To: T10 Technical Committee
From: Rob Elliott, HP (elliott@hp.com)
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Subject: 08-064r0 SAS-2 SPC-4 Differentiate between ACK NAK timeout reasons

Revision history
Revision 0 (14 January 2007) First revision

Related documents
sas2r13 - Serial Attached SCSI - 2 (SAS-2) revision 13
spc4r12 - SCSI Primary Commands - 4 (SPC-4) revision 12

Overview
There are several reasons why a target might terminate a command with CHECK CONDITION status with the sense key set to ABORTED COMMAND and the additional sense code set to ACK/NAK TIMEOUT if, while waiting for an ACK or NAK after sending a frame:

a) Timeout before ACK/NAK. The ACK/NAK Timeout timer expires (1 ms). The target sends DONE (ACK/NAK TIMEOUT) and receives a DONE in reply, so sends CLOSE
a) Timeout or BREAK before ACK/NAK. The ACK/NAK Timeout timer expires (1 ms). The target sends DONE (ACK/NAK TIMEOUT) but does not receive a DONE within 1 ms, so sends BREAK.
b) CLOSE before ACK/NAK. The target sends DONE (CREDIT TIMEOUT), DONE (RESERVED TIMEOUT 0, DONE (RESERVED TIMEOUT 1), DONE (RESERVED 0), or DONE (RESERVED 1) and receives a DONE, so sends CLOSE.
c) CLOSE before ACK/NAK. The target sends DONE (CREDIT TIMEOUT), DONE (RESERVED TIMEOUT 0, DONE (RESERVED TIMEOUT 1), DONE (RESERVED 0), or DONE (RESERVED 1) and does not receive a DONE within 1 ms, so sends CLOSE.

NOTE 1 - The SSP state machine does not send DONE (NORMAL) while waiting for an ACK or NAK, so that shouldn't ever show up.

d) BREAK before ACK/NAK. The target receives BREAK.
e) BREAK before ACK/NAK. The target sends BREAK for some reason.
f) Phy disabled before ACK/NAK. The phy is disabled while a connection is outstanding.

There is interest in distinguishing between these reasons to better diagnose system problems.

Changes are proposed to the target side state machines to distinguish between these reasons so the device server can choose a more precise additional sense code. Similar message changes are made on the initiator side for consistency, although the initiator doesn't generate CHECK CONDITION status.

Suggested changes to SAS-2

7.14.4 SL_CC (connection control) state machine

Editor's Note 1: This state machine sends Connection Closed confirmations to the port layer. Connection Closed (Transition To Idle) covers any return to SL_CC0; (Break Requested) if this phy originated a BREAK; (Break Received) if this phy received an unexpected BREAK; (Normal) if this phy sent and received CLOSE (including for STP connections); (Close Timeout) on a NOTIFY (POWER LOSS EXPECTED) or a CLOSE with no reply;

7.14.4.2 SL_CC0:Idle state

7.14.4.2.1 State description

This state is the initial state and is the state that is used when there is no connection pending or established.

Upon entry into this state, this state shall send:

a) an Enable Disable SSP (Disable) message to the SSP link layer state machines;
b) an Enable Disable SMP (Disable) message to the SMP link layer state machines;
c) an Enable Disable STP (Disable) message to the STP link layer state machines; and
d) a Connection Closed (Transition to Idle) confirmation to the port layer.

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7.14.4.3 SL_CC3:Connected state

7.14.4.3.1 State description

This state enables the SSP, STP, or SMP link layer state machine to transmit dwords during a connection. See 7.13 for details on rate matching during the connection.

If this state is entered from SL_CC1:ArbSel state or the SL_CC2:Selected state with an argument of Open SMP Connection then this state shall send an Enable Disable SMP (Enable) message to the SMP link layer state machines (see 7.18.5).

If this state is entered from SL_CC1:ArbSel state or the SL_CC2:Selected state with an argument of Open SSP Connection then this state shall send an Enable Disable SSP (Enable) message to the SSP link layer state machines (see 7.16.8).

If this state is entered from SL_CC1:ArbSel state or the SL_CC2:Selected state with an argument of Open STP Connection then this state shall send an Enable Disable STP (Enable) message to the STP link layer state machines (see 7.17.8).

This state shall request idle dwords be transmitted by repeatedly sending Transmit Idle Dword messages to the SL transmitter until the SSP, SMP, or STP link layer state machine starts transmitting.

A CLOSE Received message may be received at any time while in this state, but shall be ignored during SSP and SMP connections. If a CLOSE Received (Clear Affiliation) is received during an STP connection, this state shall clear any affiliation (see 7.17.4).

7.14.4.3.2 Transition SL_CC3:Connected to SL_CC4:DisconnectWait

This transition shall occur if a Request Close message is received.

7.14.4.3.3 Transition SL_CC3:Connected to SL_CC5:BreakWait

This transition shall occur after sending a Connection Closed (Break Requested) confirmation to the port layer if:

a) a Request Break message is received and a BREAK Received message has not been received; or
b) a NOTIFY Received (Power Loss Expected) message is received.

If a NOTIFY Received (Power Loss Expected) message was received and the SAS port that contains this state machine supports NOTIFY (Power Loss Expected) (e.g., the SAS port is a SSP target port), then this state shall include a Power Loss Expected argument.

7.14.4.3.4 Transition SL_CC3:Connected to SL_CC6:Break

This transition shall occur if a BREAK Received message is received and after sending a Connection Closed (Break Received) confirmation to the port layer.

Editor's Note 2: this should not be implicit: "If the state receives a BREAK Received message, it shall send a Connection Closed (Break Received) confirmation to the port layer"

7.14.4.3.5 Transition SL_CC3:Connected to SL_CC7:CloseSTP

This transition shall occur if a CLOSE Received message is received during an STP connection.

7.14.4.4 SL_CC4:DisconnectWait state

7.14.4.4.1 State description

This state closes the connection and releases all resources associated with the connection.

Upon entry into this state, this state shall:

1) send a Transmit CLOSE (Normal) message or Transmit CLOSE (Clear Affiliation) message to the SL transmitter (see 7.17.6); and
2) initialize and start the Close Timeout timer.

A CLOSE Received message may be received at any time while in this state. If a CLOSE Received (Clear Affiliation) is received during an STP connection, this state shall clear any affiliation (see 7.17.4).

NOTE 2 - Possible livelock scenarios occur if the BREAK_REPLY method of responding to received BREAK primitive sequences is disabled and a SAS logical phy transmits BREAK to break a connection (e.g., if its Close Timeout timer expires). SAS logical phys should respond to CLOSE faster than 1 ms to reduce susceptibility to this problem.

7.14.4.4.2 Transition SL_CC4:DisconnectWait to SL_CC0:Idle

This transition shall occur after:

a) sending a Transmit CLOSE message to the SL transmitter;
b) receiving a CLOSE Received message; and
c) sending a Connection Closed (Normal) confirmation to the port layer.

Editor's Note 3: sending Connection Closed (Normal) should not be implicit

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7.14.4.4.3 Transition SL_CC4:DisconnectWait to SL_CC5:BreakWait

This transition shall occur if a NOTIFY Received (Power Loss Expected) message is received or if:

a) a BREAK Received message has not been received;
b) no CLOSE Received message is received in response to a Transmit CLOSE message before the Close Timeout timer expires; and
c) after sending a Connection Closed (Close Timeout) confirmation to the port layer.

If a NOTIFY Received (Power Loss Expected) message was received and the SAS port that contains this state machine supports NOTIFY (Power Loss Expected) (e.g., the SAS port is a SSP target port), then this state shall include a Power Loss Expected argument.

7.14.4.4.4 Transition SL_CC4:DisconnectWait to SL_CC6:Break

This transition shall occur after receiving a BREAK Received message and after sending a Connection Closed (Break Received) confirmation to the port layer.

Editor's Note 4: sending Connection Closed (Break Received) should not be implicit

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7.14.4.9 SL_CC7:CloseSTP state

7.14.4.9.1 State description

This state closes an STP connection and releases all resources associated with the connection.

Upon entry into this state, this state shall:

1) send a Transmit CLOSE (Normal) message or Transmit CLOSE (Clear Affiliation) message to the SL transmitter (see 7.17.6); and

2) send a Connection Closed (Normal) confirmation to the port layer (see 7.14.4.9.2).

NOTE 3 - Possible livelock scenarios occur if the BREAK_REPLY method of responding to received BREAK primitive sequences is disabled and a SAS logical phy transmits BREAK to break a connection (e.g., if its Close Timeout timer expires). SAS logical phys should respond to CLOSE faster than 1 ms to reduce susceptibility to this problem.

7.14.4.9.2 Transition SL_CC7:CloseSTP to SL_CC0:Idle

This transition shall occur after sending a Connection Closed (Normal) confirmation to the port layer.

Editor's Note 5: inspect SL_CC for other cases of implicit sending confirmations in transitions

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7.16.8.3 SSP_TIM (transmit interlocked frame monitor) state machine

The SSP_TIM state machine's function is to ensure that ACKs or NAKs are received for each transmitted frame before the ACK/NAK timeout. This state machine consists of one state.

