To: T10 SAS Protocol Working Group

From: Brian Day

Subject: SAS 2.0 : 08-216 Retry to Open Limit timer fix

Revision History

Revision 0 - Initial draft

Related Documents

sas2r14 - Serial Attached SCSI - 2 Draft revision 14

08-093r0 - Results of letter ballot on forwarding SAS-2 to first public review

Overview

This proposal addresses LSI comment 488. I believe the intention is that a Retry Open is converted into a pending Tx Open after the Retry to Open Limit timer expires (see Editor Note 1 below). However, the state machine details create the timer once the pending Tx Open has already been created. Since there is currently a rule that there are only as many pending Tx Opens as PL_PM state machines, this will not allow other OPEN frames to be sent to other devices while the timer is running.

Since there is already a statement that indicates that the "oldest" pending Tx Open should be converted to a Tx Open message when there are multiple pending Tx Opens (see Editor Note 3 below), there does not seem to be a clear reason on why there can not be more pending Tx Opens than PL_PM state machines. By allowing many pending Tx Opens, it allows each of them to exist with their own independent Retry to Open timer, and allow new Tx Opens messages to occur to other devices.

Conceptually, this proposal changes the pending Tx Opens from being a one-per-logical-phy structure to a (at most) one-per-destination-address structure.

Proposed Changes

8.2 PL (port layer) state machines

8.2.1 PL state machines overview

The PL (port layer) consists of state machines that run in parallel and perform the following functions:

- a) receive requests from the SSP, SMP, and STP transport layer state machines for connection management (e.g., requests to open or close connections) and frame transmission;
- b) send requests to the SAS link layer state machines for connection management and frame transmission;
- c) receive confirmation from the SAS link layer state machines; and
- d) send confirmations to the SSP, SMP, and STP transport layer state machines.

The port layer state machines are as follows:

- a) PL_OC (port layer overall control) state machines (see 8.2.2); and
- b) PL_PM (port layer phy manager) state machines (see 8.2.3).

There is one PL_OC state machine per port (see 4.1.4). There is one PL_PM state machine for each phy contained in the port. Phys are assigned to ports by the management application layer. More than one port in a SAS device may have the same SAS address.

