PORT TRANSFER TAG field ~~shall be set to a value that is~~ different ~~value~~ than the ~~value~~ ~~target port transfer tag~~ in the previous XFER\\_RDY ~~frame~~ ~~frame~~ associated with the Data-out](#)

arguments. The new target port transfer tag ~~value~~ shall ~~not conflict with~~ be different than any other target port transfer tag currently in use. If write data is received for a subsequent XFER\_RDY frame for a command, then all target port transfer tags used for previous XFER\_RDY frames for the command are no longer in use; and

- c) set the REQUESTED OFFSET field to the data offset value associated with the previous XFER\_RDY information unit.

#### 8.2.4.3.3.5.2 Transition ST\_TTS4:Prepare\_Xfer\_Rdy to ST\_TTS2:Target\_Send\_Frame

This transition shall occur after this state constructs an XFER\_RDY frame.

This transition shall include the:

- a) Data-out arguments; and
- b) XFER\_RDY frame as an argument.

#### 8.2.4.3.3.6 ST\_TTS5:Receive\_Data\_Out state

##### 8.2.4.3.3.6.1 State description

~~If this state receives a Data-Out Arrived message from the ST\_TFR state machine, then this state shall verify the write DATA frame received with the message as follows:~~

If this state receives a Data-Out Arrived message from the ST\_TFR state machine or a read Data-Out Arrived argument from the ST\_TTS6:Process Data Out state, then this state shall verify the write DATA frame received with the Data-Out Arrived values as specified in table 111.

- ~~1) If the data offset was not expected (i.e., the CHANGING DATA POINTER bit is set to one and the value in the DATA OFFSET field is not set to the data offset associated with the XFER\_RDY frame, or the CHANGING DATA POINTER bit is set to zero and the value in the DATA OFFSET field is not set to the value in the DATA OFFSET FIELD in the previous write DATA information unit plus the number of bytes in that information unit), then this state shall send a Reception Complete (Data Offset Error) message to the ST\_TFR state machine;~~
- ~~2) If first burst is enabled and the length of the information unit DATA field is greater than the amount indicated by the FIRST BURST SIZE field in the Disconnect-Reconnect mode page (see 10.2.7.1.5), or if an XFER\_RDY frame was sent requesting the write data and the length of the information unit DATA field plus the length of the write data previously received is greater than that specified by the XFER\_RDY frame, then this state shall send a Reception Complete (Too Much Write Data) message to the ST\_TFR state machine; and~~
- ~~3) If the length of the information unit DATA field is zero, then this state shall send a Reception Complete (Information Unit Too Short) message to the ST\_TFR state machine.~~

Table 111 — Reception Complete message sent on DATA frame verification failure

Verification <sup>a</sup>	Message sent to ST_TFR	Priority <sup>b</sup>
The transport layer retries of write DATA frames is not supported, and the value in the DATA OFFSET field in the DATA frame is not set to the value in the DATA OFFSET field in the previous DATA frame received for the command plus the number of bytes in the DATA information unit in that previous DATA frame.	Reception Complete (Data Offset Error)	1
The value in the DATA OFFSET field in the DATA frame is set to a value less than the requested offset in the XFER_RDY frame that requested the write data, or greater than or equal to the requested offset in that XFER_RDY frame plus the write data length in that XFER_RDY frame.	Reception Complete (Data Offset Error)	1
First burst is enabled, and the number of bytes in the DATA field in the DATA information unit is greater than the amount of data indicated by the FIRST BURST SIZE field in the Disconnect-Reconnect mode page (see 10.2.6.1.5).	Reception Complete (Too Much Write Data)	2
A XFER_RDY frame was sent requesting write data, and the number of bytes in the DATA field in the DATA information unit plus the number of bytes of write data previously received for the XFER_RDY frame is greater than the number of bytes of data specified by the XFER_RDY frame.	Reception Complete (Too Much Write Data)	2
The number of bytes in the DATA field in the DATA information unit is zero.	Reception Complete (Information Unit Too Short)	3
<sup>a</sup> If the verification test fails, then the specified message is sent to ST_TFR state machine. <sup>b</sup> If more than one verification test fails, then the message with the highest priority shall be sent to ST_TFR state machine.		

If:

- a) transport layer retries of write DATA frames is supported;
- b) the CHANGING DATA POINTER bit is set to zero; and
- c) the value in the DATA OFFSET field is not set to the value in the DATA OFFSET FIELD in the previous DATA frame plus the number of bytes in the associated DATA information unit.

then this state shall discard all Data-out Arrived messages until the CHANGING DATA POINTER bit is set to one. The Data-out Arrived message with the CHANGING DATA POINTER bit set to one, and any additional Data-out Arrived messages, shall be processed by this state.

The Reception Complete message, if any, shall include the tag as an argument.

If the Initiator Response Timeout timer is implemented, this state shall initialize and start the Initiator Response Timeout timer after any of the following occur:

- a) this state is entered from the ST\_TTS1:Target\_Start state (~~i.e., a Request (Receive Data-Out) message is received~~ and first burst is enabled);
- b) this state is entered from the ST\_TTS2:Target\_Send\_Frame state (i.e., an XFER\_RDY was successfully transmitted); or
- c) this state is entered from the ST\_TTS6:Process\_Data\_Out state (i.e., Data-Out data was received and processed).

If the Initiator Response Timeout timer is running, this state shall stop the timer before transitioning from this state.



If the Initiator Response Timeout timer expires this state shall send a Reception Complete (Initiator Response Timeout) message to the ST\_TFR state machine.

If this state is entered from the ST\_TTS6:Process\_Data\_Out state and number of bytes ~~moved for received~~ argument equals the ~~Request (Receive-Data-Out) message equals the out arguments (i.e., request byte count)~~, then this state shall send a Reception Complete (Data-Out Received) message to the ST\_TFR state machine.

If this state receives a Cancel message from the ST\_TFR state machine, then this state shall send a Reception Complete (Cancel Acknowledged) message to the ST\_TFR state machine.

#### 8.2.4.3.3.6.2 Transition ST\_TTS5:Receive\_Data\_Out to ST\_TTS6:Process\_Data\_Out

This transition shall occur after this state receives and verifies ~~a the write DATA frame received with the~~ Data-Out Arrived ~~message~~ values.

This transition shall include the write DATA frame as an argument.

#### 8.2.4.3.3.6.3 Transition ST\_TTS5:Receive\_Data\_Out to ST\_TTS1:Target\_Start

This transition shall occur after this state sends a Reception Complete message to the ST\_TFR state machine.

#### 8.2.4.3.3.7 ST\_TTS6:Process\_Data\_Out state

##### 8.2.4.3.3.7.1 State description

This state shall process the data received in the ~~Data-Out Arrived message~~ write DATA frame argument using the Device Server Buffer (e.g., logical block address) to which the data is to be transferred.

#### 8.2.4.3.3.7.2 Transition ST\_TTS6:Process\_Data\_Out to ST\_TTS5:Receive\_Data\_Out

This transition shall occur after this state has processed the data received in ~~a Data-Out Arrived message~~ the write DATA frame argument.

This transition shall include:

- a) the write DATA frame as an arguments;
- b) the number of bytes received argument; and
- c) the received Data-Out Arrived, if any, as an argument.

#### 8.2.4.3.3.8 ST\_TTS7:Prepare\_Response state

##### 8.2.4.3.3.8.1 State description

If this state was entered ~~as with a result of this state machine receiving a Request (Send Transport Response) or a Request (Send Application Response) message~~ No-retry argument, then this state shall construct a RESPONSE frame using the received Command Complete arguments ~~or the received with the Request message (see 8.2.4.3.2)~~ Task Complete arguments as follows:

- a) FRAME TYPE field set to 07h (i.e., RESPONSE frame);
- b) HASHED DESTINATION SAS ADDRESS field set to the hashed value of the specified destination SAS address;
- c) HASHED SOURCE SAS ADDRESS field set to the hashed value of the SSP target port's SAS address;
- d) RETRY DATA FRAMES bit set to zero;
- e) RETRANSMIT bit set to zero;
- f) CHANGING DATA POINTER bit set to zero;
- g) TAG field set to the specified tag;
- h) TARGET PORT TRANSFER TAG field set to zero;
- i) DATA OFFSET field set to zero.

If this state was entered ~~as with a result of this state machine receiving a Request (Send Transport Response) message~~ ~~No-retry argument and Task Complete arguments~~, then this state shall set the fields relating to the ~~information unit~~ ~~SSP frame using the received Task Complete arguments~~ as follows:

- a) NUMBER OF FILL BYTES field set to the number of fill bytes, based on the length of the response data, if any;
- b) in the information unit, DATAPRES field set to ~~RESPONSE\_DATA~~ ~~RESPONSE DATA~~;
- c) in the information unit, STATUS field set to zero;
- d) in the information unit, SENSE DATA LENGTH field set to zero;
- e) in the information unit, RESPONSE DATA LENGTH field set to 00000004h;
- f) in the information unit, RESPONSE DATA field set as specified in table 112;
- g) in the information unit, SENSE DATA field not included; and
- h) fill bytes, if any.

Table 112 specifies how the RESPONSE DATA field shall be set based on the arguments received with the Request (Send Transport Response) message.

**Table 112 — Request argument to RESPONSE frame RESPONSE DATA field mapping**

Request argument	RESPONSE frame RESPONSE DATA field
Invalid Frame	INVALID FRAME
Function Complete	TASK MANAGEMENT FUNCTION COMPLETE
Function Succeeded	TASK MANAGEMENT FUNCTION SUCCEEDED
Function Not Supported	TASK MANAGEMENT FUNCTION NOT SUPPORTED
Function Failed	TASK MANAGEMENT FUNCTION FAILED
Incorrect Logical Unit Number	INCORRECT LOGICAL UNIT NUMBER
Overlapped Tag Attempted	OVERLAPPED TAG ATTEMPTED

If this state was entered ~~as with a result of this state machine receiving a Request (Send Application Response) message~~ ~~No-retry argument and Command Complete arguments~~, then this state ~~shall~~ shall set the fields relating to ~~the SSP frame using the~~ ~~information unit~~ ~~received Command Complete arguments~~ as follows:

- a) NUMBER OF FILL BYTES field set to the number of fill bytes, based on the length of the specified sense data, if any;
- b) in the information unit, DATAPRES field set to SENSE\_DATA if sense data is specified or NO\_DATA if sense data is not specified;
- c) in the information unit, STATUS field set to the specified status;
- d) in the information unit, SENSE DATA LENGTH field set to the length of the specified sense data, if any;
- e) in the information unit, RESPONSE DATA LENGTH field set to zero;
- f) in the information unit, RESPONSE DATA field not included;
- g) in the information unit, SENSE DATA field set to the specified sense data, if any; and
- h) fill bytes, if any.