This state machine monitors the number of frames transmitted with a Number Of Frames Transmitted counter and monitors the number of ACKs and NAKs received with a Number Of ACKs/NAKs Received counter. This state machine ensures that an ACK or NAK is received for each frame transmitted and reports an ACK/NAK timeout if they are not.

When the Number Of Frames Transmitted counter equals the Number Of ACKs/NAKs Received counter, the ACK/NAK count is balanced and this state machine shall send the Tx Balance Status (Balanced) message to the SSP_TF2:Tx_Wait state. When the Number Of Frames Transmitted counter does not equal the Number Of ACKs/NAKs Received counter, the ACK/NAK count is not balanced and this state machine shall send the Tx Balance Status (Not Balanced) message to the SSP_TF2:Tx_Wait state.

Each time a Frame Transmitted message is received, this state machine shall increment the Number Of Frames Transmitted counter.

If the ACK/NAK count is not balanced, each time an ACK Received message is received, this state machine shall:

a) increment the Number Of ACKs/NAKs Received counter; and
b) send an ACK Received confirmation to the port layer.

If the ACK/NAK count is not balanced, each time a NAK Received message is received, this state machine shall:

a) increment the Number Of ACKs/NAKs Received counter; and
b) send an NAK Received confirmation to the port layer.

If the ACK/NAK count is balanced, the ACK Received message and NAK Received message shall be ignored and the ACK/NAK Timeout timer shall be stopped.

Each time the ACK/NAK count is not balanced, the ACK/NAK Timeout timer shall be initialized and started. The ACK/NAK Timeout timer shall be re-initialized each time the Number Of ACKs/NAKs Received counter is incremented. If the ACK/NAK Timeout timer expires, this state machine shall send ~~the ACK/NAK Timeout~~a Timeout Before ACK/NAK confirmation to the port layer and to the following states:

a) SSP_TF1:Connected_Idle; and
b) SSP_TF2:Tx_Wait state.

When this state machine receives an Enable Disable SSP (Enable) message, Request Close message, or Request Break message, the Number Of Frames Transmitted counter shall be set to zero and the Number Of ACKs/NAKs Received counter shall be set to zero.

8.2.2.3.6 PL_OC2:Overall_Control state frame transmission

In order to prevent livelocks, If this port is a wide SSP port, has multiple connections established, and has a pending Tx Frame message, then this state shall send at least one Tx Frame message to a PL_PM state machine before sending a Close Connection message to the PL_PM state machine.

After this state receives a Connection Opened message from a PL_PM state machine, this state selects pending Tx Frame messages for the destination SAS address with the same initiator port bit and protocol arguments, and, as an option, the same connection rate argument, and sends the messages to the PL_PM state machine as Tx Frame messages.

This state may send a Tx Frame message to any PL_PM state machine that has established a connection with the destination SAS address when the initiator port bit and protocol arguments match those in the Tx Frame message.

After this state sends a Tx Frame message to a PL_PM state machine, it shall not send another Tx Frame message to that PL_PM state machine until it receives a Transmission Status (Frame Transmitted) message.

This state shall not send a Tx Frame message containing a Request Fence argument or Response Fence argument to any PL_PM state machine until this state has received one of the following messages for each Tx Frame message with the same nexus as specified by that Request Fence argument or Response Fence argument:

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).~~
e) Transmission Status (Timeout Before ACK/NAK);
f) Transmission Status (BREAK Before ACK/NAK);
g) Transmission Status (CLOSE Before ACK/NAK); or
h) Transmission Status (Phy Disable Before ACK/NAK),

After this state sends a Tx Frame message containing a Request Fence argument or Response Fence argument, it shall not send another Tx Frame message with the same nexus as specified by that Request Fence argument or Response Fence argument until it has received one of the following messages:

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).~~
e) Transmission Status (Timeout Before ACK/NAK);
f) Transmission Status (BREAK Before ACK/NAK);
g) Transmission Status (CLOSE Before ACK/NAK); or
h) Transmission Status (Phy Disable Before ACK/NAK),

Once this state has sent a Tx Frame message containing a Non-Interlocked argument to a PL_PM state machine, this state shall not send a Tx Frame message containing a Non-Interlocked argument with the same I_T_L_Q nexus to another PL_PM state machine until this state has received one of the following messages for each Tx Frame message containing a Non-Interlocked argument for the same I_T_L_Q nexus:

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).~~
e) Transmission Status (Timeout Before ACK/NAK);
f) Transmission Status (BREAK Before ACK/NAK);
g) Transmission Status (CLOSE Before ACK/NAK); or
h) Transmission Status (Phy Disable Before ACK/NAK),

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8.2.3.4 PL_PM3:Connected state

8.2.3.4.1 PL_PM3:Connected state description

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~~If this state receives an ACK/NAK Timeout confirmation, then this state shall send:~~

~~a) a Transmission Status (ACK/NAK Timeout) confirmation to the transport layer; and~~
~~b) a Transmission Status (ACK/NAK Timeout) message to the PL_OC state machine.~~

If this state receives a Timeout Before ACK/NAK confirmation, then this state shall send:

a) a Transmission Status (Timeout Before ACK/NAK) confirmation to the transport layer; and
b) a Transmission Status (Timeout Before ACK/NAK) message to the PL_OC state machine.

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~~If this state receives a Connection Closed (Normal) confirmation, a Connection Closed (Transition to Idle) confirmation, or a Phy Disabled confirmation after sending a Transmission Status (Frame Transmitted) confirmation, but before this state receives an ACK Received or NAK Received confirmation, then this state shall send:~~

~~a) a Transmission Status (Connection Lost Without ACK/NAK) confirmation to the transport layer; and~~
~~b) a Transmission Status (Connection Lost Without ACK/NAK) message to the PL_OC state machine.~~

If this state receives a Connection Closed (Normal) confirmation after sending a Transmission Status (Frame Transmitted) confirmation, but before this state receives an ACK Received or NAK Received confirmation, then this state shall send:

a) a Transmission Status (CLOSE Before ACK/NAK) confirmation to the transport layer; and
b) a Transmission Status (CLOSE Before ACK/NAK) message to the PL_OC state machine.

If this state receives a Connection Closed (Transition to Idle) confirmation after sending a Transmission Status (Frame Transmitted) confirmation, but before this state receives an ACK Received or NAK Received confirmation, then this state shall send:

a) a Transmission Status (BREAK Before ACK/NAK) confirmation to the transport layer; and
b) a Transmission Status (BREAK Before ACK/NAK) message to the PL_OC state machine.

If this state receives a Phy Disabled confirmation after sending a Transmission Status (Frame Transmitted) confirmation, but before this state receives an ACK Received or NAK Received confirmation, then this state shall send:

a) a Transmission Status (Phy Disable Before ACK/NAK) confirmation to the transport layer; and
b) a Transmission Status (Phy Disable Before ACK/NAK) message to the PL_OC state machine.

If this state receives a Connection Closed (Normal) confirmation, a Connection Closed (Transition to Idle) confirmation, or a Phy Disabled confirmation after sending a Tx Frame request but before receiving a Frame Transmitted confirmation, then this state shall send a Retry Frame message to the PL_OC state machine.

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If this state receives a DONE Received (ACK/NAK Timeout) or DONE Transmitted confirmation, then this state shall send a Disable Tx Frames message to the PL_OC state machine.

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9.2.4 SSP transport layer handling of link layer errors

9.2.4.1 SSP transport layer handling of link layer errors overview

The transport layer, sometimes assisted by the application layer, handles some link layer errors (e.g., NAKs and ACK/NAK timeouts). See 9.2.5 for transport layer handling of transport layer errors (e.g., invalid frame contents).

Link layer errors that occur when transmitting XFER_RDY and DATA frames are handled differently based on the TLR CONTROL field in the COMMAND frame header (see 9.2.1) and the TRANSPORT LAYER RETRIES bit in the Protocol-Specific Logical Unit mode page (see 10.2.7.3) of the logical unit that is the source of the frame.

If transport layer retries are disabled, the logical unit:

a) sets the RETRY DATA FRAMES bit to zero in each XFER_RDY frame;
b) may or may not select a different value for the TARGET PORT TRANSFER TAG field in each XFER_RDY frame than that used in the previous XFER_RDY frame for that I_T_L_Q nexus;
c) processes XFER_RDY frame link layer errors as described in 9.2.4.4.3; and
d) processes DATA frame link layer errors as described in 9.2.4.5.3.

If transport layer retries are enabled, the logical unit:

a) supports the QUERY TASK task management function (see SAM-4);
b) sets the RETRY DATA FRAMES bit to one in each XFER_RDY frame;
c) selects a different value for the TARGET PORT TRANSFER TAG field in each XFER_RDY frame than that used in the previous XFER_RDY frame for that I_T_L_Q nexus;
d) processes XFER_RDY frame link layer errors as described in 9.2.4.4.2; and
e) processes DATA frame link layer errors as described in 9.2.4.5.2.

9.2.4.2 COMMAND frame - handling of link layer errors

If an SSP initiator port transmits a COMMAND frame and receives a NAK for that frame, then the COMMAND frame was not received. The SSP initiator port should retransmit, in the same or in a new connection, the COMMAND frame at least one time (see 9.2.6.2.3.3). The SSP initiator port may reuse the tag.