Figure 118 shows examples of the port layer state machines and their interaction with the transport and link layers.
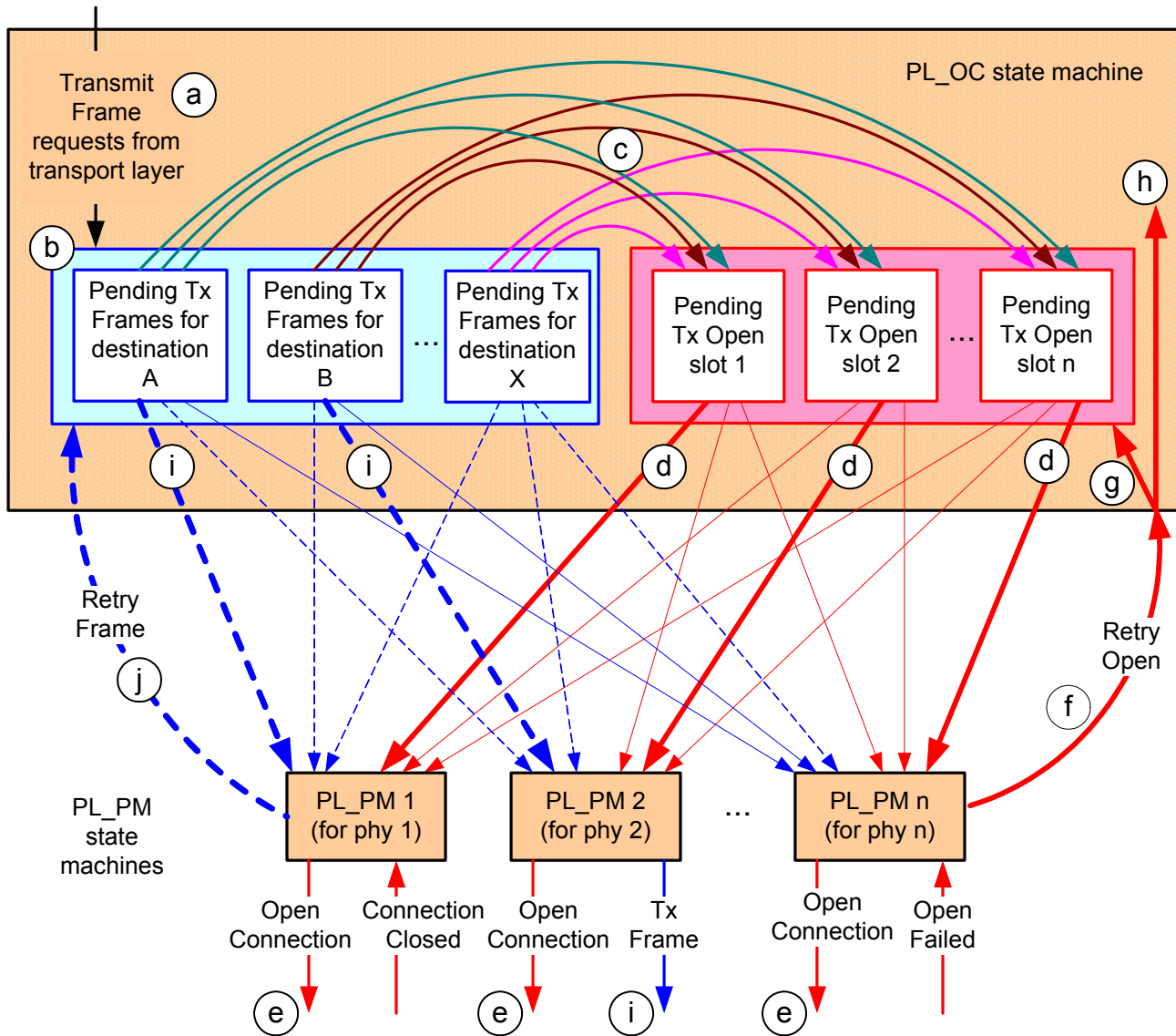

Figure 118 — Port layer examples

The following is a description of the example processes in figure 118. These example processes do not describe all of the possible condition or actions.

a) Transmit Frame requests are received by the PL_OC state machine;

b) the PL_OC state machine converts Transmit Frame requests into pending Tx Frame messages associated with the destination SAS address;

c) the PL_OC state machine generates a pending Tx Open message for a pending Tx Frame message when there is a pending Tx Open slot available (i.e., the number of pending Tx Open messages is less than or equal to the number of ~~phys~~ destination addresses);

d) the PL_OC state machine sends a pending Tx Open message as a Tx Open message to a PL_PM state machine when a PL_PM machine is available; a slot is then available for a new pending Tx Open message;

e) when a PL_PM state machine receives a Tx Open message, the PL_PM state machine attempts to establish a connection with the destination SAS address through the link layer;

f) if a PL_PM state machine is unable to establish a connection with the destination SAS address, then the PL_PM state machine sends a Retry Open message to the PL_OC state machine;

g) ~~after the Reject To Open Limit timer, if any, has expired, and~~ if there is a pending Tx Open slot available, then the PL_OC state machine converts a Retry Open message to a pending Tx Open message with the pathway blocked count and arbitration wait time context from the Retry Open message applied to the pending Tx Open message, <u>and may start the Reject to Open Limit timer</u>;

Editor's Note 1: The original wording above indicates the intention of the Retry Open being converted to a pending Tx Open after the timer expires.