If this state was entered ~~as the result of the ST\_TTS2:Target\_Send\_Frame state receiving something other than with 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 vendor-specific number of retries has not been reached)~~ ~~Retry argument~~, then this state shall construct a new RESPONSE frame using all of the values for the previous RESPONSE frame except that the RETRANSMIT bit shall be set to one.

#### 8.2.4.3.3.8.2 Transition ST\_TTS7:Prepare\_Response to ST\_TTS2:Target\_Send\_Frame

This transition shall occur after this state constructs a RESPONSE frame.

This transition shall include the RESPONSE frame and the:

- a) Command Complete arguments; or
- b) Task Complete arguments.

## Sections with changed bars only

### 8.2.5 ST (transport layer for SSP ports) state machines

#### 8.2.5.1 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 following confirmations between the ST state machines and the port layer:

- a) Transmission Status; and
- b) Frame Received;

include the following as arguments:

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

and are used to route the confirmations to the correct ST state machines.

#### 8.2.5.2 ST\_I (transport layer for SSP initiator ports) state machines

##### 8.2.5.2.1 ST\_I state machines overview

The ST\_I state machines are as follows:

- a) ST\_IFR (initiator frame router) state machine (see 8.2.4.2.2); and
- b) ST\_ITS (initiator transport server) state machine (see 8.2.4.2.3).

Figure 149 shows the ST\_I state machines.

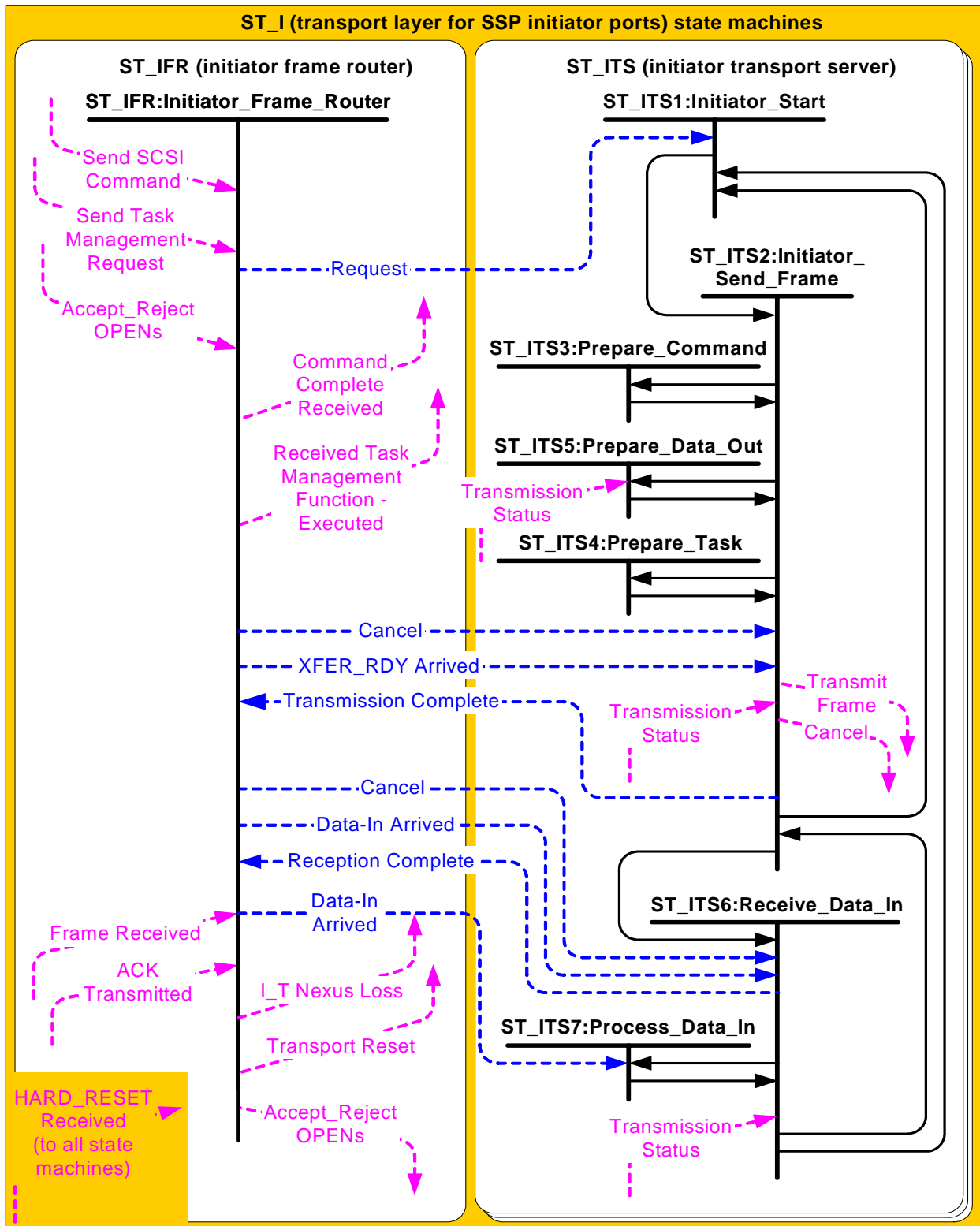


Figure 151 — ST\_I (transport layer for SSP initiator ports) state machines

Editor's Note 16: Added Data-In Arrived message into ST\_ITS7 and Transmission Status

### 8.2.5.2.2 ST\_IFR (initiator frame router) state machine

The ST\_IFR state machine performs the following functions:

- a) receives Send SCSI Command and Send Task Management transport protocol service requests from the SCSI application layer;
- b) sends messages to the ST\_ITS state machine;
- c) receives messages from the ST\_ITS state machine;
- d) receives confirmations from the port layer;
- e) sends transport protocol service confirmations to the SCSI application layer;
- f) receives vendor specific requests from the SCSI application layer;
- g) sends vendor specific confirmations to the SCSI application layer;
- h) receives Accept\_Reject OPENs requests from the SCSI application layer;
- i) sends Accept\_Reject OPENs requests to the port layer;
- j) sends L\_T Nexus Loss event notifications to the SCSI application layer; and
- k) sends Transport Reset event notifications to the SCSI application layer.

This state machine consists of one state.

This state machine shall be started after power on.

If this state machine receives a Send SCSI Command transport protocol service request then this state machine shall send a Request (Send Command) message with the following Command arguments to the ST\_ITS1:Initiator\_Start state in an ST\_ITS state machine that does not have an active task:

- a) connection rate;
- b) initiator connection tag;
- c) destination SAS address;
- d) tag;
- e) logical unit number;
- f) enable first burst value;
- g) task priority;
- h) task attribute;
- i) additional CDB length;
- j) CDB; and
- k) additional CDB bytes, if any.

If the message is a Request (Send Command) message for a command performing write operations and first burst is enabled (see 9.2.2.1), then the message shall also include the number of bytes for the first burst size as an argument.

If this state machine receives a Send Task Management Request transport protocol service request, then this state machine shall send a Request (Send Task) message with the following Task arguments to the ST\_ITS1:Initiator\_Start state in an ST\_ITS state machine that does not have an active task:

- a) connection rate;
- b) initiator connection tag;
- c) destination SAS address;
- d) retransmit bit;
- e) tag;
- f) logical unit number;
- g) task management function; and
- h) tag of task to be managed.

If this state machine receives a Frame Received (ACK/NAK Balanced) confirmation or Frame Received (ACK/NAK Not Balanced) confirmation, then this state machine shall check the frame type argument in the frame received with the confirmation (see table 104 in 9.2.1). 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 machine may check that the hashed source SAS address matches the SAS address of the SAS port that transmitted the frame and that the hashed destination SAS address matches the SAS address of the SAS port that received the frame based on the connection information. If this state machine checks these SAS addresses, and they do not match, then this state machine shall discard the frame.

If the frame type is XFER\_RDY then this state machine shall check the length of the information unit. If the length of the information unit is not correct, then this state machine shall discard the frame.

If the frame type is RESPONSE then this state machine shall check the length of the information unit. If the length of the information unit is not correct and the RESPONSE frame was for a command, then this state shall discard the frame and send a Command Complete Received confirmation to the SCSI application layer with the Service Response argument set to Service Delivery or Target Failure. If the length of the information unit is not correct and the RESPONSE frame was for a task management function, then this state shall discard the frame and send a Received Task Management Function – Executed confirmation to the SCSI application layer with the Service Response argument set to Service Delivery or Target Failure.

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

If the frame type is XFER\_RDY and the tag is for a task with no write data, then this state machine shall:

- a) discard the frame;
- b) send a Command Complete Received transport protocol service confirmation with the Delivery Result argument set to Service Delivery or Target Failure - XFER\_RDY Not Expected to the SCSI application layer; and
- c) if there is an ST\_ITS state machine for the tag, send a Cancel message to that state machine.

If the frame type is RESPONSE, and this state machine has received a RESPONSE frame for the I\_T\_L\_Q nexus, then this state machine shall discard the frame.

If the frame type is RESPONSE, the items checked in the frame are correct, and this state machine has not received a RESPONSE frame for this I\_T\_L\_Q nexus, then:

- a) this state machine shall send a protocol service confirmation to the SCSI application layer based on the content of the DATAPRES and RESPONSE DATA fields; and
- b) if there is an ST\_ITS state machine for the tag associated with the RESPONSE, then send a Cancel message to that state machine.

If the RESPONSE frame was for a command, then the delivery result and other arguments sent with the Command Complete Received protocol service confirmation are defined in 10.2.1.5. If the RESPONSE frame was for a task management request, then the delivery result and other arguments sent with the Received Task Management Function - Executed protocol service confirmation are defined in 10.2.1.14.

If the frame type is XFER\_RDY and the items checked in the frame are correct, then this state machine shall wait to receive an ACK Transmitted confirmation.

If this state machine receives an ACK Transmitted confirmation for an XFER\_RDY frame, then this state machine shall send an XFER\_RDY Arrived message to the ST\_ITS2:Initiator\_Send\_Frame state in the ST\_ITS state machine specified by the tag. The message shall include the following Xfer\_Rdy arguments:

- a) retry data frames;
- b) retransmit;
- c) target port transfer tag; and
- d) information unit.

If the frame type is DATA and the items checked in the frame are correct, then this state machine shall send a Data-In Arrived message to the ST\_ITS6:Receive\_Data\_In state in the ST\_ITS state machine specified by the tag. The message shall include the read DATA frame as an argument.

This state machine receives Transmission Complete messages and Reception Complete messages from the ST\_ITS state machines that may result in this state machine sending one of the following to the SCSI application layer:

- a) an I\_T Nexus Loss event notification;
- b) a Command Complete protocol service confirmation; or
- c) a Received Task\_Management Function - Executed protocol service confirmation.