If an SSP initiator port transmits a COMMAND frame and does not receive an ACK or NAK for that frame (e.g., times out, or the connection is broken):

1) if the connection is still open, the SSP_TF state machine closes the connection with DONE (ACK/NAK TIMEOUT) (see 7.16.8.6.5);
2) to determine whether the command was received, the application client calls Send Task Management Function Request () (see 10.2.2) with:
   A) Nexus set to the I_T_L_Q nexus of the COMMAND frame; and
   B) Function Identifier set to QUERY TASK;

   and
3) the SSP initiator port transmits the TASK frame in a new connection to the SSP target port.

If the SSP initiator port receives an XFER_RDY frame for the I_T_L_Q nexus of the command before the RESPONSE frame for the QUERY TASK, then the COMMAND frame was received and is being processed by the target port, and the XFER_RDY frame is valid.

If the SSP initiator port receives a read DATA frame for the I_T_L_Q nexus of the command before the RESPONSE frame for the QUERY TASK, then the COMMAND frame was received and is being processed by the target port, and the read DATA frame is valid.

If the SSP initiator port receives a RESPONSE frame for the I_T_L_Q nexus of the command before the RESPONSE frame for the QUERY TASK, then the COMMAND frame was received by the target port, the RESPONSE frame is valid, and the command processing is complete. The SSP initiator port may reuse the tag of the COMMAND frame.

If the SSP initiator port receives a RESPONSE frame for the QUERY TASK with a response code of TASK MANAGEMENT FUNCTION SUCCEEDED, then the COMMAND frame was received by the SSP target port (i.e., ACKed) and the command is being processed.

If the SSP initiator port receives a RESPONSE frame for the QUERY TASK with a response code of TASK MANAGEMENT FUNCTION COMPLETE, then the COMMAND frame is not being processed. If neither an XFER_RDY frame, a read DATA frame, nor a RESPONSE frame has been received for the I_T_L_Q nexus of the command, then the COMMAND frame was not received. The SSP initiator port should retransmit the COMMAND frame at least one time. The SSP initiator port may reuse the tag of the COMMAND frame.

9.2.4.3 TASK frame - handling of link layer errors

If an SSP initiator port transmits a TASK frame and receives a NAK for that frame, then the TASK frame was not received. The SSP initiator port should retransmit, in the same or in a new connection, the TASK frame at least one time with the RETRANSMIT bit set to one (see 9.2.6.2.2.2). The SSP initiator port may reuse the tag.

If an SSP initiator port transmits a TASK frame and does not receive an ACK or NAK for that frame (e.g., times out, or the connection is broken):

1) if the connection is still open, the SSP_TF state machine closes the connection with DONE (ACK/NAK TIMEOUT) (see 7.16.8.6.5); and
2) the application client calls Send Task Management Request () using the same tag (see 10.2.2);
3) the SSP initiator port transmits the TASK frame with the RETRANSMIT bit set to one in a new connection to the SSP target port (see 9.2.6.2.2.2).

If the SSP initiator port receives a RESPONSE frame for the TASK frame that arrives before the ACK or NAK for the TASK frame, then the TASK frame was received by the SSP target port (i.e., ACKed), the RESPONSE frame is valid, and the task management function is complete (see 9.2.6.2.2.3). The initiator port may reuse the tag of the TASK frame.

9.2.4.4 XFER_RDY frame - handling of link layer errors

9.2.4.4.1 XFER_RDY frame overview

If transport layer retries are enabled, then the SSP target port processes link layer errors that occur while transmitting XFER_RDY frames as described in 9.2.4.4.2.

If transport layer retries are disabled, then the SSP target port processes link layer errors that occur while transmitting XFER_RDY frames as described in 9.2.4.4.3.

9.2.4.4.2 XFER_RDY frame with transport layer retries enabled

If an SSP target port transmits an XFER_RDY frame and receives a NAK for that frame, the SSP target port retransmits, in the same or a new connection, the XFER_RDY frame with a different value in the TARGET PORT TRANSFER TAG field, with the RETRANSMIT bit set to one, and with the other fields set to the same values as in the original XFER_RDY frame (see 9.2.6.3.3.3).

If an SSP target port transmits an XFER_RDY frame and does not receive an ACK or NAK for that frame (e.g., times out, or the connection is broken):

1) if the connection is still open, the SSP_TF state machine closes the connection with DONE (ACK/NAK TIMEOUT) (see 7.16.8.6.5); and
2) the SSP target port retransmits, in a new connection, the XFER_RDY frame with:
   A) the TARGET PORT TRANSFER TAG field set to a different value than in the original XFER_RDY frame;
   B) the RETRANSMIT bit set to one; and
   C) the other fields set to the same values as in the original XFER_RDY frame (see 9.2.6.3.3.3).

If an SSP initiator port receives a new XFER_RDY frame with the RETRANSMIT bit set to one while processing the previous XFER_RDY frame for that I_T_L_Q nexus, the ST_ITS state machine stops processing the previous XFER_RDY frame (i.e., stops transmitting write DATA frames) and starts servicing the new XFER_RDY frame (see 9.2.6.2.3). The ST_ITS state machine does not transmit any write DATA frames for the previous XFER_RDY frame after transmitting a write DATA frame for the new XFER_RDY frame.

The SSP target port may reuse the value in the TARGET PORT TRANSFER TAG field from the previous XFER_RDY frame after it receives a write DATA frame for the new XFER_RDY frame.

An SSP target port retransmits each XFER_RDY frame that does not receive an ACK at least one time.

9.2.4.4.3 XFER_RDY frame with transport layer retries disabled

If an SSP target port transmits an XFER_RDY frame and receives a NAK for that frame:

1) the device server calls Send Command Complete () to return CHECK CONDITION status for that command with the sense key set to ABORTED COMMAND and the additional sense code set to NAK RECEIVED (see 10.2.3); and
2) the SSP target port transmits the RESPONSE frame in the same or a new connection.

If an SSP target port transmits an XFER_RDY frame and does not receive an ACK or NAK for that frame (e.g., times out, or the connection is broken):

1) if the connection is still open, the SSP_TF state machine closes the connection with DONE (ACK/NAK TIMEOUT) (see 7.16.8.6.5);
2) the device server calls Send Command Complete () to return CHECK CONDITION status for that command with the sense key set to ABORTED COMMAND and the additional sense code set to:
   A) ACK/NAK TIMEOUT (see 10.2.3);
   B) TIMEOUT CAUSED ACK/NAK TIMEOUT;
   C) BREAK CAUSED ACK/NAK TIMEOUT;
   D) CLOSE CAUSED ACK/NAK TIMEOUT; or
   E) PHY DISABLE CAUSED ACK/NAK TIMEOUT;

   and
3) the SSP target port transmits the RESPONSE frame in a new connection.

9.2.4.5 DATA frame - handling of link layer errors

9.2.4.5.1 DATA frame overview

If an SSP target port transmits a read DATA frame for a command with transport layer retries enabled, then the SSP target port processes link layer errors that occur while transmitting read DATA frames as described in 9.2.4.5.2.

If an SSP target port transmits a read DATA frame for a command with transport layer retries disabled, then the SSP target port processes link layer errors that occur while transmitting read DATA frames as described in 9.2.4.5.3.

An SSP initiator port processes link layer errors that occur while transmitting write DATA frames transmitted in response to an XFER_RDY frame that has its RETRY DATA FRAMES bit set to one as described in 9.2.4.5.2.

An SSP initiator port processes link layer errors that occur while transmitting write DATA frames in response to an XFER_RDY frame that has its RETRY DATA FRAMES bit set to zero as described in 9.2.4.5.3.

9.2.4.5.2 DATA frame with transport layer retries enabled

If an SSP target port transmits a read DATA frame and receives a NAK for that frame, then the read DATA frame was not received. The SSP target port retransmits, in the same or in a new connection, all the read DATA frames since a previous time when ACK/NAK balance occurred (see 9.2.6.3.3.4).

If an SSP target port transmits a read DATA frame and does not receive an ACK or NAK for that frame (e.g., times out, or the connection is broken):

1) if the connection is still open, the SSP_TF state machine closes the connection with DONE (ACK/NAK TIMEOUT) (see 7.16.8.6.5); and
2) the ST_TTS state machine retransmits, in a new connection, all the read DATA frames since a previous time when ACK/NAK balance occurred (see 9.2.6.3.3.4).

If an SSP initiator port transmits a write DATA frame and receives a NAK for that frame, then the write DATA frame was not received. The SSP_ITS state machine retransmits, in the same or in a new connection, all the write DATA frames for the previous XFER_RDY frame (see 9.2.6.2.3.3.2).

If an SSP initiator port transmits a write DATA frame and does not receive an ACK or NAK for that frame (e.g., times out, or the connection is broken):

1) the SSP_TF state machine closes the connection with DONE (ACK/NAK TIMEOUT) (see 7.16.8.6.5); and
2) the ST_ITS state machine retransmits, in a new connection, all the write DATA frames for the previous XFER_RDY frame (see 9.2.6.2.3.3.2).