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h) if the PL_OC state machine does not convert a Retry Open to a pending Tx Open frame, then the PL_OC discards the Retry Open message. The PL_OC state machine may create a new Tx Open message for the same pending Tx Frame at a later time. If the PL_OC state machine discards a Retry Open message, then the pathway blocked count and arbitration wait time context from the Retry Open message are also discarded;

i) <u>after the Reject To Open Limit timer, if any, has expired, and</u> after a PL_PM state machine establishes a connection with a destination SAS address, the PL_OC state machine sends pending Tx Frame messages for the destination to the PL_PM state machine as Tx Frame messages;

j) if a PL_PM state machine is unable to send a Tx Frame message to the link layer as a Tx Frame request (e.g., due to a credit timeout), then the PL_PM state machine sends a Retry Frame message to the PL_OC state machine, and the PL_OC state machine converts the Retry Frame message into a pending Tx Frame message; and

k) if the PL_PM state machine is able to send a Tx Frame message as a Tx Frame request to the link layer, then the PL_PM state machine sends a Transmission Status confirmation to the transport layer.

The Transmission Status confirmation from either the PL_OC state machine or a PL_PM state machine shall include the following as arguments:

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

8.2.2 PL_OC (port layer overall control) state machine

8.2.2.1 PL_OC state machine overview

A PL_OC state machine:

a) receives requests from the SSP, SMP, and STP transport layers;
b) sends messages to the PL_PM state machine;
c) receives messages from the PL_PM state machine;
d) selects frames to transmit;
e) selects phys on which to transmit frames;
f) receives confirmations from the link layer;
g) sends confirmations to the transport layer;
h) has Arbitration Wait Time timers;
i) has I_T Nexus Loss timers; and
j) may have Reject To Open Limit timers.

This state machine consists of the following states:

a) PL_OC1:Idle (see 8.2.2.2) (initial state); and
b) PL_OC2:Overall_Control (see 8.2.2.3).

After power on this state machine shall start in the PL_OC1:Idle state.

The PL_OC state machine shall maintain:

a) a pool of pending Tx Frame messages for each destination SAS address; and
b) ~~as many~~ <u>a pool of</u> pending Tx Open message slots ~~as there are phys in the port~~.

There shall only be at most a single pending Tx Open message slot for each destination SAS address. There may be fewer total pending Tx Open message slots than the total number of destination SAS addresses.

Editor's Note 2: I don't particularly like how I said this. Point is only a single pending Tx Open is allowed per address at any one point in time, but there may a smaller overall pool of slots.

The PL_OC state machine shall maintain the timers listed in table 67.

Table 67 — PL_OC state machine timers

| Timer	Maximum number of timers	Initial value
I_T Nexus Loss timer	One per destination SAS address	Depending on the protocol used by the port: a) for SSP target ports, the value in the I_T NEXUS LOSS TIME field in the Protocol-Specific Port mode page (see 10.2.7.4); b) for SSP initiator ports, the value in the I_T NEXUS LOSS TIME field in the Protocol-Specific Port mode page for the SSP target port with that destination SAS address (see 10.2.7.4); c) for STP target ports, the value in the STP SMP I_T NEXUS LOSS TIME field in the SMP CONFIGURE GENERAL function (see 10.4.3.18); d) for STP initiator ports, the value in the STP SMP I_T NEXUS LOSS TIME field in the SMP REPORT GENERAL function (see 10.4.3.4) for the STP target port with that destination SAS address; or e) for SMP initiator ports, the value in the STP SMP I_T NEXUS LOSS TIME field in the SMP REPORT GENERAL function (see 10.4.3.4).
Arbitration Wait Time timer	One per pending Tx Open message	0000h, a vendor-specific value less than 8000h (see 7.12.3), or the value received with a Retry Open message.
Reject To Open Limit timer	One per Retry Open message	Depending on the protocol used by the port: a) for SSP target ports, the value in the REJECT TO OPEN LIMIT field in the Protocol-Specific Port mode page (see 10.2.7.4); b) for SSP initiator ports, a vendor specific value; c) for STP target ports, the value in the STP REJECT TO OPEN LIMIT field in the SMP CONFIGURE GENERAL function (see 10.4.3.18); or d) for STP initiator ports, a vendor specific value.