If this state receives a Transmission Complete (I\_T Nexus Loss) from an ST\_ITS state machine, then this state machine shall send an I\_T Nexus Loss event notification to the SCSI application layer.

Table 103 defines other messages received from ST\_ITS state machines that require a protocol service confirmation and the Delivery Result argument sent with the corresponding service confirmation that shall be sent upon receipt of the message.

**Table 113 — Arguments sent with confirmations based on messages received**

<b>Message received from ST_ITS state machine</b>	<b>Protocol service confirmation and Delivery Result argument sent to the SCSI application layer</b>
Transmission Complete (Command Delivered)	Command Complete Received (Task Complete)
Transmission Complete (Data-Out Delivered)	Command Complete Received (Task Complete)
Transmission Complete (Command Failed, Connection Failed)	Command Complete Received (Service Delivery or Target Failure - Connection Failed)
Transmission Complete (Command Failed, NAK Received)	Command Complete Received (Service Delivery or Target Failure - NAK Received)
Transmission Complete (Task Delivered)	Received Task Management Function - Executed with the service response argument based on the content of the corresponding RESPONSE frame (see 10.2.1.14)
Transmission Complete (Task Failed, Connection Failed)	Received Task Management Function - Executed (Service Delivery or Target Failure - Connection Failed)
Transmission Complete (Task Failed, NAK Received)	Received Task Management Function - Executed (Service Delivery or Target Failure - NAK Received)
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)
Reception Complete (Data-In Received)	Command Complete Received (Task Complete)
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 (Incorrect Data Length)	Command Complete Received (Service Delivery or Target Failure - DATA Incorrect Data Length)
Reception Complete (Command Failed, Connection Failed)	Command Complete Received (Service Delivery or Target Failure - Connection Failed)

The protocol service confirmation shall include the tag as an argument.

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

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.

This state machine may receive vendor specific requests from the SCSI application layer that cause this state machine to send Cancel messages to all the ST\_ITS state machines.

### 8.2.5.2.3 ST\_ITS (initiator transport server) state machine

#### 8.2.5.2.3.1 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 8.2.4.2.3.2) (initial state);
- b) ST\_ITS2:Initiator\_Send\_Frame state (see 8.2.4.2.3.3);
- c) ST\_ITS3:Prepare\_Command state (see 8.2.4.2.3.4);
- d) ST\_ITS4:Prepare\_Task state (see 8.2.4.2.3.5);
- e) ST\_ITS5:Prepare\_Data\_Out state (see 8.2.4.2.3.6);
- f) ST\_ITS6:Receive\_Data\_In state (see 8.2.4.2.3.7); and
- g) ST\_ITS7:Process\_Data\_In state (see 8.2.4.2.3.8).

This state machine shall start in the ST\_ITS1:Initiator\_Start state after power on. There shall be one ST\_ITS state machine for each possible task or task management function for the SAS initiator port.

If transport layer retries are enabled, this state machine shall retain the data offset for the last XFER\_RDY frame received, for use as the restart point in case of a retry for write DATA frames.

This state machine shall transition to the ST\_ITS1:Initiator\_Start state from any other state after receiving a HARD\_RESET Received confirmation.

#### 8.2.5.2.3.2 ST\_ITS1:Initiator\_Start state

##### 8.2.5.2.3.2.1 State description

This state is the initial state of an ST\_ITS state machine.

##### 8.2.5.2.3.2.2 Transition ST\_ITS1:Initiator\_Start to ST\_ITS2:Initiator\_Send\_Frame

This transition shall occur after this state receives a Request message from the ST\_IFR state machine.

If a Request (Send Command) message was received, then this transition shall include the Command arguments.

If a Request (Send Task) message was received, then this transition shall include the Task arguments.

#### 8.2.5.2.3.3 ST\_ITS2:Initiator\_Send\_Frame state

##### 8.2.5.2.3.3.1 State description

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 performing 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\_ITS7: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.

All Transmit Frame requests shall include the SSP frame (i.e., 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 DATA frame from the ST\_ITS7: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;
- 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 this state shall wait for 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 xxx in 8.2.2.3.4), then this state shall send the Transmission Complete message indicated in table 104 to the ST\_IFR state machine. The message shall include the following arguments:

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

If the confirmation is Transmission Status (Frame Transmitted) and the Transmit Frame request was for a COMMAND frame not performing a read operation, a TASK frame, or a write DATA frame where the number of data bytes that have been transmitted equal the request byte count, 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).

NOTE 52 - If the number of data bytes requested to be 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 write 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 write DATA frames sent for the I\_T\_L\_Q nexus.

If the confirmation is Transmission Status (NAK Received), the Transmit Frame request was for a COMMAND frame not performing a read operation or a TASK frame, and a vendor specific number of retries has not been reached, then this state shall process:

- a) the COMMAND frame as if it was received from the ST\_ITS3:Prepare\_Command state; or
- b) the TASK frame as if it was received from the ST\_ITS4:Prepare\_Task state.

Table 104 defines the confirmations received from the port layer after a Transmission Status (Frame Transmitted) and the message that shall be sent by this state to the ST\_IFR state machine upon receipt of the confirmation based on the conditions under which the confirmation was received.

**Table 114 — Messages sent to the ST\_IFR state machine based on port layer confirmations**

Confirmation received from the port layer	Conditions under which confirmation was received	Message sent to ST_IFR
Transmission Status (ACK Received)	The Transmit Frame request was for a COMMAND frame and there is no data to transfer for the command.	Transmission Complete (Command Delivered)
Transmission Status (ACK Received)	The Transmit Frame request was for a TASK frame.	Transmission Complete (Task Delivered)
Transmission Status (ACK Received)	The Transmit Frame request was for a write DATA frame and: a) the number of data bytes transmitted equal the request byte count; and b) this state has received a Transmission Status (ACK Received) confirmation for each write DATA frame transmitted for the request.	Transmission Complete (Data-Out Delivered)
Transmission Status (ACK/NAK Timeout) or Transmission Status (Connection Lost Without ACK/NAK)	The Transmit Frame request was for a COMMAND frame.	Transmission Complete (Command Failed, Connection Failed)
Transmission Status (NAK Received)	The Transmit Frame request was for a COMMAND frame and if the vendor-specific number of retries has been reached.	Transmission Complete (Command Failed, NAK Received)
Transmission Status (ACK/NAK Timeout) or Transmission Status (Connection Lost Without ACK/NAK)	The Transmit Frame request was for a TASK frame.	Transmission Complete (Task Failed, Connection Failed)
Transmission Status (NAK Received)	The Transmit Frame request was for a TASK frame and if the vendor-specific number of retries has been reached.	Transmission Complete (Task Failed, NAK Received)
Transmission Status (NAK Received)	The Transmit Frame request was for a write DATA frame and: a) the RETRY DATA FRAMES bit was set to zero in the XFER_RDY frame requesting the data; or b) the RETRY DATA FRAMES bit was set to one in the XFER_RDY frame requesting the data, and the vendor-specific number of retries has been reached.	Transmission Complete (Data Failed, NAK Received)
Transmission Status (ACK/NAK Timeout) or Transmission Status (Connection Lost Without ACK/NAK)		Transmission Complete (Data Failed, Connection Failed)

After this state sends a Transmission Complete (Command Failed, Connection Failed) this state shall continue processing messages and confirmations.

NOTE 53 - The application client may determine the command was received and is being processed by the device server and allow the command to complete.

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NOTE 54 - The Cancel message results from a vendor specific request from the SCSI application layer after the SCSI application layer has used a task management function to determine that the SAS target port did not receive the COMMAND frame.

If this state receives a Cancel 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 shall send a Transmission Complete (Cancel Acknowledged) message to the ST\_IFR state machine.

If this state receives a Cancel 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. The Cancel request shall include the following arguments:

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

If this state receives a Transmission Status (Cancel Acknowledged) confirmation, then this state shall send a Transmission Complete (Cancel Acknowledged) message to the ST\_IFR state machine.

If this state receives an XFER\_RDY Arrived message, then this state shall verify the XFER\_RDY frame received with the previous XFER\_RDY frame and the write data of the command as specified in table 105.

**Table 115 — Reception Complete message sent on XFER\_RDY frame verification failure**

Verification <sup>a</sup>	Message sent to ST_IFR	Priority <sup>b</sup>
The value in the WRITE DATA LENGTH field in the XFER_RDY information unit is zero.	Transmission Complete (XFER_RDY Incorrect Write Data Length)	1
The value in the WRITE DATA LENGTH field in the XFER_RDY information unit plus the number of bytes of write data previously transmitted for the command is greater than the number of bytes of data specified by the command.	Transmission Complete (XFER_RDY Incorrect Write Data Length)	1
First burst is not enabled, this is the first XFER_RDY frame for a command, and the value in the REQUESTED OFFSET field in the XFER_RDY information unit is not set to zero.	Transmission Complete (XFER_RDY Requested Offset Error)	2
First burst is enabled, this is the first XFER_RDY frame for a command, and the value in the REQUESTED OFFSET field in the XFER_RDY information unit is not equal to the value indicated by the first burst size field in the Disconnect-Reconnect mode page (see 10.2.6.1.5).	Transmission Complete (XFER_RDY Requested Offset Error)	2
The transport layer retries of write DATA frames is not supported, and the value in the REQUESTED OFFSET field in the XFER_RDY information unit is not set to the value in the REQUESTED OFFSET field in the previous XFER_RDY information unit sent for the command plus the value in the WRITE DATA LENGTH field in the previous XFER_RDY information unit.	Transmission Complete (XFER_RDY Requested Offset Error)	2
The transport layer retries of write DATA frames is supported, the RETRANSMIT bit set to zero, and the value in the REQUESTED OFFSET field in the XFER_RDY information unit is not set to the value in the REQUESTED OFFSET field of a previous XFER_RDY information unit sent for the command plus the value in the WRITE DATA LENGTH field in the previous XFER_RDY information unit.	Transmission Complete (XFER_RDY Requested Offset Error)	2
The transport layer retries of write DATA frames is supported, the RETRANSMIT bit set to one, and the value in the REQUESTED OFFSET field in the XFER_RDY information unit is not equal to the value in the REQUESTED OFFSET field of the previous XFER_RDY information unit sent for the command.	Transmission Complete (XFER_RDY Requested Offset Error)	2
<sup>a</sup> If the verification test fails, then the specified message is sent to ST_IFR state machine. <sup>b</sup> If more than one verification test fails, then the message with the highest priority shall be sent to ST_IFR state machine.		