If that SSP initiator port receives a new XFER_RDY frame or a RESPONSE frame for the command while retransmitting or preparing to retransmit the write DATA frames, the ST_IFR state machine and ST_ITS state machine process the XFER_RDY frame or RESPONSE frame and stop retransmitting the write DATA frames (see 9.2.6.2.2 and 9.2.6.2.3). The ST_ITS state machine does not transmit a write DATA frame for the previous XFER_RDY frame after transmitting a write DATA frame in response to the new XFER_RDY frame.

For both reads and writes, the CHANGING DATA POINTER bit is set to one in the first retransmitted DATA frame and the CHANGING DATA POINTER bit is set to zero in subsequent DATA frames.

The ST_ITS state machine and ST_TTS state machine retransmit each DATA frame that does not receive an ACK at least one time (see 9.2.6.2.3 and 9.2.6.3.3). The number of times they retransmit each DATA frame is vendor-specific.

9.2.4.5.3 DATA frame with transport layer retries disabled

If an SSP target port transmits a read DATA frame and receives a NAK for that frame:

1) the device server calls Send Command Complete () to return CHECK CONDITION status for that command with the sense key set to ABORTED COMMAND and the additional sense code set to NAK RECEIVED (see 10.2.3); and
2) the SSP target port transmits the RESPONSE frame in the same or a new connection.

If an SSP target port transmits a read DATA frame and does not receive an ACK or NAK for that frame (e.g., times out, or the connection is broken):

1) if the connection is still open, the SSP_TF state machine closes the connection with DONE (ACK/NAK TIMEOUT) (see 7.16.8.6.5);
2) the device server calls Send Command Complete () to return CHECK CONDITION status for that command with the sense key set to ABORTED COMMAND and the additional sense code set to:
   A) ACK/NAK TIMEOUT (see 10.2.3);
   B) TIMEOUT CAUSED ACK/NAK TIMEOUT;
   C) BREAK CAUSED ACK/NAK TIMEOUT;
   D) CLOSE CAUSED ACK/NAK TIMEOUT; or
   E) PHY DISABLE CAUSED ACK/NAK TIMEOUT;

   and
3) the SSP target port transmits the RESPONSE frame in a new connection.

If an SSP initiator port transmits a write DATA frame and does not receive an ACK or NAK for that frame (e.g., times out, or the connection is broken):

1) the SSP_TF state machine closes the connection with DONE (ACK/NAK TIMEOUT) (see 7.16.8.6.5); and
2) the application client aborts the command (see 10.2.2).

If an SSP initiator port transmits a write DATA frame and receives a NAK for that frame, the application client aborts the command (see 10.2.2).

9.2.4.6 RESPONSE frame - handling of link layer errors

If an SSP target port transmits a RESPONSE frame and receives a NAK for that frame, the SSP target port retransmits, in the same or a new connection, the RESPONSE frame at least one time with the RETRANSMIT bit set to one and with the other fields set to the same values as in the original RESPONSE frame (see 9.2.6.3.3.3).

If an SSP target port transmits a RESPONSE frame and does not receive an ACK or NAK for that frame (e.g., times out, or the connection is broken):

1) if the connection is still open, the SSP_TF state machine closes the connection with DONE (ACK/NAK TIMEOUT) (see 7.16.8.6.5); and
2) the SSP target port retransmits, in a new connection, the RESPONSE frame with:
   A) the RETRANSMIT bit set to one; and
   B) the other fields set to the same values as in the original RESPONSE frame (see 9.2.6.3.3.3).

The ST_TTS state machine retransmits each RESPONSE frame that does not receive an ACK at least one time (see 9.2.6.3.3). The number of times it retransmits each RESPONSE frame is vendor-specific.

If an SSP initiator port receives a RESPONSE frame with a RETRANSMIT bit set to one, and it has previously received a RESPONSE frame for the same I_T_L_Q nexus, the ST_IFR state machine discards the extra RESPONSE frame (see 9.2.6.3.2). If the ST_IFR state machine has not previously received a RESPONSE frame for the I_T_L_Q nexus, then it considers the RESPONSE frame to be the valid RESPONSE frame.

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

9.2.6.2.2 ST_IFR (initiator frame router) state machine

9.2.6.2.2.4 Processing Transmission Complete and Reception Complete messages

If this state receives a Transmission Complete (I_T Nexus Loss), then this state machine shall send a Nexus Loss event notification to the SCSI application layer.

Table 1 defines the transport protocol service confirmation and its argument generated as a result of receiving a Transmission Complete message or a Reception Complete message that indicate an error occurred during

the transmission or reception of a frame.

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

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

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

Message received from ST_ITS state machine	Protocol service confirmation and Delivery Result argument sent to the SCSI application layer
Reception Complete (Cancel Acknowledged)	Command Complete Received (Service Delivery or Target Failure - Cancel Acknowledged)

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

9.2.6.2.3 ST_ITS (initiator transport server) state machine

9.2.6.2.3.3 ST_ITS2:Initiator_Send_Frame state

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

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

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

If this state is entered from the ST_ITS5:Prepare_Data_Out state for transmission of a write DATA frame, then this state shall send a Transmit Frame (Non-Interlocked) request to the port layer after this state has received an XFER_RDY Arrived message.

If this state is entered from the ST_ITS5:Prepare_Data_Out state for transmission of a write DATA frame and first bust is enabled, then this state shall send a Transmit Frame (Non-Interlocked) request to the port layer after this state has received a Transmission Status (Frame Transmitted) confirmation and a Transmission Status (ACK Received) confirmation for the COMMAND frame.

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

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

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

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

If the confirmation is not Transmission Status (Frame Transmitted) or Transmission Status (I_T Nexus Loss) (see table 152 in 8.2.2.3.4), and the Transmit Frame request was for a COMMAND frame or a DATA frame, then this state shall send a Transmission Complete (Command Failed, Connection Failed) message to the ST_IFR state machine. The message shall include the tag.

If the confirmation is not Transmission Status (Frame Transmitted) or Transmission Status (I_T Nexus Loss) (see table 152 in 8.2.2.3.4), and the Transmit Frame request was for a TASK frame, then this state shall send a Transmission Complete (Task Failed, Connection Failed) message to the ST_IFR state machine. The message shall include the tag.

If the confirmation is Transmission Status (Frame Transmitted), and the Transmit Frame request was for a COMMAND frame not requesting a read operation, a COMMAND frame not requesting a write operation, a TASK frame, or a write DATA frame where the number of data bytes that have been transmitted equal the Data-Out Buffer Size state machine argument, 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).~~
e) Transmission Status (Timeout Before ACK/NAK);
f) Transmission Status (BREAK Before ACK/NAK);
g) Transmission Status (CLOSE Before ACK/NAK); or
h) Transmission Status (Phy Disable Before ACK/NAK),

If the confirmation is Transmission Status (Frame Transmitted), and the Transmit Frame request was for a COMMAND frame requesting a write operation, or a write DATA frame where the number of data bytes that have been transmitted is less than the Data-Out Buffer Size state machine argument and the write data length from the previous XFER_RDY frame, then this state shall wait to receive one of the following confirmations:

a) Transmission Status (ACK Received);
b) Transmission Status (NAK Received);
~~c) Transmission Status (ACK/NAK Timeout);~~
~~d) Transmission Status (Connection Lost Without ACK/NAK); or~~
e) Transmission Status (Timeout Before ACK/NAK);
f) Transmission Status (BREAK Before ACK/NAK);
g) Transmission Status (CLOSE Before ACK/NAK);
h) Transmission Status (Phy Disable Before ACK/NAK); or
i) XFER_RDY Arrived message.

If a XFER_RDY Arrived message is received, then the ST_ITS shall respond to the XFER_RDY frame as if a Transmission Status (ACK Received) was received.

NOTE 4 - If the number of data bytes requested to be transmitted for the Send SCSI Command 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)~~Transmission Status (Timeout Before ACK/NAK), Transmission Status (BREAK Before ACK/NAK), Transmission Status (CLOSE Before ACK/NAK), Transmission Status (Phy Disable Before ACK/NAK) confirmation for Transmit Frame requests for previous write DATA frames sent for the I_T_L_Q nexus.

After a Transmission Status (Frame Transmitted) is received, if a confirmation of Transmission Status (NAK Received) is received, the Transmit Frame request was for a COMMAND frame, and the vendor-specific number of retries has not been reached, then this state shall send a Transmit Frame (interlocked) request to the port layer (i.e., the last COMMAND frame is retransmitted).

After a Transmission Status (Frame Transmitted) is received, if a confirmation of Transmission Status (NAK Received) is received, the Transmit Frame request was for a TASK frame, and the vendor-specific number of retries has not been reached, then this state shall send a Transmit Frame (interlocked) request to the port layer (i.e., the last TASK frame is retransmitted).

Table 2 defines the messages that this state shall send to the ST_IFR state machine upon receipt of the listed

confirmations, based on the conditions under which each confirmation was received.