Figure 119 shows the PL_OC state machine.
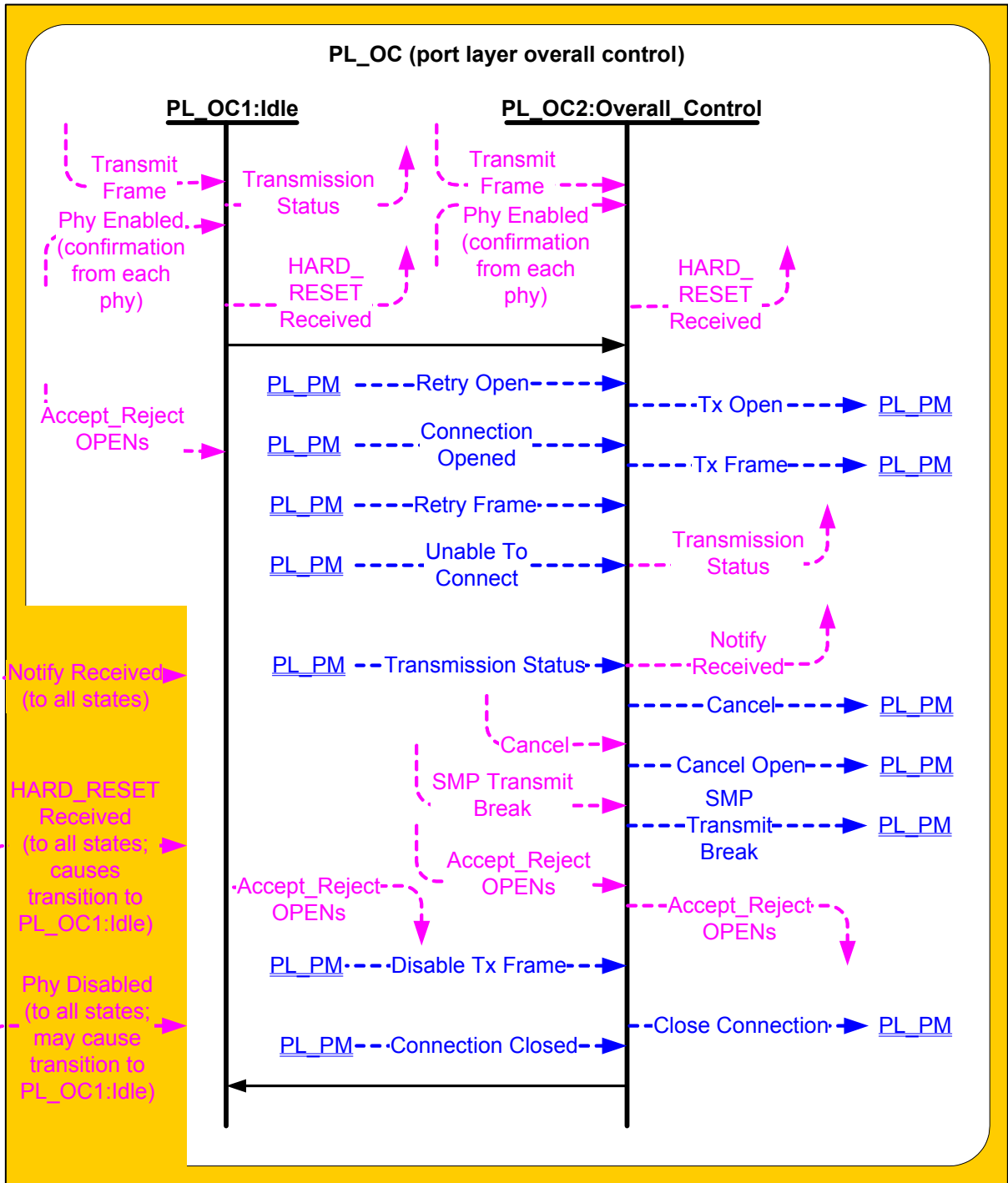
Figure 119 — PL_OC (port layer overall control) state machine

8.2.2.2 PL_OC1:Idle state

8.2.2.2.1 PL_OC1:Idle state description

This state is the initial state of the PL_OC state machine.