#### 8.2.5.2.3.3.3 Transition ST\_ITS2:Initiator\_Send\_Frame to ST\_ITS1:Initiator\_Start

This transition shall occur after this state has sent one of the following to the ST\_IFR state machine:

- a) a Transmission Complete (Command Delivered) message;
- b) a Transmission Complete (Command Failed, NAK Received) message sent as the result of reaching the vendor-specific number of retries for a COMMAND frame;
- c) a Transmission Complete (Task Failed, NAK Received) message sent as the result of reaching the vendor-specific number of retries for a TASK frame;
- d) a Transmission Complete (Command Failed, Connection failed) message and the command was for a non-data operation;

- e) any Transmission Complete message for a TASK or write DATA frame; or
- f) a Transmission Complete (Cancel Acknowledged) message.

#### 8.2.5.2.3.3.4 Transition ST\_ITS2:Initiator\_Send\_Frame to ST\_ITS3:Prepare\_Command

This transition shall occur if this state was entered from the ST\_ITS1:Initiator\_Start state with Command arguments.

This transition shall include the Command arguments.

#### 8.2.5.2.3.3.5 Transition ST\_ITS2:Initiator\_Send\_Frame to ST\_ITS4:Prepare\_Task

This transition shall occur if this state was entered from the ST\_ITS1:Initiator\_Start state with Task arguments.

This transition shall include the Task arguments.

#### 8.2.5.2.3.3.6 Transition ST\_ITS2:Initiator\_Send\_Frame to ST\_ITS5:Prepare\_Data\_Out

This transition shall include a No-retry argument and occur after this state receives:

- a) a Transmission Status (Frame Transmitted) confirmation followed by a Transmission Status (ACK\_Received) confirmation for a COMMAND frame for a write operation and first burst is enabled;
- b) an XFER\_RDY Arrived message; or
- c) a Transmission Status (Frame Transmitted) confirmation for a Transmit Frame (Non-Interlocked) request if the number of data bytes that has been transmitted for the request is less than the first burst size or the write data length specified in the XFER\_RDY;

NOTE 55 - This transition occurs even if this state has not received a Transmission Status (ACK Received) for the write DATA frame.

This transition shall include a Retry argument and occur after:

- a) this state receives one of the following confirmations from the port layer or arguments from the ST\_ITS5:Prepare\_Data\_Out state for a write DATA frame:
  - A) Transmission Status (NAK Received);
  - B) Transmission Status (ACK/NAK Timeout); or
  - C) Transmission Status (Connection Lost without ACK/NAK);
- b) the RETRY DATA FRAMES bit set to one in the XFER\_RDY frame for the write operation; and
- c) the vendor-specific number of retries, if any, for the write DATA frame has not been reached.

This transition shall include the:

- a) Xfer\_Rdy arguments: and
- b) Command arguments.

#### 8.2.5.2.3.3.7 Transition ST\_ITS2:Initiator\_Send\_Frame to ST\_ITS6:Receive\_Data\_In

This transition shall occur after this state receives a Transmission Status (Frame Transmitted) confirmation for a COMMAND frame for a command performing a read operation.

This transition shall include the Command arguments.

NOTE 56 - This transition occurs even if this state has not received a Transmission Status (ACK Received) for the COMMAND frame.

### 8.2.5.2.3.4 ST\_ITS3:Prepare\_Command state

#### 8.2.5.2.3.4.1 State description

This state shall construct a COMMAND frame based on the Command arguments:

- a) FRAME TYPE field set to 06h (i.e., COMMAND frame);

- b) HASHED DESTINATION SAS ADDRESS field set to the hashed value of the specified destination SAS address;
- c) HASHED SOURCE SAS ADDRESS field set to the hashed value of the SSP initiator port's SAS address;
- d) RETRY DATA FRAMES bit set to zero;
- e) RETRANSMIT bit set to zero;
- f) CHANGING DATA POINTER bit set to zero;
- g) NUMBER OF FILL BYTES field set zero.
- h) TAG field set to the specified tag;
- i) TARGET PORT TRANSFER TAG field set to zero;
- j) DATA OFFSET field set to zero;
- k) in the information unit, LOGICAL UNIT NUMBER field set to the specified logical unit number;
- l) in the information unit, ENABLE FIRST BURST bit set to the specified enable first burst bit;
- m) in the information unit, TASK PRIORITY field set to the specified task priority;
- n) in the information unit, TASK ATTRIBUTE field set to the specified task attribute;
- o) in the information unit, ADDITIONAL CDB LENGTH field set to the specified additional CDB length;
- p) in the information unit, CDB field set to the specified CDB; and
- q) in the information unit, ADDITIONAL CDB BYTES field set to the specified additional CDB bytes, if any.

#### 8.2.5.2.3.4.2 Transition ST\_ITS3:Prepare\_Command to ST\_ITS2:Initiator\_Send\_Frame

This transition shall occur after this state constructs a COMMAND frame.

This transition shall include the COMMAND frame as an argument.

This transition shall include the Command arguments.

#### 8.2.5.2.3.5 ST\_ITS4:Prepare\_Task state

##### 8.2.5.2.3.5.1 State description

This state shall construct a TASK frame based on Task arguments:

- a) FRAME TYPE field set to 16h (i.e., TASK frame);
- b) HASHED DESTINATION SAS ADDRESS field set to the hashed value of the specified destination SAS address;
- c) HASHED SOURCE SAS ADDRESS field set to the hashed value of the SSP initiator port's SAS address;
- d) RETRY DATA FRAMES bit set to zero;
- e) RETRANSMIT bit set to the specified retransmit bit;
- f) CHANGING DATA POINTER bit set to zero;
- g) NUMBER OF FILL BYTES field set zero.
- h) TAG field set to the specified tag;
- i) TARGET PORT TRANSFER TAG field set to zero;
- j) DATA OFFSET field set to zero;
- k) in the information unit, LOGICAL UNIT NUMBER field set to the specified logical unit number;
- l) in the information unit, TASK MANAGEMENT FUNCTION field set to the specified task management function; and
- m) in the information unit, TAG OF TASK TO BE MANAGED field set to the specified tag of task to be managed.

##### 8.2.5.2.3.5.2 Transition ST\_ITS4:Prepare\_Task to ST\_ITS2:Initiator\_Send\_Frame

This transition shall occur after this state constructs a TASK frame.

This transition shall include the TASK frame as an argument.

### 8.2.5.2.3.6 ST\_ITS5:Prepare\_Data\_Out state

#### 8.2.5.2.3.6.1 State description

This state shall construct a write DATA frame using the following based on the Xfer\_Rdy arguments or, if first burst is enabled, the Command arguments:

- a) FRAME TYPE field set to 01h (i.e., DATA frame);
- b) HASHED DESTINATION SAS ADDRESS field set to the hashed value of the specified destination SAS address;
- c) HASHED SOURCE SAS ADDRESS field set to the hashed value of the SSP initiator port's SAS address;
- d) RETRY DATA FRAMES bit set to zero;
- e) RETRANSMIT bit set to zero;
- f) CHANGING DATA POINTER bit set as specified in this subclause;
- g) NUMBER OF FILL BYTES field set to the number of fill bytes, based on the length of the specified data;
- h) TAG field set to the specified tag;
- i) TARGET PORT TRANSFER TAG field set to the specified target port transfer tag;
- j) DATA OFFSET field set as specified in this subclause; and
- k) in the information unit, DATA field set to the specified data.
- l) fill bytes, if any.

If this state is entered with a No-retry argument then this state shall set the CHANGING DATA POINTER bit to zero and;

- a) if this state was entered with Xfer\_Rdy arguments, then set the DATA OFFSET field to the value in the DATA OFFSET field in the previous write DATA frame plus the number of bytes in the previous write DATA information unit; or
- b) if this state was entered with Commands arguments, then set the DATA OFFSET field to zero.

If this state is entered with a Retry argument then this state shall set the CHANGING DATA POINTER bit in the frame to one and;

- a) if this state was entered with Xfer\_Rdy arguments, then set the DATA OFFSET field to the data offset value associated with the XFER\_RDY frame; or
- b) if this state was entered with command arguments, then set the DATA OFFSET field to zero.

#### 8.2.5.2.3.6.2 Transition ST\_ITS5:Prepare\_Data\_Out to ST\_ITS2:Initiator\_Send\_Frame

This transition shall occur after this state constructs a write DATA frame.

This transition shall include the:

- a) Xfer\_Rdy arguments;
- b) Command arguments;
- c) DATA frame as an argument; and
- d) received Transmission Status, if any, as an argument.

### 8.2.5.2.3.7 ST\_ITS6:Receive\_Data\_In state

#### 8.2.5.2.3.7.1 State description

If this state receives a Data-In Arrived message from the ST\_IFR state machine or a Data-In Arrived argument from the ST\_ITS7:Process\_Data\_In state, then this state shall verify the values in the read DATA frame received with the message or the argument as defined in table 106.

**Table 116 — Reception Complete message sent on DATA frame verification failure**

Verification <sup>a</sup>	Message sent to ST_IFR	Priority <sup>b</sup>
The transport layer retries of read DATA frames is not supported, and the value in the DATA OFFSET field in the DATA frame is not set to the value in the DATA OFFSET field in the previous DATA frame received for the command plus the number of bytes in the DATA information unit in that previous DATA frame.	Reception Complete (Data Offset Error)	1
The value in the DATA OFFSET field in the DATA frame is greater than or equal to the number of bytes of data specified by the command (i.e., by the CDB delivered in the COMMAND frame).	Reception Complete (Data Offset Error)	1
The number of bytes in the DATA field in the DATA information unit plus the number of bytes of read data previously received for the command is greater than the number of bytes of data specified by the command (i.e., by the CDB delivered in the COMMAND frame).	Reception Complete (Too Much Read Data)	2
The number of bytes in the DATA field in the DATA information unit is zero.	Reception Complete (Incorrect Data Length)	3
<sup>a</sup> If the verification test fails, then the specified message is sent to the ST_IFR state machine. <sup>b</sup> If more than one verification test fails, then the message with the highest priority shall be sent to ST_IFR state machine.		

If:

- a) transport layer retries of read DATA frames is supported;
- b) the CHANGING DATA POINTER bit is set to zero;
- c) the value in the DATA OFFSET field is not set to the value in the DATA OFFSET FIELD in the previous DATA frame plus the number of bytes in the associated DATA information unit; and
- d) value in the DATA OFFSET field is within the range of the requested data,

then this state shall discard all Data-In Arrived messages until the CHANGING DATA POINTER bit is set to one. The Data-in Arrived message with the CHANGING DATA POINTER bit set to one, and any additional Data-in Arrived messages, shall be processed by this state.

If this state receives Transmission Status (ACK/NAK Timeout) or Transmission Status (Connection Lost Without ACK/NAK), then this state shall send a Reception Complete (Command Failed, Connection Failed) to the ST\_IFR state machine.

After this state sends a Reception Complete (Command Failed, Connection Failed), this state shall continue processing messages and confirmations.

NOTE 57 - The application client may determine the command was received and is being processed by the device server and allow the command to complete.