Table 2 — Messages sent to the ST_IFR state machine

Confirmation received from the port layer	Conditions under which confirmation was received	Message sent to ST_IFR state machine
~~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, ACK/NAK Timeout)~~
	~~The Transmit Frame request was for a TASK frame.~~	~~Transmission Complete (Task Failed, ACK/NAK Timeout)~~
Transmission Status (Timeout Before ACK/NAK)	The Transmit Frame request was for a COMMAND frame.	Transmission Complete (Command Failed, Timeout Caused ACK/NAK Timeout)
	The Transmit Frame request was for a TASK frame.	Transmission Complete (Task Failed, Timeout Caused ACK/NAK Timeout)
Transmission Status (BREAK Before ACK/NAK)	The Transmit Frame request was for a COMMAND frame.	Transmission Complete (Command Failed, BREAKCaused ACK/NAK Timeout)
	The Transmit Frame request was for a TASK frame.	Transmission Complete (Task Failed, BREAK Caused ACK/NAK Timeout)
Transmission Status (CLOSE Before ACK/NAK)	The Transmit Frame request was for a COMMAND frame.	Transmission Complete (Command Failed, CLOSE Caused ACK/NAK Timeout)
	The Transmit Frame request was for a TASK frame.	Transmission Complete (Task Failed, CLOSE Caused ACK/NAK Timeout)
Transmission Status (Phy Disable Before ACK/NAK)	The Transmit Frame request was for a COMMAND frame.	Transmission Complete (Command Failed, Phy Disable Caused ACK/NAK Timeout)
	The Transmit Frame request was for a TASK frame.	Transmission Complete (Task Failed, Phy Disable Caused ACK/NAK Timeout)

Table 2 — Messages sent to the ST_IFR state machine

Confirmation received from the port layer	Conditions under which confirmation was received	Message sent to ST_IFR state machine
Transmission Status (NAK Received)	The Transmit Frame request was for a COMMAND frame and the vendor-specific number of retries has been reached.	Transmission Complete (Command Failed, NAK Received)
	The Transmit Frame request was for a TASK frame and 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-Out Failed, NAK Received)
~~Transmission Status (ACK/NAK Timeout) or Transmission Status (Connection Lost Without ACK/NAK)~~		~~Transmission Complete (Data-Out Failed, ACK/NAK Timeout)~~
Transmission Status (Timeout Before ACK/NAK)		Transmission Complete (Data-Out Failed, Timeout Caused ACK/NAK Timeout)
Transmission Status (BREAK Before ACK/NAK)		Transmission Complete (Data-Out Failed, BREAKCaused ACK/NAK Timeout)
Transmission Status (CLOSE Before ACK/NAK)		Transmission Complete (Data-Out Failed, CLOSE Caused ACK/NAK Timeout)
Transmission Status (Phy Disable Before ACK/NAK)		Transmission Complete (Data-Out Failed, Phy Disable Caused ACK/NAK Timeout)

After this state sends a Transmission Complete (Command Failed, ACK/NAK Timeout) this state shall continue processing messages and confirmations.

NOTE 5 - The application client may determine the command was received and is being processed by the device server and allow the command to complete. The application client may accomplish this by the use of the QUERY TASK task management request.

If this state receives a Return to Start message or a Return to Start argument, 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.

If this state receives a Cancel message or a Cancel argument, 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 or a Cancel argument, 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.

NOTE 6 - 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 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 state machine argument as specified in table 3. If the verification fails, then this state sends the Transmission Complete message specified in table 3 to the ST_IFR state machine.

Table 3 — Transmission Complete messages for XFER_RDY frame verification failures

Message sent to ST_IFR [a]	Condition
Transmission Complete (XFER_RDY Incorrect Write Data Length)	The Write Data Length Xfer_Rdy state machine argument is zero.
	The Requested Offset Xfer_Rdy state machine argument plus the Write Data Length Xfer_Rdy state machine argument is greater than the Data-Out Buffer Size state machine argument.
Transmission Complete (XFER_RDY Requested Offset Error)	First burst is disabled, this is the first XFER_RDY frame for a command, and the value in the Requested Offset Xfer_Rdy state machine argument is not set to zero.
	First burst is enabled, this is the first XFER_RDY frame for a command, and the value in the Requested Offset Xfer_Rdy state machine argument is not equal to the value indicated by the FIRST BURST SIZE field in the Disconnect-Reconnect mode page (see 10.2.7.2.5).
	Transport layer retries are disabled and the Requested Offset Xfer_Rdy state machine argument is not equal to the Previous Requested Offset state machine variable plus the Previous Write Data Length Field state machine variable.
	Transport layer retries are enabled, the Retransmit Bit Xfer_Rdy state machine argument is set to zero, and the Requested Offset Xfer_Rdy state machine argument is not equal to the Previous Requested Offset state machine variable plus the Previous Write Data Length state machine variable.
	Transport layer retries are enabled, this is not the first XFER_RDY frame for the command, the Retransmit Bit Xfer_Rdy state machine argument is set to one, and the Requested Offset Xfer_Rdy state machine argument is not equal to the Previous Requested Offset state machine variable.

[a] If more than one condition is true, then this state shall send the Transmission Complete (XFER_RDY Incorrect Write Data Length) message to the ST_IFR state machine.

After this state verifies an XFER_RDY frame, it shall:

a) set the Data-Out Buffer Offset state machine variable to the Requested Offset Xfer_Rdy state machine argument;
b) set the Previous Requested Offset state machine variable to the Requested Offset Xfer_Rdy state machine argument; and

c) set the Previous Write Data Length state machine variable to the Requested Write Data Length Xfer_Rdy state machine argument.

9.2.6.2.3.3.1 Transition ST_ITS2:Initiator_Send_Frame to ST_ITS1:Initiator_Start

This transition shall occur after:

a) this state has sent one of the following to the ST_IFR state machine:
   A) a Transmission Complete (Command Failed, NAK Received) message;
   B) a Transmission Complete (Task Failed, ACK/NAK Timeout) message;
   C) a Transmission Complete (Task Failed, NAK Received) message;
   D) a Transmission Complete (Command Failed, ACK/NAK Timeout) message and the command was for a non-data operation;
   E) a Transmission Complete (Data-Out Failed, NAK Received) message;
   F) a Transmission Complete (Data-Out Failed, ACK/NAK Timeout) message;
   G) a Transmission Complete (XFER_RDY Incorrect Write Data Length) message;
   H) a Transmission Complete (XFER_RDY Requested Offset Error) message; or
   I) a Transmission Complete (Cancel Acknowledged) message;

or

b) this state has received a Return To Start message or Return To Start argument, and has received:
   A) confirmations for all Transmit Frame requests sent to the port layer; or
   B) a Transmission Status (Cancel Acknowledged) confirmation.

9.2.6.2.3.3.2 Transition ST_ITS2:Initiator_Send_Frame to ST_ITS5:Prepare_Data_Out

If first burst is enabled, this transition shall occur and include the First Burst argument after this state receives:

a) a Transmission Status (Frame Transmitted) confirmation followed by a Transmission Status (ACK Received) for a COMMAND frame requesting a write operation; or
b) a Transmission Status (Frame Transmitted) confirmation for a Transmit Frame (Non-interlocked) request if the Data-Out Buffer Offset state machine variable is less than the first burst size.

This transition shall occur after this state receives:

a) an XFER_RDY Arrived message; or
b) a Transmission Status (Frame Transmitted) confirmation for a Transmit Frame (Non-interlocked) request if the Data-Out Buffer Offset state machine variable is less than the Requested Offset Xfer_Rdy state machine argument plus the Write Data Length Xfer_Rdy state machine argument.

NOTE 7 - 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 or arguments 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);~~
   D) Transmission Status (Timeout Before ACK/NAK);
   E) Transmission Status (BREAK Before ACK/NAK);
   F) Transmission Status (CLOSE Before ACK/NAK); or
   G) Transmission Status (Phy Disable Before ACK/NAK),
b) the RETRY DATA FRAMES bit is set to one in the XFER_RDY frame for the write operation;
c) the Data-Out Buffer Offset state machine variable is set to the Requested Offset Xfer_Rdy state machine argument;
d) all write DATA frames that have received a Transmission Status (Frame Transmitted) confirmation have received a Transmission Status confirmation; and
e) the vendor-specific number of retries, if any, for the write DATA frame has not been reached.

9.2.6.2.3.3.3 Transition ST_ITS2:Initiator_Send_Frame to ST_ITS6:Process_Data_In

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

NOTE 8 - This transition occurs even if this state has not received a Transmission Status (ACK Received) for the COMMAND frame.

9.2.6.2.3.7 ST_ITS6:Receive_Data_In state

9.2.6.2.3.7.1 State description

If this state receives a Data-In Arrived message, then this state shall verify the values in the read DATA frame received with the message as defined in table 4.

If the verification fails, then this state sends the Reception Complete message specified in table 4 to the ST_IFR state machine.