If this state receives a HARD_RESET Received confirmation, then this state shall send a HARD_RESET Received confirmation to the transport layer.

If this state receives a Notify Received (Power Loss Expected) confirmation, then this state shall send a Notify Received (Power Loss Expected) confirmation to the transport layer.

If this state receives an Accept_Reject Opens request, then this state shall send an Accept_Reject Opens request to all link layers in the port.

If this state receives a Transmit Frame request, then this state shall send a Transmission Status (No Phys In Port) confirmation to the transport layer.

If an I_T Nexus Loss timer expires for a destination SAS address, this state shall perform the following:

a)   delete the I_T Nexus Loss timer for the SAS address;
b)   send a Transmission Status (I_T Nexus Loss) confirmation for each pending Tx Frame message for the SAS address; and
c)   discard each pending Tx Frame message for the SAS address and any corresponding pending Tx Open messages.

If the port is an STP target port or an STP initiator port, the port shall handle all pending commands as described in 4.5.

8.2.2.2.2 Transition PL_OC1:Idle to PL_OC2:Overall_Control

This transition shall occur after a Phy Enabled confirmation is received for at least one phy assigned to the port.

8.2.2.3 PL_OC2:Overall_Control state

8.2.2.3.1 PL_OC2:Overall_Control state overview

This state may receive Transmit Frame requests from the transport layers (i.e., SSP and SMP) and Retry frame messages from PL_PM state machines. This state shall create a pending Tx Frame message for each received Transmit Frame request and Retry Frame message. There may be more than one pending Tx Frame message at a time for each SSP transport layer. There shall be only one pending Tx Frame message at a time for each SMP transport layer.

This state selects PL_PM state machines through which connections are established. This state shall only attempt to establish connections through PL_PM state machines whose phys are enabled. In a vendor-specific manner, this state selects PL_PM state machines on which connections are established to transmit frames. This state shall receive a response to a message from a PL_PM state machine before sending another message to that PL_PM state machine.

This state also:

a)   receives connection management requests from the transport layers;
b)   sends connection management messages to PL_PM state machines;
c)   receives connection management messages from PL_PM state machines; and
d)   sends connection management confirmations to the transport layers.

After receiving a Transmit Frame request for a destination SAS address for which there is no connection established and for which no I_T Nexus Loss timer has been created, this state shall create an I_T Nexus Loss timer for that SAS address if:

a)   the protocol is SSP, the port is an SSP target port, the Protocol-Specific Port mode page is implemented, and the I_T NEXUS LOSS TIME field in the Protocol-Specific Port mode page (see 10.2.7.4) is not set to 0000h;
b)   the protocol is STP, the port is an STP target port, and the STP SMP I_T NEXUS LOSS TIME field in the SMP CONFIGURE GENERAL function is not set to 0000h; or
c)   the protocol is SMP, the port is an SMP initiator port, and the STP SMP I_T NEXUS LOSS TIME field in the SMP CONFIGURE GENERAL function is not set to 0000h.

This state may create an I_T Nexus Loss timer for that SAS address if:

a)   the protocol is SSP and the port is an SSP initiator port; or;
b)   the protocol is STP and the port is an STP initiator port.

When this state creates an I_T Nexus Loss timer it shall:

1) initialize the I_T Nexus Loss timer as specified in table 67 (see 8.2.2.1); and
2) not start the I_T Nexus Loss timer.

If this state machine is in an SSP initiator port, then this state may create an I_T Nexus Loss timer for the SAS address. If a state machine in an SSP initiator port and creates an I_T Nexus Loss timer, then the state machine should use the value in the I_T NEXUS LOSS TIME field in the Protocol-Specific Port mode page for the SSP target port (see 10.2.7.4) as the initial value for its I_T Nexus Loss timer.

If there are no pending Tx Frame messages for a destination SAS address and an I_T Nexus Loss timer has been created for that destination SAS address, then this state shall delete the I_T Nexus Loss timer for that destination SAS address.

