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To: Serial Attached SCSI Protocol Working Group
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Date: 17 June 2002

Subject: SSP transport layer state machines, rev 0

Introduction

This is the first attempt at including all SSP transport layer functions into one set of state machines for initiators and one for targets. In this revision, only the SCSI initiator device elements are included. There are two reasons for this: first, so that these may be reviewed as soon as possible, and, second, though the SCSI target device elements are already under construction, it is expected that review and revision of the SCSI initiator device elements will result in significant modification to the SCSI target device elements.

9.2.7 SSP transport layer state machines

9.2.7.1 Overview

The SSP transport layer contains several state machines that process service requests from the ULP and return service responses to the ULP. These state machines reside in the SCSI initiator device and the SCSI target device. The SSP transport state machines are as follows:

- a) Application client manager (ACM state machine)
- b) Application client (AC state machine)
- c) Task router (TR state machine)
- d) Task manager (TM state machine)
- e) Device server (DS state machine)

9.2.7.2 Initiator device state machines

9.2.7.2.1 Initiator device state machine overview

The initiator device processes service requests from the ULP. These service requests may be tasks (i.e., commands or linked commands) or task management functions. The application client manager receives service requests from the ULP and creates an application client for each request. The application client manager may also receive service requests from the ULP after an application client has been created (e.g., an Abort Task task management function) and use these to further manage the application client. The application client manager also communicates with the port layer state machine to specify when resources are available so that connections may be accepted or rejected.

The application client manager contains the ST_ACM:Application_Client_Manager state.

Once created, the application client:

- a) generates an SAS frame containing a device service request or device task management request and informs the port layer state machine that there is an interlocked frame to transmit to a SCSI target device;
- b) creates any SAS data frames associated with the request and informs the port layer state machine that there are one or more interlocked or non-interlocked frames to transmit to a SCSI target device;
- c) receives and processes any SAS frames from the port layer state machine from the SCSI target device;
- d) receives and processes any transmission information received from the port layer state machine (e.g., retrying an SAS data frame for which a NAK had been received); and,
- e) provides a response to the ULP and the application client manager when the task or function is complete.

The application client state machine contains the following states:

- a) ST_AC0:Send state,
- b) ST_AC1:Prepare_Send_Data state,
- c) ST_AC2:Receive state,
- d) ST_AC3:Process_Receive_Data state, and
- e) ST_AC4:Process_Response state.