Table 4 — Reception Complete messages for read DATA frame verification failures

Message sent to ST_IFR [a]	Condition
Reception Complete (Data Offset Error)	Transport layer retries are disabled, and the DATA OFFSET field in the read DATA frame is not equal to the Data-In Buffer Offset state machine variable.
	The DATA OFFSET field in the read DATA frame is greater than the Data-In Buffer Size state machine argument.
Reception Complete (Too Much Read Data)	The number of bytes in the DATA field in the read Data information unit plus the Data-In Buffer Offset state machine variable is greater than the Data-In Buffer Size state machine argument.
Reception Complete (Incorrect Data Length)	The number of bytes in the DATA field in the read Data information unit is zero.

[a] If more than one condition is true, then this state shall select which message to send to the ST_IFR state machine using the following order:
1) Reception Complete (Data Offset Error);
2) Reception Complete (Too Much Read Data); or
3) Reception Complete (Incorrect Data Length).

If:

a) transport layer retries are enabled;
b) the CHANGING DATA POINTER bit is set to zero;
c) the DATA OFFSET field is not set to the Data-In Buffer Offset state machine variable;
d) the DATA OFFSET field is less than the Data-In Buffer Size state machine argument; and
e) the DATA OFFSET field plus the number of bytes in the DATA field in the read Data information unit is less than or equal to the Data-In Buffer Size state machine argument,

then this state should discard all Data-In Arrived messages until a read DATA frame is received in which the CHANGING DATA POINTER bit is set to one. This state shall resume processing additional Data-In Arrived messages when it receives a Data-In Arrived message with the CHANGING DATA POINTER bit set to one.

Editor's Note 6: The above wording should parallel that for write DATA frames in ST_TTS5:Receive_Data_Out. Items d)e) are part of "verification"

If the read DATA frame verification is successful or after this state resumes processing Data-In Arrived messages, then this state shall process the data received in the read DATA frame and set the Data-In Buffer

Offset state machine variable to the DATA OFFSET field plus the number of bytes in the DATA field in the read Data information unit.

If data received in the read DATA frame overlaps data previously received and verified successfully, this state may either discard the overlapping data, or replace the previously received data with the new data.

If this state receives ~~Transmission Status (ACK/NAK Timeout) or Transmission Status (Connection Lost Without ACK/NAK)~~a Transmission Status (Timeout Before ACK/NAK), Transmission Status (BREAK Before ACK/NAK), Transmission Status (CLOSE Before ACK/NAK), Transmission Status (Phy Disable Before ACK/NAK) confirmation, then this state shall send a Reception Complete (Command Failed, Connection Failed) message to the ST_IFR state machine.

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

NOTE 9 - The application client may determine the command was received and is being processed by the device server and allow the command to complete.

If this state receives a Cancel message, 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.

NOTE 10 - 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.

9.2.6.2.3.7.2 Transition ST_ITS6:Receive_Data_In to ST_ITS1:Initiator_Start

This transition shall occur after this state:

a) sends one of the following to the ST_IFR state machine:
   A) a Reception Complete (Data Offset Error) message;
   B) a Reception Complete (Too Much Read Data) message;
   C) a Reception Complete (Incorrect Data Length) message; or
   D) a Reception Complete (Cancel Acknowledged) message;

   or

b) receives a Return To Start message.

9.2.6.2.3.7.3 Transition ST_ITS6:Receve_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 requesting a read operation.

9.2.6.3 ST_T (transport layer for SSP target ports) state machines

9.2.6.3.2 ST_TFR (target frame router) state machine

9.2.6.3.2.3 Processing transport protocol service requests and responses

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 an ST_TTS state machine that does not have an active task. The 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) source SAS address set to the SAS address of the SSP target port;
e) tag;
f) device server buffer;
g) request byte count; and

h) application client buffer offset.

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 an ST_TTS state machine that does not have an active task. The message shall include the following Data-Out state machine 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) source SAS address set to the SAS address of the SSP target port;
e) tag;
f) device server buffer;
g) request byte count;
h) application client buffer offset; and
i) target port transfer tag.

If first burst is enabled, then the Request (Receive Data_Out) message shall also include the Enable First Burst argument and First Burst Size argument. The First Burst Size argument shall be set to the first burst size from the Disconnect-Reconnect mode page (see 10.2.7.2.5).

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, then this state machine shall send a Request (Send Application Response) message to the ST_TTS state machine specified by the tag. The message shall include the following Application Response 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) source SAS address set to the SAS address of the SSP target port;
e) tag;
f) status;
g) sense data, if any; and
h) response fence.

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 the following to the ST_TTS state machine specified by the tag:

a) a Request (Send Transport Response) message with the Transport Response arguments;
b) the service response argument set as specified in table 5; and
c) the response fence argument set to the Task Management Function Executed protocol service response Response Fence argument.

Table 5 specifies which argument to send with Request (Send Transport Response) based on the Service Response argument that was received.

Table 5 — Task Management Function Executed Service Response argument mapping to Request (Send Transport Response) service response argument

Task Management Function Executed protocol service response Service Response argument received	Request (Send Transport Response) message service response argument
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:

1) discard the Terminate Data Transfer request and any corresponding Send Data-In or Receive Data-Out request; and
2) 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_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_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 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 6 defines

messages received from ST_TTS state machines and the corresponding service confirmations, if any, that shall be sent upon receipt of the message.

Table 6 — Confirmations sent to the SCSI application layer (part 1 of 2)

Message received from ST_TTS state machine	Protocol service confirmation sent to SCSI application layer
Transmission Complete (Xfer_Rdy Delivered)	None
Transmission Complete (Response Delivered)	None
Transmission Complete (Response Failed) [a]	None
Transmission Complete (Data Transfer Terminated)	Data Transfer Terminated
Transmission Complete (Data-In Delivered)	Data-In Delivered with the Delivery Result argument set to DELIVERY SUCCESSFUL
Transmission Complete (Xfer_Rdy Failed, NAK Received)	Data-Out Received with the Delivery Result argument set to DELIVERY FAILURE - NAK RECEIVED
~~Transmission Complete (Xfer_Rdy Failed, ACK/NAK Timeout)~~	~~Data-Out Received with the Delivery Result argument set to DELIVERY FAILURE - CONNECTION FAILED~~
~~Transmission Complete (Xfer_Rdy Failed, Connection Failed)~~	~~Data-Out Received with the Delivery Result argument set to DELIVERY FAILURE - CONNECTION FAILED~~
Transmission Complete (Xfer_Rdy Failed, Timeout Caused ACK/NAK Timeout)	Data-Out Received with the Delivery Result argument set to DELIVERY FAILURE - TIMEOUT CAUSED ACK/NAK TIMEOUT
Transmission Complete (Xfer_Rdy Failed, CLOSE Caused ACK/NAK Timeout)	Data-Out Received with the Delivery Result argument set to DELIVERY FAILURE - CLOSE CAUSED ACK/NAK TIMEOUT
Transmission Complete (Xfer_Rdy Failed, BREAK Caused ACK/NAK Timeout)	Data-Out Received with the Delivery Result argument set to DELIVERY FAILURE - BREAK CAUSED ACK/NAK TIMEOUT
Transmission Complete (Xfer_Rdy Failed, Phy Disable Caused ACK/NAK Timeout)	Data-Out Received with the Delivery Result argument set to DELIVERY FAILURE - PHY DISABLE CAUSED ACK/NAK TIMEOUT
Transmission Complete (Data-In Failed, NAK Received)	Data-In Delivered with the Delivery Result argument set to DELIVERY FAILURE - NAK RECEIVED
~~Transmission Complete (Data-In Failed, ACK/NAK Timeout)~~	~~Data-In Delivered with the Delivery Result argument set to DELIVERY FAILURE - CONNECTION FAILED~~
~~Transmission Complete (Data-In Failed, Connection Failed)~~	~~Data-In Delivered with the Delivery Result argument set to DELIVERY FAILURE - CONNECTION FAILED~~

[a] SAM-4 does not define a mechanism for the device server to determine the result of its Send Command Complete and Task Management Function Executed transport protocol service response calls.

Table 6 — Confirmations sent to the SCSI application layer (part 2 of 2)

Message received from ST_TTS state machine	Protocol service confirmation sent to SCSI application layer
Transmission Complete (Data-In Failed, Timeout Caused ACK/NAK Timeout)	Data-In Delivered with the Delivery Result argument set to DELIVERY FAILURE - TIMEOUT CAUSED ACK/NAK TIMEOUT
Transmission Complete (Data-In Failed, CLOSE Caused ACK/NAK Timeout)	Data-In Delivered with the Delivery Result argument set to DELIVERY FAILURE - CLOSE CAUSED ACK/NAK TIMEOUT
Transmission Complete (Data-In Failed, BREAK Caused ACK/NAK Timeout)	Data-In Delivered with the Delivery Result argument set to DELIVERY FAILURE - BREAK CAUSED ACK/NAK TIMEOUT
Transmission Complete (Data-In Failed, Phy Disable Caused ACK/NAK Timeout)	Data-In Delivered with the Delivery Result argument set to DELIVERY FAILURE - PHY DISABLE CAUSED ACK/NAK TIMEOUT
Reception Complete (Data-Out Received)	Data-Out Received with the Delivery Result argument set to DELIVERY SUCCESSFUL
Reception Complete (Data Offset Error)	Data-Out Received with the Delivery Result argument set to DELIVERY FAILURE - DATA OFFSET ERROR
Reception Complete (Too Much Write Data)	Data-Out Received with the Delivery Result argument set to DELIVERY FAILURE - TOO MUCH WRITE DATA
Reception Complete (Information Unit Too Short)	Data-Out Received with the Delivery Result argument set to DELIVERY FAILURE - INFORMATION UNIT TOO SHORT
Reception Complete (Initiator Response Timeout)	Data-Out Received with the Delivery Result argument set to DELIVERY FAILURE - INITIATOR RESPONSE TIMEOUT
Reception Complete (Data Transfer Terminated)	Data Transfer Terminated

[a] SAM-4 does not define a mechanism for the device server to determine the result of its Send Command Complete and Task Management Function Executed transport protocol service response calls.