If this state receives a HARD_RESET Received confirmation, then this state shall discard all pending Tx Frame messages and delete all I_T Nexus Loss timers and send a HARD_RESET Received confirmation to the transport layer.

If this state receives a Notify Received (Power Loss Expected) confirmation, then this state shall:

a) discard all pending Tx Frame messages, if any;
b) delete all I_T Nexus Loss timers, if any;
c) send a Close Connection message to all the PL_PM state machines;
d) send a Cancel Open message to all the PL_PM state machines; and
e) send a Notify Received (Power Loss Expected) confirmation to the transport layer.

8.2.2.3.2 PL_OC2:Overall_Control state establishing connections

This state receives Phy Enabled confirmations indicating when a phy is available.

This state receives Retry Open messages from a PL_PM state machine.

This state creates pending Tx Open messages based on pending Tx Frame messages and Retry Open messages. Pending Tx Open messages are sent to a PL_PM state machine as Tx Open messages.

If this state receives a Retry Open (Retry) message, then this state shall process the Retry Open message.

If this state receives a Retry Open (No Destination) or a Retry Open (Open Timeout Occurred) message and an I_T Nexus Loss timer has not been created for the destination SAS address (e.g., an SSP target port does not support the I_T NEXUS LOSS TIME field in the Protocol-Specific Port mode page or the field is set to 0000h), then this state shall process the Retry Open message as either a Retry Open message or an Unable To Connect message. This selection is vendor-specific.

If this state receives a Retry Open (Pathway Blocked) message and an I_T Nexus Loss timer has not been created for the destination SAS address, then this state shall process the Retry Open message.

If this state receives a Retry Open (No Destination), Retry Open (Open Timeout Occurred), or Retry Open (Pathway Blocked) message, and an I_T Nexus Loss timer has been created for the destination SAS address with an initial value of FFFFh, then this state shall process the Retry Open message (i.e., the Retry Open message is never processed as an Unable to Connect message).

If this state receives a Retry Open (No Destination) or a Retry Open (Open Timeout Occurred) message, an I_T Nexus Loss timer has been created for the destination SAS address, and there is no connection established with the destination SAS address, then this state shall check the I_T Nexus Loss timer, and:

a) if the I_T Nexus Loss timer is not running, the I_T nexus loss time is not set to FFFFh, and the CONFIGURING bit is set to zero in the REPORT GENERAL response (see 10.4.3.4) for each expander device between this port and the destination port that is two or more levels away from this port, then this state shall start the timer;
b) if the I_T Nexus Loss timer is not running and the I_T nexus loss time is not set to FFFFh, then this state shall start the timer;
c) if the I_T Nexus Loss timer is running, then this state shall not stop the timer; and
d) if the I_T Nexus Loss timer has expired, then this state shall process the Retry Open message as if it were an Unable To Connect message (see 8.2.2.3.4).

If this state receives a Retry Open (Pathway Blocked) message, an I_T Nexus Loss timer has been created for the destination SAS address, and there is no connection established with the destination SAS address, then this state shall check the I_T Nexus Loss timer, and:

 a) if the I_T Nexus Loss timer is running, then this state shall not stop the timer; and
 b) if the I_T Nexus Loss timer has expired, then this state shall process the Retry Open message as if it were an Unable To Connect message (see 8.2.2.3.4).

If this state receives a Retry Open (Retry) and an I_T Nexus Loss timer is running for the destination SAS address, then this state shall:

 a) stop the I_T Nexus Loss timer (if the timer has been running); and
 b) initialize the I_T Nexus Loss timer.

This state shall create a pending Tx Open message if:

 a) this state has a pending Tx Frame message or has received a Retry Open message;
 b) ~~this state has fewer pending Tx Open messages than the number of PL_PM state machines (i.e., the number of phys in the port);~~there is a pending Tx Open slot available for the destination SAS address;
 c) there is no pending Tx Open message for the destination SAS address; and
 d) there is no connection established with the destination SAS address.