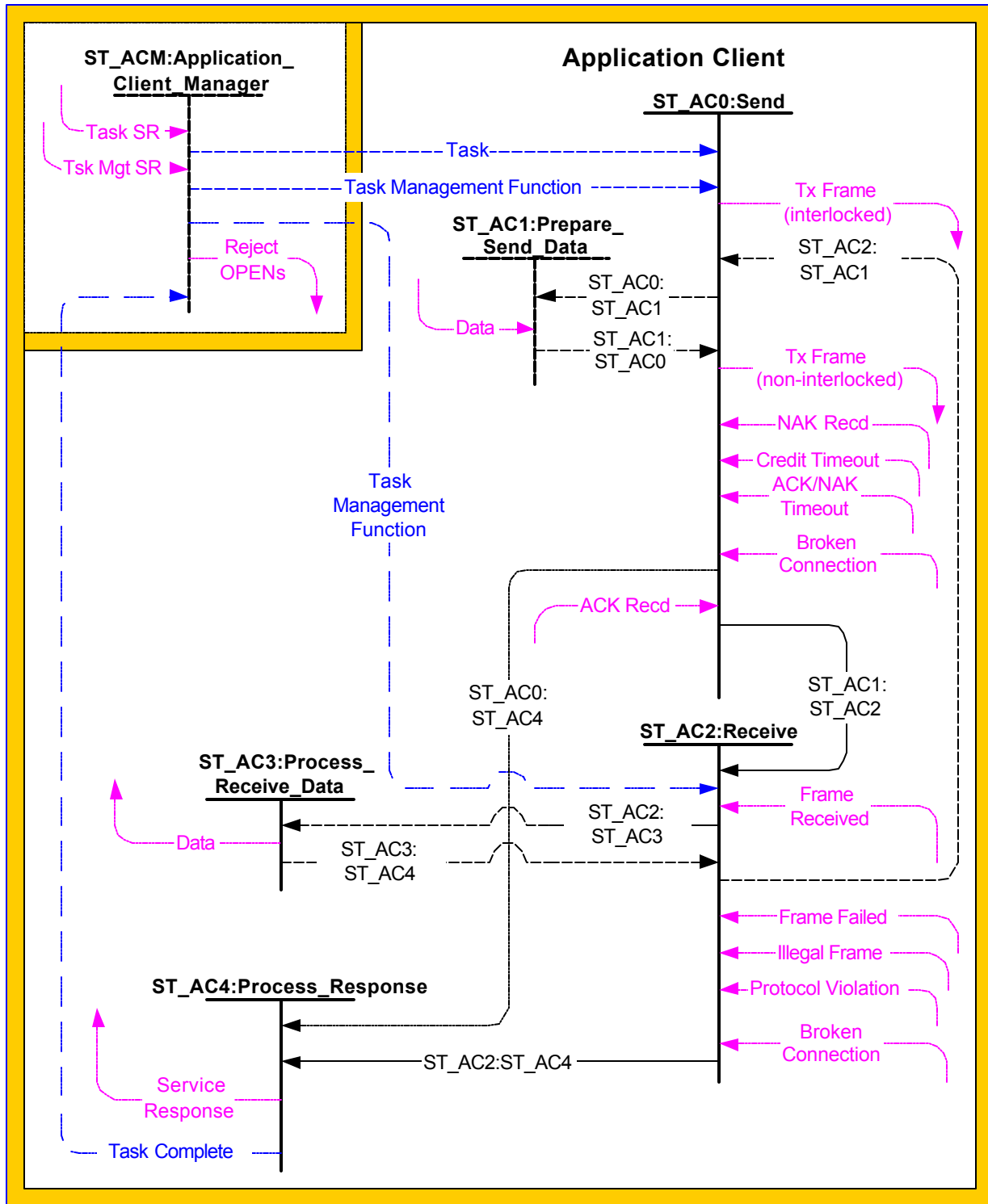


Figure 1. SSP initiator device state machine

9.2.7.2.2 ST_ACM:Application_Client_Manager state

9.2.7.2.2.1 ST_ACM:Application_Client_Manager state description

The application client manager state machine receives service requests for tasks or task management functions from the ULP. A request for a task or task management function from the ULP shall consist of the target identifier (i.e., WWN), LUN, CDB, and task attribute. An application client is created to process the task or task management function.

When creating an application client the application client manager state machine shall pass one of two possible sets of parameters to the ST_AC0:Send state:

- a) A request for a task to be processed (either a non-linked or linked command), or.
- b) A request for a task management function to be processed.

For either type of request the sets of parameters passed to the AT_AC0:Send state shall include the HASHED DESTINATION DEVICE NAME, CMD_ID, tag, LUN, CDB, and task attribute.

[Editor's note: the port state machine has to be responsible for generating outgoing and checking incoming HASHED SOURCE DEVICE NAMES as the transport layer does not specify which port is to be used for the transfer.]

The application client manager state shall inform the port state machine as to whether it may accept an attempt to open a connection by a target port or shall reject an attempt to open a connection by a target port based on initiator resources available.

The application client manager state machine may be informed by the ULP that a process is to be halted or aborted. The application client manager state machine shall then pass this information to the ST_AC0:Send and ST_AC2:Receive machines.

The application client manager state machine shall be informed by the ST_AC4:Process_Response state when a service response has been sent to the ULP completing the task or task management function.

9.2.7.2.3 ST_AC0:Send state

9.2.7.2.3.1 ST_AC0:Send state description

This ST_AC0:Send state is initiated when a task or task management function received from the application client manager. All frames to be sent to the SCSI target port shall be constructed in the ST_AC0:Send state. After frames are constructed, the ST_AC0:Send state shall pass them to the port layer state machine for transmission. Along with the frame, the ST_AC0:Send state shall inform the port layer state machine if the frame is interlocked or not.

The ST_AC0:Send state shall notify the ST_AC2:Receive state that a task or task management function requiring received frames has been transmitted to the SCSI target device.

The ST_AC0:Send state shall be notified by the ST_AC2:Receive state when an XFER_RDY has been received allowing for data transfer.

The ST_AC0:Send state shall be notified by the port layer state machine whenever an ACK is received for a transmitted frame or any connection error is detected. These errors include:

- a) a NAK is received for a transmitted frame,
- b) an ACK/NAK timeout has occurred and the connection has been terminated,
- c) a Credit timeout has occurred and the connection has been terminated, or,
- d) the connection is broken.