NOTE 58 - The Cancel message results from a vendor specific request from the SCSI application layer after the SCSI application layer has used a task management function to determine that the SAS target port did not receive the COMMAND frame.



If this state is entered from the ST\_ITS7:Process\_Data\_In state and number of bytes moved for the data in command equals the request byte count, then this state shall send a Reception Complete (Data-In Received) message to the ST\_IFR state machine.

If this state receives a Cancel message from the ST\_IFR state machine, then this state shall send a Reception Complete (Cancel Acknowledged) message to the ST\_IFR state machine. The Reception Complete message shall include the tag as an argument.

#### **8.2.5.2.3.7.2 Transition ST\_ITS6:Receive\_Data\_In to ST\_ITS1:Initiator\_Start**

This transition shall occur after this state sends one of the following to the ST\_IFR state machine:

- a) a Reception Complete (Data-In Received) message;
- b) a Reception Complete (Data Offset Error) message;
- c) a Reception Complete (Too Much Read Data) message;
- d) a Reception Complete (Incorrect Data Length) message; or
- e) a Reception Complete (Cancel Acknowledged) message.

#### **8.2.5.2.3.7.3 Transition ST\_ITS6:Receive\_Data\_In to ST\_ITS2:Initiator\_Send\_Frame**

This transition shall occur after this state receives a Transmission Status (NAK Received) confirmation for a COMMAND frame for a command performing a read operation.

This transition shall include the Command arguments.

#### **8.2.5.2.3.7.4 Transition ST\_ITS6:Receive\_Data\_In to ST\_ITS7:Process\_Data\_In**

This transition shall occur after this state receives and verifies the read DATA frame received with the Data-In Arrived values.

This transition shall include the:

- a) Command arguments; and
- b) read DATA frame as an argument.

### **8.2.5.2.3.8 ST\_ITS7:Process\_Data\_In state**

#### **8.2.5.2.3.8.1 State description**

This state shall process the data received in the read DATA frame argument.

#### **8.2.5.2.3.8.2 Transition ST\_ITS7:Process\_Data\_In to ST\_ITS6:Receive\_Data\_In**

This transition shall occur after this state has processed the data received in the read DATA frame argument.

This transition shall include the:

- a) Command arguments;
- b) read DATA frame as an argument; and
- c) received Data-In Arrived, if any, as an argument.

### **8.2.5.3 ST\_T (transport layer for SSP target ports) state machines**

#### **8.2.5.3.1 ST\_T state machines overview**

The ST\_T state machines are as follows:

- a) ST\_TFR (target frame router) state machine (see 8.2.4.3.2); and
- b) ST\_TTS (target transport server) state machine (see 8.2.4.3.3).

This state machine may maintain the timers listed in table 107.

**Table 117 — ST\_T state machine timers**

<b>Timer</b>	<b>Initial value</b>
Initiator Response Timeout	The value in the INITIATOR RESPONSE TIMEOUT field in the Protocol-Specific Port mode page (see 10.2.6.2).

Figure 150 shows the ST\_T state machines.

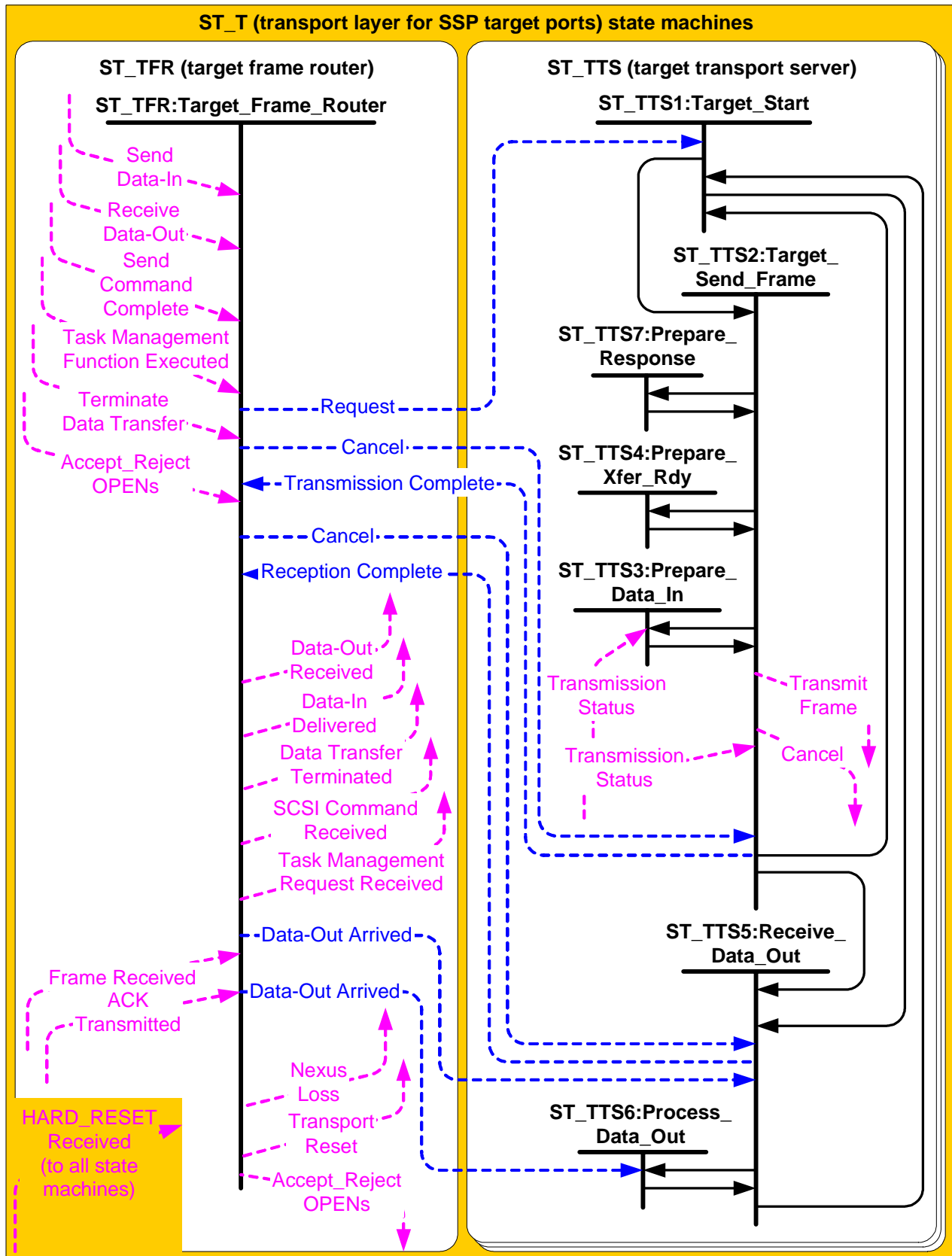


Figure 152 — ST\_T (transport layer for SSP target ports) state machines

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Editor's Note 17: Added Data-Out Arrived message into ST\_TTS6 and Transmission Status confirmation into ST\_TTS3 to allow for non-interlocked DATA frame transfers. Also removed the ST\_TTS5 to ST\_TTS2 transition which was not defined in SAS 1.1. rev 9 and is not needed.

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### 8.2.5.3.2 ST\_TFR (target frame router) state machine

The ST\_TFR state machine performs the following functions:

- 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 messages from the ST\_TTS state machine;
- f) receives Accept\_Reject OPENs requests from the SCSI application layer;
- g) sends Accept\_Reject OPENs requests to the port layer;
- h) sends Nexus Loss event notifications to the SCSI application layer; and
- i) sends Transport Reset event notifications to the SCSI application layer.

This state machine consists of one state.

This state machine shall be started after power on.

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 104 in 9.2.1). 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 received frame are zero. If any reserved fields are checked and they are not set to zero, then this state machine shall send a Request (Send Transport Response) message with an argument of Invalid Frame to the ST\_TTS1:Target\_Start state in an ST\_TTS state machine that does not have an active task. The check of reserved fields described above shall not apply to the reserved fields within the CDB in a COMMAND frame. Checking of reserved fields in a CDB is described in SPC-3.

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

If the frame type is COMMAND or TASK then this state machine shall check the length of the information unit. If the length of the information unit is not correct, then this state machine shall send a Request (Send Transport Response) message with an argument of Invalid Frame to the ST\_TTS1:Target\_Start state in an ST\_TTS state machine that does not have an active task.

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 port layer.

If the frame type is TASK and this state machine does not check tags, then this state machine shall ignore the RETRANSMIT bit.

If the frame type is COMMAND or TASK, then this state machine may check the target port transfer tag. If this state checks the target port transfer tag and the tag is set to a value other than FFFFh, then this state machine shall send a Request (Send Transport Response) message with an argument of Invalid Frame to the ST\_TTS1:Target\_Start state in an ST\_TTS state machine that does not have an active task.

If the frame type is TASK, then this state machine shall check the logical unit number. If the logical unit number is unknown, then this state machine shall send a Request (Send Transport Response) message with

an argument of Incorrect Logical Unit Number to the ST\_TTS1:Target\_Start state in an ST\_TTS state machine that does not have an active task.

If the frame type is DATA and this frame is for first burst data or this state machine did not assign a target port transfer tag for the data transfer, 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 Request (Send Transport Response) message with an argument of Invalid Frame to the ST\_TTS1:Target\_Start state in an ST\_TTS state machine that does not have an active task.

If this state machine sends a Request (Send Transport Response) message with an argument of Invalid Frame to the ST\_TTS1:Target\_Start state in an ST\_TTS state machine, then this state machine shall discard the frame and shall include the following Transport Response arguments in the message:

- a) connection rate;
- b) initiator connection tag;
- c) destination SAS address set to the SAS address from which the invalid frame was received;
- d) source SAS address set to the SAS address of the SAS port containing the state machine; and
- e) tag.

If the frame type is COMMAND or TASK and the items checked in the frame are correct, then this state machine shall wait to receive an ACK Transmitted confirmation.

If the frame type is COMMAND, the items checked in the frame are correct, and this state machine receives an ACK Transmitted confirmation, then this state machine shall send a SCSI Command Received transport protocol service indication with the following arguments to the SCSI application layer:

- a) source SAS address (i.e., the SAS address that transmitted the COMMAND frame);
- b) tag;
- c) logical unit number;
- d) task attribute;
- e) task priority;
- f) CDB; and
- g) additional CDB bytes, if any.

If the frame type is TASK, the items checked in the frame are correct, and this state machine receives an ACK Transmitted confirmation, then this state machine shall send a Task Management Request Received transport protocol service indication to the SCSI application layer. The indication shall include:

- a) source SAS address (i.e., the SAS address that transmitted the TASK frame);
- b) tag;
- c) logical unit number;
- d) task management function; and
- e) tag of the task to be managed.