This state may create a pending Tx Open message if:

 a) this state has a pending Tx Frame message, or this state has received a Retry Open message and has not processed the message by sending a confirmation; and
 b) ~~this state has fewer pending Tx Open messages than the number of PL_PM state machines.~~there is a pending Tx Open slot available for the destination SAS address.

~~This state shall have no more pending Tx Open messages than the number of PL_PM state machines.~~

If this state receives a Retry Open message and there are pending Tx Frame messages for which pending Tx Open messages have not been created, then this state should create a pending Tx Open message from the Retry Open message.

If this state does not create a pending Tx Open message from a Retry Open message (e.g., ~~the current number of pending Tx Open messages equals the number of phys~~ there is not an available pending Tx Open slot for the destination SAS address), then this state shall discard the Retry Open message. This state may create a new pending Tx Open message at a later time for the pending Tx Frame message that resulted in the Retry Open message.

If this state receives a Retry Open (Opened By Destination) message and the initiator port bit and protocol arguments match those in the Tx Open messages that resulted in the Retry Open message, then this state may discard the Retry Open message and use the established connection to send pending Tx Frame messages as Tx Frame messages to the destination SAS address. If this state receives a Retry Open (Opened By Destination) message, then, if this state has a pending Tx Open slot available, this state may create a pending Tx Open message from the Retry Open message.

> NOTE 22 - If a connection is established by another port as indicated by a Retry Open (Opened By Destination) message, credit may not be granted for frame transmission. In this case this state may create a pending Tx Open message from a Retry Open message in order to establish a connection where credit is granted.

This state shall send a pending Tx Open message as a Tx Open message to a PL_PM state machine that has an enabled phy and does not have a connection established. If there is more than one pending Tx Open message, this state should send a Tx Open message for the pending Tx Open message that has been pending for the longest time first.

Editor's Note 3: The above paragraph indicates the oldest pending Tx Open should be converted as the next Tx Open message.

If this state creates a pending Tx Open message from one of the following messages:

- a) Retry Open (Opened By Destination);
- b) Retry Open (Opened By Other);
- c) Retry Open (Collided);
- d) Retry Open (Pathway Blocked); or
- e) if the CONTINUE AWT bit is set to one in the Protocol-specific Port mode page (see 10.2.7.4), Retry Open (Retry),

then this state shall:

1) create an Arbitration Wait Time timer for the pending Tx Open message;
2) set the Arbitration Wait Time timer for the pending Tx Open message to the arbitration wait time argument from the Retry Open message; and
3) start the Arbitration Wait Time timer for the pending Tx Open message.

> Editor's Note 4: Should the AWT continue to increment while the Retry to Open is running? That is current what the spec says to do.

When a pending Tx Open message is sent to a PL_PM state machine as a Tx Open message, the Tx Open message shall contain the following arguments to be used in an OPEN address frame:

- a) initiator port bit from the Transmit Frame request;
- b) protocol from the Transmit Frame request;
- c) connection rate from the Transmit Frame request;
- d) initiator connection tag from the Transmit Frame request;
- e) destination SAS address from the Transmit Frame request;
- f) source SAS address from the Transmit Frame request;
- g) pathway blocked count; and
- h) arbitration wait time.

If this state creates a pending Tx Open message from one of the following:

- a) a Transmit Frame request;
- b) a Retry Open (No Destination) message;
- c) a Retry Open (Open Timeout Occurred) message; or
- d) if the CONTINUE AWT bit is set to zero in the Protocol-specific Port mode page (see 10.2.7.4), a Retry Open (Retry) message,

then this state shall:

- a) set the pathway blocked count argument in the Tx Open message to zero; and
- b) set the arbitration wait time argument in the Tx Open message to zero or a vendor-specific value less than 8000h (see 7.12.3).