The ST_AC0:Send state shall process any received error or task management function for the task received from the application client manager. This processing may include:

- a) instructing the port layer state machine to retransmit a frame, or,

- b) informing the ST_AC4:Process_Response state that a task is complete either because all frames for a task or task management function have been transmitted successfully, or an error or task management function has caused the task to be completed unsuccessfully.

9.2.7.2.3.2 Transition ST_AC0:ST_AC1 (Send:Prepare_Send_Data)

The ST_AC0:ST_AC1 transition shall occur whenever the ST_AC0 state requires data to include in a frame. This may be a zero-time state.

9.2.7.2.3.3 Transition ST_AC0:ST_AC2 (Send:Receive)

The ST_AC0:ST_AC2 transition shall occur whenever the ST_AC0 has passed all frames to be transmitted to the SCSI target port to the port layer state machine and a response is required from the SCSI target port to continue processing. There are several cases where this may occur:

- a) After passing a frame containing a COMMAND information unit requesting data from the SCSI target device;
- b) After passing a frame containing a COMMAND information unit requesting data to be sent to the SCSI target device when an XFER_RDY information unit is required to transfer the data;
- c) After passing a frame containing a TASK information unit requiring a RESPONSE information from the SCSI target device before further processing; or,
- d) After all data for a task or task management function has been transferred and a RESPONSE information unit is required for further processing.

9.2.7.2.3.4 Transition ST_AC0:ST_AC4 (Send:Process_Response)

The ST_AC0:ST_AC4 transition shall occur whenever the ST_AC0 state has completed processing a task in error and has information to be communicated by the ST_AC4 state to the ULP and the application client manager.

9.2.7.2.4 ST_AC1:Prepare_Send_Data state

9.2.7.2.4.1 ST_AC1:Prepare_Send_Data state description

In the ST_AC1:Prepare_Send_Data state the data required for inclusion in an SAS frame to be transmitted to the SCSI target port is prepared.

9.2.7.2.4.2 Transition ST_AC1:ST_AC0 (Prepare_Send_Data:Send)

The ST_AC0:ST_AC4 transition shall occur when data is available to be included in a frame for transmission.

9.2.7.2.5 ST_AC2:Receive state

9.2.7.2.5.1 ST_AC2:Receive state description

The ST_AC2:Receive state receives all frames from the SCSI target device passed from the port layer state machine and process the content of these frames.

The ST_AC2:Receive state shall be notified by the port layer state machine whenever an error occurs during receipt of a frame. These errors include:

- a) a frame failed,
- b) it was an illegal frame,
- c) there was a protocol violation, or,
- d) the connection is broken.

The ST_AC2:Receive state shall process any received error or task management function for the task received from the application client manager. This processing may include informing the

ST_AC4:Process_Response state that a task is complete either because all frames for a task or task management function have been transmitted successfully, or an error or task management function has caused the task to be completed unsuccessfully.

9.2.7.2.5.2 Transition ST_AC2:ST_AC3 (Receive:Process_Receive_Data)

The ST_AC2:ST_AC3 transition shall occur whenever the ST_AC2 state has received a frame with data that requires processing. This may be a zero-time state.

9.2.7.2.5.3 Transition ST_AC2:ST_AC4 (Receive:Process_Response)

The ST_AC2:ST_AC4 transition shall occur whenever the ST_AC2 state has completed processing a task (either with or without error) and has information to be communicated by the ST_AC4 state to the ULP and the application client manager.

9.2.7.2.6 ST_AC3:Process_Receive_Data state

9.2.7.2.6.1 ST_AC3:Process_Receive_Data state description

In the ST_AC3:Process_Receive_Data state data from a received SAS frame is processed. This may be a zero time state.

9.2.7.2.6.2 Transition ST_AC3:ST_AC2 (Process_Receive_Data:Receive)

The ST_AC3:ST_AC2 transition shall occur after the data from a received SAS frame has been processed.

9.2.7.2.7 ST_AC3:Process_Response_Data state

9.2.7.2.7.1 ST_AC3:Process_Response_Data state description

In the ST_AC3:Process_Response_Data state service response data is passed to the ULP and the application client manager is notified that the task or task management function is complete.