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

If the frame type is DATA, and the tag matches a tag for an outstanding command performing write operations without first burst data enabled or for which no Transmission Complete (Xfer\_Rdy Delivered) message has been received from an ST\_TTS state machine, then this state machine shall discard the frame.

If the frame type is DATA and a target port transfer tag was assigned in an XFER\_RDY frame for the request, then this state machine shall check the target port transfer tag. If the target port transfer tag does not specify a valid state machine, then this state machine shall discard the frame.

If the frame type is DATA and the items checked in the frame are correct, and there is first burst data enabled or this state machine has received a Transmission Complete (Xfer\_Rdy Delivered) from the ST\_TTS state machine for the request, then this state machine shall send a Data-Out Arrived message to the ST\_TTS5:Receive\_Data\_Out state in the ST\_TTS state machine specified by the tag in the frame. The message shall include the content of the write DATA frame.

If this state machine receives a Send Data-In transport protocol service request from the SCSI application layer, then this state machine shall send a Request (Send Data-In) message to the ST\_TTS1:Target\_Start state in an ST\_TTS state machine that does not have an active task.

If this state machine receives a Receive Data-Out transport protocol service request from the SCSI application layer, then this state machine shall send a Request (Receive Data-Out) message to the ST\_TTS1:Target\_Start state in an ST\_TTS state machine that does not have an active task.

A Request (Send Data-In) message shall include the following Data-in arguments:

- a) connection rate;
- b) initiator connection tag;
- c) destination SAS address (i.e., the SAS address to which the read DATA frame is to be transmitted);
- d) tag;
- e) device server buffer;
- f) request byte count; and
- g) application client buffer offset.

A Request (Receive Data-Out) message shall include the following Data-out arguments:

- a) connection rate;
- b) initiator connection tag;
- c) destination SAS address (i.e., the SAS address to which the XFER\_RDY frame is to be transmitted);
- d) tag;
- e) device server buffer;
- f) request byte count;
- g) application client buffer offset;
- h) first burst; and
- i) target port transfer tag.

If this state machine receives a Send Command Complete transport protocol service response from the SCSI application layer with the Service Response argument set to TASK COMPLETE or LINKED COMMAND COMPLETE, then this state machine shall send a Request (Send Application Response) message to the ST\_TTS1:Target\_Start state in the ST\_TTS state machine specified by the tag. The message shall include the following Command Complete arguments:

- a) connection rate;
- b) initiator connection tag;
- c) destination SAS address (i.e., the SAS address to which the RESPONSE frame is to be transmitted);
- d) tag;
- e) status; and
- f) sense data, if any.

If this state machine receives a Task Management Function Executed transport protocol service response from the SCSI application layer, then this state machine shall send a Request (Send Transport Response) message to the ST\_TTS1:Target\_Start state in an ST\_TTS state machine that does not have an active task with the argument specified in table 108 and the following Task Complete arguments:

- a) connection rate;
- b) initiator connection tag;
- c) destination SAS address (i.e., the SAS address to which the RESPONSE frame is to be transmitted); and
- d) tag.

Table 108 specifies which argument to send with Request (Send Transport Response) based on the Service Response argument that was received.

**Table 118 — Task Management Function Executed Service Response argument mapping**

<b>Task Management Function Executed protocol service response Service Response argument received</b>	<b>Request (Send Transport Response) argument to send</b>
FUNCTION COMPLETE	Task Management Function Complete
FUNCTION SUCCEEDED	Task Management Function Succeeded
FUNCTION REJECTED	Task Management Function Not Supported
INCORRECT LOGICAL UNIT NUMBER	Incorrect Logical Unit Number
SERVICE DELIVERY OR TARGET FAILURE - Overlapped Tag Attempted	Overlapped Tag Attempted

If this state machine receives a Terminate Data Transfer protocol service request from the SCSI application layer and this state machine has not sent a Request message to a ST\_TTS state machine for the Send Data-In or Receive Data-Out protocol service request to which the Terminate Data Transfer request applies, then this state machine shall discard the Terminate Data Transfer request and any corresponding Send Data-In or Receive Data-Out request. This state shall then send a Data Transfer Terminated protocol service confirmation to the SCSI application layer.

If this state machine receives a Terminate Data Transfer protocol service request from the SCSI application layer and this state machine has sent a Request message to a ST\_TTS state machine for the Send Data-In protocol service request to which the Terminate Data Transfer request applies, then this state machine shall send a Cancel message to the ST\_TTS2:Target\_Send\_Frame state in the ST\_TTS state machine specified by the tag and the Send Data-In protocol service request.

If this state machine receives a Terminate Data Transfer protocol service request from the SCSI application layer and this state machine has sent a Request message to a ST\_TTS state machine for the Receive Data-Out protocol service request to which the Terminate Data Transfer request applies, then this state machine shall send a Cancel message to the ST\_TTS5:Receive\_Data\_Out state in the ST\_TTS state machine specified by the tag and the Receive Data-Out protocol service request.

This state machine receives Transmission Complete and Reception Complete messages from the ST\_TTS state machines that may result in this state machine sending a Nexus Loss event notification or a protocol service confirmation to the SCSI application layer. If this state machine receives a Transmission Complete (I\_T Nexus Loss) message, then this state machine shall send a Nexus Loss event notification to the SCSI

application layer. Table 109 defines the received messages that require a protocol service confirmation and the corresponding service confirmations that shall be sent upon receipt of the message.

**Table 119 — Confirmations sent to the SCSI application layer**

Message received from ST_TTS state machine	Protocol service confirmation sent to SCSI application layer
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, Connection Failed)	Data-Out Received with the Delivery Result argument set to DELIVERY FAILURE - CONNECTION FAILED
Transmission Complete (Data Failed, NAK Received)	Data-In Delivered with the Delivery Result argument set to DELIVERY FAILURE - NAK RECEIVED
Transmission Complete (Data Failed, Connection Failed)	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
Transmission Complete (Data Transfer Terminated)	Data Transfer Terminated
Reception Complete (Data Transfer Terminated)	Data Transfer Terminated

Each protocol service confirmation shall include the tag as an argument.

If this state machine receives an Accept\_Reject OPENS (Accept SSP) or Accept\_Reject OPENS (Reject SSP) request, then this state machine shall send a corresponding Accept\_Reject OPENS request 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.



### 8.2.5.3.3 ST\_TTS (target transport server) state machine

#### 8.2.5.3.3.1 ST\_TTS state machine overview

The ST\_TTS state machine performs the following functions:

- a) receives and processes messages from the ST\_TFR state machine;
- b) sends messages to the ST\_TFR state machine;
- c) communicates with the port layer using requests and confirmations regarding frame transmission; and
- d) receives HARD\_RESET Received confirmations from the port layer.

This state machine consists of the following states:

- a) ST\_TTS1:Target\_Start (see 8.2.4.3.3.2) (initial state);
- b) ST\_TTS2:Target\_Send\_Frame (see 8.2.4.3.3.3);
- c) ST\_TTS3:Prepare\_Data\_In (see 8.2.4.3.3.4);
- d) ST\_TTS4:Prepare\_Xfer\_Rdy (see 8.2.4.3.3.5);
- e) ST\_TTS5:Receive\_Data\_Out (see 8.2.4.3.3.6);
- f) ST\_TTS6:Process\_Data\_Out (see 8.2.4.3.3.7); and
- g) ST\_TTS7:Prepare\_Response (see 8.2.4.3.3.8).

This state machine shall start in the ST\_TTS1:Target\_Start state after power on. There shall be one ST\_TTS state machine for each possible task that may be accepted by the SAS target port.

If transport layer retries are enabled, this state machine shall:

- a) retain the data offset for a read DATA frame transmitted for which ACK/NAK Balance was achieved (i.e., when the number of read DATA frames sent matches the number of ACK Received confirmations received) for use as the restart point in case of a retry for read DATA frames; and
- b) retain the data offset for the last XFER\_RDY frame transmitted, for use in the following cases:
  - A) if this state machine retries the XFER\_RDY frame, then this state machine shall place the retained data offset into the DATA OFFSET field of the retransmitted XFER\_RDY frame; or
  - B) if the SSP initiator port retries write DATA frames, then this state machine shall use the retained data offset to reestablish the write data context.

This state machine shall transition to the ST\_TTS1:Target\_Start state from any other state after receiving a HARD\_RESET Received confirmation.

#### 8.2.5.3.3.2 ST\_TTS1:Target\_Start state

##### 8.2.5.3.3.2.1 State description

This state is the initial state of an ST\_TTS state machine.

##### 8.2.5.3.3.2.2 Transition ST\_TTS1:Target\_Start to ST\_TTS2:Target\_Send\_Frame

This transition shall occur after this state receives a Request message from the ST\_TFR state machine other than a Request (Receive Data-Out) message if first burst is enabled.

If a Request (Send Transport Response) message was received, then this transition shall include the Transport Response arguments.

If a Request (Send Data-in) message was received, then this transition shall include the Data-in arguments.

If a Request (Send Data-out) message was received, then this transition shall include the Data-out arguments.

If a Request (Send Application Response) was received, then this transition shall include the received arguments (i.e., the Command Complete arguments or the Task Complete arguments).

### 8.2.5.3.3.2.3 Transition ST\_TTS1:Target\_Start to ST\_TTS5:Receive\_Data\_Out

This transition shall occur after this state receives a Request (Receive Data-Out) message from the ST\_TFR state machine and first burst is enabled.

This transition shall include the Data-out arguments.

### 8.2.5.3.3.3 ST\_TTS2:Target\_Send\_Frame state

#### 8.2.5.3.3.3.1 State description

If this state is entered from the ST\_TTS3:Prepare\_Data\_In state for transmission of a read 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\_TTS4: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, then this state shall send a Transmit Frame (Interlocked) request to the port layer.

NOTE 59 - The XFER\_RDY and RESPONSE frame rules ensure that wide ports do not send an XFER\_RDY or RESPONSE frame on a phy until all the ACKs have been transmitted for write DATA frames on a different phy. In a narrow port, the link layer ensures that ACK/NAKs are balanced before transmitting an interlocked frame.

All Transmit Frame requests from this state shall include the SSP frame (i.e., the DATA frame from the ST\_TTS3:Prepare\_Data\_In state, the XFER\_RDY frame from the ST\_TTS4:Prepare\_Xfer\_Rdy state, or the RESPONSE frame from the ST\_TTS7:Prepare\_Response state) and the following arguments to be used for any OPEN address frame:

- a) 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), then this state shall send a Transmission Complete (I\_T Nexus Loss) message to the ST\_TFR state machine. The 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), then this state shall send the Transmission Complete message defined in table 110 to the ST\_TFR state machine. The message shall include the following arguments:

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

If the confirmation is Transmission Status (Frame Transmitted) and the Transmit Frame request was for an XFER\_RDY frame, a RESPONSE frame, or a read DATA frame where the number of bytes that have been transmitted equal the request byte count (i.e., all data has been transferred for the request), 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).