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

9.2.6.3.3 ST_TTS (target transport server) state machine

9.2.6.3.3.3 ST_TTS2:Target_Send_Frame state

9.2.6.3.3.3.1 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_TTS6:Prepare_Response state for transmission of a RESPONSE frame, then this state shall send a Transmit Frame (Interlocked) request to the port layer.

All Transmit Frame requests from this state shall include the read 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_TTS6: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 argument;
d) Initiator Connection Tag argument;
e) Destination SAS Address argument; and
f) Source SAS Address argument.

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

If the confirmation or argument 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 or argument is not Transmission Status (Frame Transmitted) or Transmission Status (I_T Nexus Loss), then this state shall send the Transmission Complete message defined in table 7 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:

a) an XFER_RDY frame; or
b) a RESPONSE frame,

then this state shall wait to receive one of the following confirmations:

a) Transmission Status (ACK Received);
b) Transmission Status (NAK Received);
~~c) Transmission Status (ACK/NAK Timeout); or~~
~~d) Transmission Status (Connection Lost Without ACK/NAK).~~
e) Transmission Status (Timeout Before ACK/NAK);
f) Transmission Status (BREAK Before ACK/NAK);
g) Transmission Status (CLOSE Before ACK/NAK); or
h) Transmission Status (Phy Disable Before ACK/NAK).

If the confirmation is Transmission Status (Frame Transmitted) and the Transmit Frame request was for a read DATA frame, then this state shall:

a) increment the Read Data Frames Transmitted state machine variable by one; and
b) set the Read Data Offset state machine variable to the current Read Data Offset state machine variable plus the number of read data bytes transmitted in the DATA frame associated with the Transmission Status (Frame Transmitted) confirmation.

If the confirmation is Transmission Status (ACK Received) and the Transmit Frame request was for a read DATA frame, then this state shall increment the Read Data Frames ACKed state machine variable by one.

If the confirmation is Transmission Status (Frame Transmitted), the Transmit Frame request was for a read DATA frame, and the Read Data Offset state machine variable is equal to the Read Data Buffer End state machine variable, then this state shall wait to receive:

a) Transmission Status (ACK Received) confirmations or arguments for each outstanding read DATA frame (i.e., Read Data Frames Transmitted state machine variable equals the Read Data Frames ACKed state machine variable); or
b) one of the following:
   A) Transmission Status (NAK Received);
   ~~B) Transmission Status (ACK/NAK Timeout); or~~
   ~~C) Transmission Status (Connection Lost Without ACK/NAK).~~
   D) Transmission Status (Timeout Before ACK/NAK);

E) Transmission Status (BREAK Before ACK/NAK);
F) Transmission Status (CLOSE Before ACK/NAK); or
G) Transmission Status (Phy Disable Before ACK/NAK).

NOTE 11 - If the number of data bytes that have been transmitted for a Request (Send Data-In) message are fewer than the Request Byte Count Data-In state machine argument, 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)~~Transmission Status (Timeout Before ACK/NAK), Transmission Status (BREAK Before ACK/NAK), Transmission Status (CLOSE Before ACK/NAK), Transmission Status (Phy Disable Before ACK/NAK) confirmation.

When the Read Data Frames Transmitted state machine variable equals the Read Data Frames ACKed state machine variable and the Transmit Frame request was for a read DATA frame, this state shall:

a) not modify the Balance Point Read Data Offset state machine variable (i.e., the balance point remains at the last point at which balance occurred); or
b) set the Balance Point Read Data Offset state machine variable to the current Read Data Offset state machine variable.

If the Transmit Frame request was for a RESPONSE frame, the vendor-specific number of retries has not been reached, and this state receives one of the following confirmations:

a) Transmission Status (NAK Received);
~~b) Transmission Status (ACK/NAK Timeout); or~~
~~c) Transmission Status (Connection Lost Without ACK/NAK),~~
d) Transmission Status (Timeout Before ACK/NAK);
e) Transmission Status (BREAK Before ACK/NAK);
f) Transmission Status (CLOSE Before ACK/NAK); or
g) Transmission Status (Phy Disable Before ACK/NAK),

then this state shall:

a) set the RETRANSMIT bit to one;
b) set the other fields to the same values as contained in the failed RESPONSE frame; and
c) resend a Transmit Frame (Interlocked) request to the port layer for the failed RESPONSE frame.

If transport layer retries are enabled, the Transmit Frame request was for a XFER_RDY frame, the vendor-specific number of retries has not been reached, and this state receives one of the following confirmations:

a) Transmission Status (NAK Received);
~~b) Transmission Status (ACK/NAK Timeout); or~~
~~c) Transmission Status (Connection Lost Without ACK/NAK),~~
d) Transmission Status (Timeout Before ACK/NAK);
e) Transmission Status (BREAK Before ACK/NAK);
f) Transmission Status (CLOSE Before ACK/NAK); or
g) Transmission Status (Phy Disable Before ACK/NAK),

then this state shall:

a) set the RETRANSMIT bit to one;
b) set 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 state machine arguments and is 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;
c) set the other fields to the same values contained in the failed XFER_RDY frame; and
d) resend a Transmit Frame (Interlocked) request to the port layer for the failed XFER_RDY frame.

Table 7 defines messages that this state shall send to the ST_TFR state machine upon receipt of the listed confirmations and arguments, based on the conditions under which each confirmation or argument was received.

Table 7 — Messages sent to the ST_TFR state machine (part 1 of 3)

Confirmation received from the port layer or argument received from ST_TTS3:Prepare_Data_In	**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 a Target Port Transfer Tag argument
	Transmit Frame request was for a RESPONSE frame	Transmission Complete (Response Delivered)
	The Transmit Frame request was for a read DATA frame and: a) the Read Data Offset state machine variable is equal to the Read Data Buffer End state machine variable; and b) the Read Data Offset state machine variable is equal to the Balance Point Read Data Offset state machine variable.	Transmission Complete (Data-In Delivered)
Transmission Status (NAK Received), ~~Transmission Status (ACK/NAK Timeout), or Transmission Status (Connection Lost Without ACK/NAK)~~Transmission Status (Timeout Before ACK/NAK), Transmission Status (BREAK Before ACK/NAK), Transmission Status (CLOSE Before ACK/NAK), Transmission Status (Phy Disable Before ACK/NAK)	The Transmit Frame request was for a RESPONSE frame and the vendor-specific number of retries has been reached.	Transmission Complete (Response Failed)

Table 7 — Messages sent to the ST_TFR state machine (part 2 of 3)

Confirmation received from the port layer or argument received from ST_TTS3:Prepare_Data_In	Conditions under which confirmation was received	Message sent to the ST_TFR state machine
Transmission Status (NAK Received)	The Transmit Frame request was for an XFER_RDY frame and: a) if transport layer retries are disabled; or b) if transport layer retries are enabled and 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 (Timeout Before ACK/NAK)		Transmission Complete (Xfer_Rdy Failed, Timeout Caused ACK/NAK Timeout)
Transmission Status (CLOSE Before ACK/NAK)		Transmission Complete (Xfer_Rdy Failed, CLOSE Caused ACK/NAK Timeout)
Transmission Status (BREAK Before ACK/NAK)		Transmission Complete (Xfer_Rdy Failed, BREAK Caused ACK/NAK Timeout)
Transmission Status (Phy Disable Before ACK/NAK)		Transmission Complete (Xfer_Rdy Failed, Phy Disable Caused ACK/NAK Timeout)

Table 7 — Messages sent to the ST_TFR state machine (part 3 of 3)

Confirmation received from the port layer or argument received from ST_TTS3:Prepare_Data_In	Conditions under which confirmation was received	Message sent to the ST_TFR state machine
Transmission Status (NAK Received)	The Transmit Frame request was for a read DATA frame and: a) if transport layer retries are disabled; or b) if transport layer retries are enabled and the vendor-specific number of retries has been reached.	Transmission Complete (Data-In Failed, NAK Received)
~~Transmission Status (ACK/NAK Timeout) or Transmission Status (Connection Lost Without ACK/NAK)~~		~~Transmission Complete (Data-In Failed, Connection Failed)~~
Transmission Status (Timeout Before ACK/NAK)		Transmission Complete (Data-In Failed, Timeout Caused ACK/NAK Timeout)
Transmission Status (CLOSE Before ACK/NAK)		Transmission Complete (Data-In Failed, CLOSE Caused ACK/NAK Timeout)
Transmission Status (BREAK Before ACK/NAK)		Transmission Complete (Data-In Failed, BREAK Caused ACK/NAK Timeout)
Transmission Status (Phy Disable Before ACK/NAK)		Transmission Complete (Data-In Failed, Phy Disable Caused ACK/NAK Timeout)

Table 8 defines messages that this state shall send to the ST_TFR state machine upon receipt of the listed confirmations and arguments.