NOTE 60 - If the number of data bytes that have been transmitted for the Request (Send Data-In) message are fewer than the request byte count, then this state transitions to the ST\_TTS3:Prepare\_Data\_In state to construct the additional read DATA frames for the 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 read DATA frames sent for the I\_T\_L\_Q nexus (see 8.2.4.3.3.3.4).

Table 110 defines the confirmations to be received from the port layer after a Transmission Status (Frame Transmitted) and the message that shall be sent by this state to the ST\_TFR state machine upon receipt of the confirmation based on the conditions under which the confirmation was received.

**Table 120 — Messages sent to the ST\_TFR state machine based on port layer confirmations**

Confirmation received from the port layer	Conditions under which confirmation was received	Message sent to the ST_TFR state machine
Transmission Status (ACK Received)	The Transmit Frame request was for an XFER_RDY frame.	Transmission Complete (Xfer_Rdy Delivered) with the target port transfer tag argument
Transmission Status (ACK Received)	Transmit Frame request was for a RESPONSE frame	Transmission Complete (Response Delivered)
Transmission Status (ACK Received)	The Transmit Frame request was for a read DATA frame and: a) the number of data bytes transmitted equal the request byte count; and b) this state has received a Transmission Status (ACK Received) confirmation for each read DATA frame transmitted for the request.	Transmission Complete (Data-In Delivered)
Transmission Status (NAK Received), Transmission Status (ACK/NAK Timeout), or Transmission Status (Connection Lost Without ACK/NAK)	The Transmit Frame request was for a RESPONSE frame and the vendor-specific number of retries has been reached.	Transmission Complete (Response Delivery Failed)
Transmission Status (NAK Received)	The Transmit Frame request was for an XFER_RDY frame and: a) the TRANSPORT LAYERS RETRIES bit is set to zero in the Protocol-Specific Logical Unit mode page (see x.x.x); or b) the vendor-specific number of retries has been reached.	Transmission Complete (Xfer_Rdy Failed, NAK Received)
Transmission Status (ACK/NAK Timeout) or Transmission Status (Connection Lost Without ACK/NAK)		Transmission Complete (Xfer_Rdy Failed, Connection Failed)
Transmission Status (NAK Received)	The Transmit Frame request was for a read DATA frame and: a) the TRANSPORT LAYERS RETRIES bit is set to zero in the Protocol-Specific Logical Unit mode page (see x.x.x); or b) the vendor-specific number of retries has been reached.	Transmission Complete (Data Failed, NAK Received)
Transmission Status (ACK/NAK Timeout) or Transmission Status (Connection Lost Without ACK/NAK)		Transmission Complete (Data Failed, Connection Failed)

If this state receives a Cancel message from the ST\_TFR state machine and this state has received confirmations for all Transmit Frame requests sent to the port layer, then this state shall send a Transmission Complete (Cancel Acknowledged) message to the ST\_TFR state machine.

If this state receives a Cancel message from the ST\_TFR 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 to cancel previous Transmit Frame requests. The Cancel request shall include the following arguments:

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

Upon receipt of a Transmission Status (Cancel Acknowledged) confirmation this state shall send a Transmission Complete (Cancel Acknowledged) message to the ST\_TFR state machine.

A Transmission Complete message to the ST\_TFR state machine shall include the following arguments:

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

#### **8.2.5.3.3.3.3 Transition ST\_TTS2:Target\_Send\_Frame to ST\_TTS1:Target\_Start**

This transition shall occur after this state has sent a Transmission Complete message other than Transmission Complete (Xfer\_Rdy Delivered) to the ST\_TFR state machine.

#### **8.2.5.3.3.3.4 Transition ST\_TTS2:Target\_Send\_Frame to ST\_TTS3:Prepare\_Data\_In**

This transition shall include a No-retry argument and occur:

- a) if this state was entered from the ST\_TTS1:Target\_Start state with Data-in arguments; or
- b) after this state receives a Transmission Status (Frame Transmitted) confirmation for a read DATA frame and the number of bytes moved for a Request (Send Data-In) message is less than the requested byte count.

This transition shall include a Retry argument and occur after:

- a) this state receives one of the following confirmations from the port layer or arguments from the ST\_TTS3:Prepare\_Data\_In state for a read DATA frame:
  - A) Transmission Status (NAK Received);
  - B) Transmission Status (ACK/NAK Timeout); or
  - C) Transmission Status (Connection Lost without ACK/NAK);
- b) the TRANSPORT LAYERS RETRIES bit is set to one in the Protocol-Specific Logical Unit mode page (see x.x.x); and
- c) the vendor-specific number of retries, if any, for the read DATA frame has not been reached.

This transition shall include the Data-in arguments.

If this state was entered from the ST\_TTS1:Target\_Start state, then this transition shall include the First Frame argument.

If this state receives a Transmission Status from the port layer or from the ST\_TTS3:Prepare\_Data\_In state, then this transition shall include the Next Frame argument.

#### **8.2.5.3.3.3.5 Transition ST\_TTS2:Target\_Send\_Frame to ST\_TTS4:Prepare\_Xfer\_Rdy**

This transition shall include a No-retry argument and occur if this state was entered from the ST\_TTS1:Target\_Start state with Data-out arguments and:

- a) first burst is enabled, all first burst data has been received, and there is more data associated with the Data-out arguments to transfer;
- b) first burst is not enabled and no XFER\_RDY has been transmitted associated with the Data-out arguments; or
- c) all data for a previous XFER\_RDY has been received and there is more data associated with the Data-out arguments to transfer.

This transition shall include a Retry argument and occur after:

- a) this state receives one of the following confirmations for a XFER\_RDY frame:
  - A) Transmission Status (NAK Received);
  - B) Transmission Status (ACK/NAK Timeout); or
  - C) Transmission Status (Connection Lost without ACK/NAK);

- b) the TRANSPORT LAYERS RETRIES bit is set to one in the Protocol-Specific Logical Unit mode page (see x.x.x); and
- c) the vendor-specific number of retries, if any, for the XFER\_RDY frame has not been reached.

This transition shall include the Data-out arguments.

If this state was entered from the ST\_TTS1:Target\_Start state, then this transition shall include the First Xfer\_Rdy argument.

If this receives a Transmission Status, then this transition shall include the Next Xfer\_Rdy argument.

#### **8.2.5.3.3.3.6 Transition ST\_TTS2:Target\_Send\_Frame to ST\_TTS5:Receive\_Data\_Out**

This transition shall occur after this state receives a Transmission Status (Frame Transmitted) confirmation for an XFER\_RDY frame followed by a Transmission Status (ACK Received) confirmation for the frame.

This transition shall include the Data-out arguments.

#### **8.2.5.3.3.3.7 Transition ST\_TTS2:Target\_Send\_Frame to ST\_TTS7:Prepare\_Response**

This transition shall include a No-retry argument and occur if this state:

- a) was entered from the ST\_TTS1:Target\_Start state with Command Complete arguments; or
- b) was entered from the ST\_TTS1:Target\_Start state with Task Complete arguments.

This transition shall include a Retry argument and the previous RESPONSE frame, and occur if this state:

- a) receives one of the following confirmations for a RESPONSE frame:
  - A) Transmission Status (NAK Received);
  - B) Transmission Status (ACK/NAK Timeout); or
  - C) Transmission Status (Connection Lost without ACK/NAK); and
- b) the vendor-specific number of retries for the RESPONSE frame has not been reached. The number of retries for a RESPONSE frame shall be greater than or equal to one.

This transition shall include the:

- a) Command Compete arguments; or
- b) Task Compete arguments.

#### **8.2.5.3.3.4 ST\_TTS3:Prepare\_Data\_In state**

##### **8.2.5.3.3.4.1 State description**

This state retrieves the data from the Device Server Buffer and constructs a read DATA frame. This state shall use the Data-in arguments to construct the frame (see 8.2.4.3.2).

This state shall generate the following values when constructing the read DATA frame:

- a) FRAME TYPE field set to 01h (i.e., DATA frame);
- b) HASHED DESTINATION SAS ADDRESS field set to the hashed value of the specified destination SAS address;
- c) HASHED SOURCE SAS ADDRESS field set to the hashed value of the SSP target port's SAS address;
- d) RETRY DATA FRAMES bit set to zero;
- e) RETRANSMIT bit set to zero;
- f) CHANGING DATA POINTER set as specified in this subclause;
- g) NUMBER OF FILL BYTES field set to the number of fill bytes needed for the specified data;
- h) TAG field set to the specified tag;
- i) TARGET PORT TRANSFER TAG field set to zero;
- j) DATA OFFSET field set as specified in this subclause; and
- k) in the information unit, DATA field set to the specified data; and
- l) fill bytes, if any.

If this state is entered with a No-retry argument then this state shall generate the following values when constructing the frame:

- a) set the CHANGING DATA POINTER bit set to zero; and
- b) if this state is entered with the:
  - A) First Frame argument, then set the DATA OFFSET field to the specified application client buffer offset; or
  - B) Next Frame argument, then set the DATA OFFSET field to the value in the DATA OFFSET field in the previous read DATA frame plus the number of bytes in the previous read DATA information unit.

If this state is entered with a Retry argument then this state shall generate the following values when constructing the frame:

- a) set the CHANGING DATA POINTER bit in the frame to one; and
- b) set the DATA OFFSET field to a data offset value associated with a previous ACK/NAK balance.

#### 8.2.5.3.3.4.2 Transition ST\_TTS3:Prepare\_Data\_In to ST\_TTS2:Target\_Send\_Frame

This transition shall occur after this state constructs a read DATA frame.

This transition shall include the:

- a) Data-in arguments; and
- b) read DATA frame as an argument; and
- c) received Transmission Status, if any, as an argument.

#### 8.2.5.3.3.5 ST\_TTS4:Prepare\_Xfer\_Rdy state

##### 8.2.5.3.3.5.1 State description

This state shall construct an XFER\_RDY frame using the Data-out arguments (see 8.2.4.3.2):

- a) FRAME TYPE field set to 05h (i.e., XFER\_RDY frame);
- b) HASHED DESTINATION SAS ADDRESS field set to the hashed value of the specified destination SAS address;
- c) HASHED SOURCE SAS ADDRESS field set to the hashed value of the SSP target port's SAS address;
- d) RETRY DATA FRAMES bit set to the value of the TRANSPORT LAYER RETRIES bit in the Protocol-Specific Logical Unit mode page (see 10.2.6.3);
- e) RETRANSMIT bit set as specified in this subclause;
- f) CHANGING DATA POINTER bit set to zero;
- g) NUMBER OF FILL BYTES field set to zero;
- h) TAG field set to the specified tag;
- i) TARGET PORT TRANSFER TAG field set to a vendor-specific value, unless otherwise specified in this subclause;
- j) DATA OFFSET field set to zero; and
- k) in the information unit, REQUESTED OFFSET field set as specified in this subclause; and
- l) in the information unit, WRITE DATA LENGTH field set to the specified write data length.