Table 8 — Additional messages sent to the ST_TFR state machine

Confirmation received from the port layer or argument received from ST_TTS3:Prepare_Data_In	Message sent to the ST_TFR state machine
Transmission Status (Bad Destination)	Transmission Complete (Connection Failed)
Transmission Status (Connection Rate Not Supported)	Transmission Complete (Connection Failed)
Transmission Status (Protocol Not Supported)	Transmission Complete (Connection Failed)
Transmission Status (Reserved Abandon 1)	Transmission Complete (Connection Failed)
Transmission Status (Reserved Abandon 2)	Transmission Complete (Connection Failed)
Transmission Status (Reserved Abandon 3)	Transmission Complete (Connection Failed)
Transmission Status (STP Resources Busy)	Transmission Complete (Connection Failed)
Transmission Status (Wrong Destination)	Transmission Complete (Connection Failed)
Transmission Status (Zone Violation)	Transmission Complete (Connection Failed)
Transmission Status (Break Received)	Transmission Complete (Data Transfer Terminated)

If this state receives a Cancel message or a Cancel argument and this state has received confirmations for all Transmit Frame requests sent to the port layer, then this state shall send a Transmission Complete (Data Transfer Terminated) message to the ST_TFR state machine.

If this state receives a Cancel message or a Cancel argument 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 or argument this state shall send a Transmission Complete (Data Transfer Terminated) 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.

9.2.6.3.3.3.2 Transition ST_TTS2:Target_Send_Frame to ST_TTS1:Target_Start

This transition shall occur after this state sends a Transmission Complete message other than Transmission Complete (Xfer_Rdy Delivered) to the ST_TFR state machine.

9.2.6.3.3.3.3 Transition ST_TTS2:Target_Send_Frame to ST_TTS3:Prepare_Data_In

This transition shall occur after this state receives a Transmission Status (Frame Transmitted) confirmation for a read DATA frame if the Read Data Offset state machine variable is less than the Read Data Buffer End state machine variable (i.e., there is more read data to transfer).

If transport layer retries are enabled and the vendor-specific number of retries, if any, for the read DATA frame has not been reached, this transition shall occur and include a Retry argument after this state receives one of the following confirmations 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).~~
d) Transmission Status (Timeout Before ACK/NAK);
e) Transmission Status (BREAK Before ACK/NAK);
f) Transmission Status (CLOSE Before ACK/NAK); or
g) Transmission Status (Phy Disable Before ACK/NAK),

9.2.6.3.3.3.4 Transition ST_TTS2:Target_Send_Frame to ST_TTS5:Receive_Data_Out

This transition shall occur after this state sends a Transmission Complete (Xfer_Rdy Delivered) message to the ST_TFR state machine.

10.2 SCSI application layer

10.2.2 Application client error handling

If an SSP initiator port calls Command Complete Received () with a Service Response of:

a) Service Delivery or Target Failure - XFER_RDY Information Unit Too Short;
b) Service Delivery or Target Failure - XFER_RDY Information Unit Too Long;
c) Service Delivery or Target Failure - XFER_RDY Incorrect Write Data Length;
d) Service Delivery or Target Failure - XFER_RDY Requested Offset Error;
e) Service Delivery or Target Failure - XFER_RDY Not Expected;
f) Service Delivery or Target Failure - DATA Information Unit Too Short;
g) Service Delivery or Target Failure - DATA Too Much Read Data;
h) Service Delivery or Target Failure - DATA Data Offset Error;
i) Service Delivery or Target Failure - DATA Not Expected;
j) Service Delivery or Target Failure - NAK Received,

then the application client shall abort the command (e.g., by sending an ABORT TASK task management function).

After an application client calls Send SCSI Command (), if Command Complete Received () returns a Service Response of:

a) Service Delivery or Target Failure - Timeout Caused ACK/NAK Timeout~~,~~ ;
b) Service Delivery or Target Failure - BREAK Caused ACK/NAK Timeout;
c) Service Delivery or Target Failure - CLOSE Caused ACK/NAK Timeout; or
d) Service Delivery or Target Failure - Phy Disable Caused ACK/NAK Timeout;

the application client shall send a QUERY TASK task management function with Send Task Management Request () to determine whether the command was received successfully. If Received Task Management Function Executed () returns a Service Response of FUNCTION SUCCEEDED, the application client shall assume the command was delivered successfully. If Received Task Management Function Executed () returns a Service Response of FUNCTION COMPLETE, and Command Complete Received () has not yet been invoked a second time for the command in question (e.g., indicating a RESPONSE frame arrived for the command before the QUERY TASK was processed), the application client shall assume the command was not delivered successfully and may reuse the tag. The application client should call Send SCSI Command () again with identical arguments.

After a Received Task Management Function Executed () call with a Service Response of Service Delivery or Target Failure - ACK/NAK Timeout, an application client should call Send Task Management Request () with identical arguments, including the same tag.

After a Command Complete Received () or Received Task Management Function Executed () call returns a Service Response other than:

a) Service Delivery or Target Failure - Timeout Caused ACK/NAK Timeout~~,~~ ;
b) Service Delivery or Target Failure - BREAK Caused ACK/NAK Timeout;
c) Service Delivery or Target Failure - CLOSE Caused ACK/NAK Timeout; or
d) Service Delivery or Target Failure - Phy Disable Caused ACK/NAK Timeout;

~~an~~the application client shall not reuse the tag until it determines the tag is no longer in use by the logical unit (e.g., the ACK for the RESPONSE frame was seen by the SSP target port). Examples of ways the application client may determine that a tag may be used are:

a) receiving another frame in the same connection;
b) receiving a DONE (NORMAL) or DONE (CREDIT TIMEOUT) in the same connection; or
c) receiving a DONE (ACK/NAK TIMEOUT) in the same connection, then running a QUERY TASK task management function to confirm that the tag is no longer active in the logical unit.

10.2.3 Device server error handling

If the SCSI target device performs tag checking and an SSP target port calls SCSI Command Received () with a tag already in use by another SCSI command (i.e., an overlapped command) in any logical unit, the task router and device server(s) shall abort all task management functions received on that I_T nexus and shall respond to the overlapped command as defined in SAM-4.

If an SSP target port calls Data-Out Received () with a Delivery Result set to a value in table 9, the device server shall terminate the command with CHECK CONDITION status with the sense key set to ABORTED COMMAND and the additional sense code set as indicated in table 9.

Table 9 — Delivery Result to additional sense code mapping

Delivery Result	Additional sense code
DELIVERY FAILURE - DATA OFFSET ERROR	DATA OFFSET ERROR
DELIVERY FAILURE - TOO MUCH WRITE DATA	TOO MUCH WRITE DATA
DELIVERY FAILURE - INFORMATION UNIT TOO SHORT	INFORMATION UNIT TOO SHORT
~~DELIVERY FAILURE - ACK/NAK TIMEOUT~~	~~ACK/NAK TIMEOUT~~
DELIVERY FAILURE - TIMEOUT CAUSED ACK/NAK TIMEOUT	ACK/NAK TIMEOUT or TIMEOUT CAUSED ACK/NAK TIMEOUT
DELIVERY FAILURE - CLOSE CAUSED ACK/NAK TIMEOUT	ACK/NAK TIMEOUT or CLOSE CAUSED ACK/NAK TIMEOUT
DELIVERY FAILURE - BREAK CAUSED ACK/NAK TIMEOUT	ACK/NAK TIMEOUT or BREAK CAUSED ACK/NAK TIMEOUT
DELIVERY FAILURE - PHY DISABLE CAUSED ACK/NAK TIMEOUT	ACK/NAK TIMEOUT or PHY DISABLE CAUSED ACK/NAK TIMEOUT
DELIVERY FAILURE - NAK RECEIVED	NAK RECEIVED
DELIVERY FAILURE - INITIATOR RESPONSE TIMEOUT	INITIATOR RESPONSE TIMEOUT

Suggested changes to SPC-4

In the additional sense code assignments:

4Bh 00h DATA PHASE ERROR
4Bh 01h INVALID TARGET PORT TRANSFER TAG RECEIVED
4Bh 02h TOO MUCH WRITE DATA

4Bh 03h ACK/NAK TIMEOUT
4Bh 04h NAK RECEIVED
4Bh 05h DATA OFFSET ERROR
4Bh 06h INITIATOR RESPONSE TIMEOUT
4Bh 07h TIMEOUT CAUSED ACK/NAK TIMEOUT
4Bh 08h CLOSE CAUSED ACK/NAK TIMEOUT
4Bh 08h BREAK CAUSED ACK/NAK TIMEOUT
4Bh 09h PHY DISABLE CAUSED ACK/NAK TIMEOUT