If first burst is enabled, this state shall adjust the write data length to reflect the amount of first burst data.

If this state is entered with a No-retry argument then this state shall generate the following values when constructing the XFER\_RDY frame:

- a) set the RETRANSMIT bit set to zero;
- b) if the TRANSPORT LAYER RETRIES bit is set to one in the Protocol-Specific Logical Unit mode page (see x.x.x), then the value in the TARGET PORT TRANSFER TAG field shall be set to a value that is different than the target port transfer tag in the previous XFER\_RDY frame associated with the Data-out arguments. The new target port transfer tag shall also be different than any other target port transfer tag currently in use. If write data is received for a subsequent XFER\_RDY frame for a command, then all target port transfer tags used for previous XFER\_RDY frames for the command are no longer in use; and
- c) if this state is entered with the:

- A) First Xfer\_Rdy argument, then set the REQUESTED OFFSET field to the specified application client buffer offset; or
- B) Next Xfer\_Rdy argument, then set the REQUESTED OFFSET field to the value in the REQUESTED OFFSET field in the previous XFER\_RDY information unit plus the WRITE DATA LENGTH field of the previous XFER\_RDY information unit.

If this state is entered with a Retry argument then this state shall generate the following values when constructing the frame:

- a) set the RETRANSMIT bit in the frame to one;
- b) set the value in the TARGET PORT TRANSFER TAG field to a value that is different than the target port transfer tag in the previous XFER\_RDY frame associated with the Data-out arguments. The new target port transfer tag shall be different than any other target port transfer tag currently in use. If write data is received for a subsequent XFER\_RDY frame for a command, then all target port transfer tags used for previous XFER\_RDY frames for the command are no longer in use; and
- c) set the REQUESTED OFFSET field to the data offset value associated with the previous XFER\_RDY information unit.

#### **8.2.5.3.3.5.2 Transition ST\_TTS4:Prepare\_Xfer\_Rdy to ST\_TTS2:Target\_Send\_Frame**

This transition shall occur after this state constructs an XFER\_RDY frame.

This transition shall include the:

- a) Data-out arguments; and
- b) XFER\_RDY frame as an argument.

### 8.2.5.3.3.6 ST\_TTS5:Receive\_Data\_Out state

#### 8.2.5.3.3.6.1 State description

If this state receives a Data-Out Arrived message from the ST\_TFR state machine or a read Data-Out Arrived argument from the ST\_TTS6:Process\_Data\_Out state, then this state shall verify the write DATA frame received with the Data-Out Arrived values as specified in table 111.

**Table 121 — Reception Complete message sent on DATA frame verification failure**

Verification <sup>a</sup>	Message sent to ST_TFR	Priority <sup>b</sup>
The transport layer retries of write DATA frames is not supported, and the value in the DATA OFFSET field in the DATA frame is not set to the value in the DATA OFFSET field in the previous DATA frame received for the command plus the number of bytes in the DATA information unit in that previous DATA frame.	Reception Complete (Data Offset Error)	1
The value in the DATA OFFSET field in the DATA frame is set to a value less than the requested offset in the XFER_RDY frame that requested the write data, or greater than or equal to the requested offset in that XFER_RDY frame plus the write data length in that XFER_RDY frame.	Reception Complete (Data Offset Error)	1
First burst is enabled, and the number of bytes in the DATA field in the DATA information unit is greater than the amount of data indicated by the FIRST BURST SIZE field in the Disconnect-Reconnect mode page (see 10.2.6.1.5).	Reception Complete (Too Much Write Data)	2
A XFER_RDY frame was sent requesting write data, and the number of bytes in the DATA field in the DATA information unit plus the number of bytes of write data previously received for the XFER_RDY frame is greater than the number of bytes of data specified by the XFER_RDY frame.	Reception Complete (Too Much Write Data)	2
The number of bytes in the DATA field in the DATA information unit is zero.	Reception Complete (Information Unit Too Short)	3
<sup>a</sup> If the verification test fails, then the specified message is sent to ST_TFR state machine. <sup>b</sup> If more than one verification test fails, then the message with the highest priority shall be sent to ST_TFR state machine.		

If:

- a) transport layer retries of write DATA frames is supported;
- b) the CHANGING DATA POINTER bit is set to zero; and
- c) the value in the DATA OFFSET field is not set to the value in the DATA OFFSET FIELD in the previous DATA frame plus the number of bytes in the associated DATA information unit,

then this state shall discard all Data-out Arrived messages until the CHANGING DATA POINTER bit is set to one. The Data-out Arrived message with the CHANGING DATA POINTER bit set to one, and any additional Data-out Arrived messages, shall be processed by this state.

The Reception Complete message, if any, shall include the tag as an argument.

If the Initiator Response Timeout timer is implemented, this state shall initialize and start the Initiator Response Timeout timer after any of the following occur:

- a) this state is entered from the ST\_TTS1:Target\_Start state and first burst is enabled;
- b) this state is entered from the ST\_TTS2:Target\_Send\_Frame state (i.e., an XFER\_RDY was successfully transmitted); or



- c) this state is entered from the ST\_TTS6:Process\_Data\_Out state (i.e., Data-Out data was received and processed).

If the Initiator Response Timeout timer is running, this state shall stop the timer before transitioning from this state.

If the Initiator Response Timeout timer expires this state shall send a Reception Complete (Initiator Response Timeout) message to the ST\_TFR state machine.

If this state is entered from the ST\_TTS6:Process\_Data\_Out state and number of bytes received argument equals the Data-out arguments (i.e., request byte count), then this state shall send a Reception Complete (Data-Out Received) message to the ST\_TFR state machine.

If this state receives a Cancel message from the ST\_TFR state machine, then this state shall send a Reception Complete (Cancel Acknowledged) message to the ST\_TFR state machine.

#### **8.2.5.3.3.6.2 Transition ST\_TTS5:Receive\_Data\_Out to ST\_TTS6:Process\_Data\_Out**

This transition shall occur after this state receives and verifies the write DATA frame received with the Data-Out Arrived values.

This transition shall include the write DATA frame as an argument.

#### **8.2.5.3.3.6.3 Transition ST\_TTS5:Receive\_Data\_Out to ST\_TTS1:Target\_Start**

This transition shall occur after this state sends a Reception Complete message to the ST\_TFR state machine.

#### **8.2.5.3.3.7 ST\_TTS6:Process\_Data\_Out state**

##### **8.2.5.3.3.7.1 State description**

This state shall process the data received in the write DATA frame argument using the Device Server Buffer (e.g., logical block address) to which the data is to be transferred.

##### **8.2.5.3.3.7.2 Transition ST\_TTS6:Process\_Data\_Out to ST\_TTS5:Receive\_Data\_Out**

This transition shall occur after this state has processed the data received in the write DATA frame argument.

This transition shall include:

- a) the write DATA frame as an arguments;
- b) the number of bytes received argument; and
- c) the received Data-Out Arrived, if any, as an argument.

#### **8.2.5.3.3.8 ST\_TTS7:Prepare\_Response state**

##### **8.2.5.3.3.8.1 State description**

If this state was entered with a No-retry argument, then this state shall construct a RESPONSE frame using the received Command Complete arguments or the received Task Complete arguments as follows:

- a) FRAME TYPE field set to 07h (i.e., RESPONSE frame);
- b) HASHED DESTINATION SAS ADDRESS field set to the hashed value of the specified destination SAS address;
- c) HASHED SOURCE SAS ADDRESS field set to the hashed value of the SSP target port's SAS address;
- d) RETRY DATA FRAMES bit set to zero;
- e) RETRANSMIT bit set to zero;
- f) CHANGING DATA POINTER bit set to zero;
- g) TAG field set to the specified tag;
- h) TARGET PORT TRANSFER TAG field set to zero;
- i) DATA OFFSET field set to zero.

If this state was entered with a No-retry argument and Task Complete arguments, then this state shall set the fields relating to the SSP frame using the received Task Complete arguments as follows:

- a) NUMBER OF FILL BYTES field set to the number of fill bytes, based on the length of the response data, if any;
- b) in the information unit, DATAPRES field set to RESPONSE DATA;
- c) in the information unit, STATUS field set to zero;
- d) in the information unit, SENSE DATA LENGTH field set to zero;
- e) in the information unit, RESPONSE DATA LENGTH field set to 00000004h;
- f) in the information unit, RESPONSE DATA field set as specified in table 112;
- g) in the information unit, SENSE DATA field not included; and
- h) fill bytes, if any.

Table 112 specifies how the RESPONSE DATA field shall be set based on the arguments received with the Request (Send Transport Response) message.

**Table 122 — Request argument to RESPONSE frame RESPONSE DATA field mapping**

Request argument	RESPONSE frame RESPONSE DATA field
Invalid Frame	INVALID FRAME
Function Complete	TASK MANAGEMENT FUNCTION COMPLETE
Function Succeeded	TASK MANAGEMENT FUNCTION SUCCEEDED
Function Not Supported	TASK MANAGEMENT FUNCTION NOT SUPPORTED
Function Failed	TASK MANAGEMENT FUNCTION FAILED
Incorrect Logical Unit Number	INCORRECT LOGICAL UNIT NUMBER
Overlapped Tag Attempted	OVERLAPPED TAG ATTEMPTED

If this state was entered with a No-retry argument and Command Complete arguments, then this state shall set the fields relating to the SSP frame using the received Command Complete arguments as follows:

- a) NUMBER OF FILL BYTES field set to the number of fill bytes, based on the length of the specified sense data, if any;
- b) in the information unit, DATAPRES field set to SENSE\_DATA if sense data is specified or NO\_DATA if sense data is not specified;
- c) in the information unit, STATUS field set to the specified status;
- d) in the information unit, SENSE DATA LENGTH field set to the length of the specified sense data, if any;
- e) in the information unit, RESPONSE DATA LENGTH field set to zero;
- f) in the information unit, RESPONSE DATA field not included;
- g) in the information unit, SENSE DATA field set to the specified sense data, if any; and
- h) fill bytes, if any.

If this state was entered with a Retry argument, then this state shall construct a new RESPONSE frame using all of the values for the previous RESPONSE frame except that the RETRANSMIT bit shall be set to one.

#### **8.2.5.3.3.8.2 Transition ST\_TTS7:Prepare\_Response to ST\_TTS2:Target\_Send\_Frame**

This transition shall occur after this state constructs a RESPONSE frame.

This transition shall include the RESPONSE frame and the:

- a) Command Complete arguments; or
- b) Task Complete arguments.