If a pending Tx Open message was created as the result of this state receiving a Retry Open (Retry) message and:

- a) the protocol for the connection is SSP, the Protocol-Specific Port mode page is implemented, and the REJECT TO OPEN LIMIT field in the Protocol-Specific Port mode page (see 10.2.7.4) is not set to zero; or
- b) the protocol for the connection is STP and the STP REJECT TO OPEN LIMIT field is not set to zero in the SMP REPORT GENERAL response (see 10.4.3.4),

then this state shall:

1) create a Reject To Open Limit timer associated with the pending Tx Open message that received the Retry Open (Retry) message;
2) initialize the Reject To Open Limit timer as specified in table 67 (see 8.2.2.1);
3) start the Reject To Open Limit timer; and
4) wait at least until the Reject To Open Limit timer expires before sending a Tx Open message.

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If a pending Tx Open message was created as the result this state receiving a Retry Open (Pathway Blocked) message, then this state shall set the pathway blocked count argument in the Tx Open message to the value of the pathway blocked count argument received with the message plus one, unless the pathway blocked count received with the argument is FFh.

If a pending Tx Open message was created as the result of this state receiving one of the following:

  a) a Retry Open (Opened By Destination) message;
  b) a Retry Open (Opened By Other) message;
  c) a Retry Open (Collided) message;
  d) a Retry Open (Pathway Blocked) message; or
  e) if the CONTINUE AWT bit is set to one in the Protocol-specific Port mode page (see 10.2.7.4), a Retry Open (Retry) message,

then this state shall set the arbitration wait time argument in the Tx Open message to be the value from the Arbitration Wait Time timer created as a result of the Retry Open message.

After this state sends a Tx Open message, this state shall discard the pending Tx Open message from which the Tx Open messages was created. After this state discards a pending Tx Open message, this state may create a new pending Tx Open message.

If this state receives a Connection Opened message and the initiator port bit and protocol arguments match those in a pending Tx Open message, then any Reject To Open Limit timer associated with that pending Tx Open message shall be discarded.

If this state receives a Connection Opened message and the initiator port bit and protocol arguments match those in any pending Tx Frame messages, then this state may use the established connection to send pending Tx Frame messages as Tx Frame messages to the destination SAS address.

8.2.2.3.3 PL_OC2:Overall_Control state connection established

If this state receives a Connection Opened message or a Retry Open (Opened By Destination) message for a SAS address, and an I_T Nexus Loss timer has been created for the SAS address, then this state shall:

  a) stop the I_T Nexus Loss timer for the SAS address, if the timer has been running; and
  b) initialize the I_T Nexus Loss timer.

8.2.2.3.4 PL_OC2:Overall_Control state unable to establish a connection

If this state receives a Retry Open (No Destination), Retry Open (Open Timeout Occurred), or Retry Open (Pathway Blocked) message and the I_T Nexus Loss timer for the SAS address has expired, then this state shall perform the following:

  a) delete the I_T Nexus Loss timer for the SAS address;
  b) discard the Retry Open message;
  c) send a Transmission Status (I_T Nexus Loss) confirmation for the pending Tx Frame message from which the Retry Open message resulted;
  d) discard the pending Tx Frame message from which the Retry Open message resulted;
  e) if this state has any pending Tx Frame messages with the same destination SAS address and protocol as the Retry Open message, and this state has not sent a Tx Open message to a PL_PM state machine for the messages, then this state shall send a Transmission Status (I_T Nexus Loss) confirmation for each pending Tx Frame message and discard the pending Tx Frame messages and any corresponding pending Tx Open messages; and
  f) if this state has any pending Tx Frame messages with the same destination SAS address and protocol as the Retry Open message, and this state has sent a Tx Open message to a PL_PM state machine for a message, then this state shall send a Cancel Open message to each PL_PM state machine to which it has sent a Tx Open message. After receiving an Unable To Connect (Cancel Acknowledge) message from a PL_PM state machine in response to the Cancel Open message, then this state shall send a Transmission Status (I_T Nexus Loss) confirmation for each pending Tx Frame message and discard the pending Tx Frame messages and any corresponding pending Tx Open messages.

If this state receives a Retry Open (No Destination), Retry Open (Open Timeout Occurred), or Retry Open (Pathway Blocked) message and processes it as an Unable To Connect message, or this state receives an Unable To Connect message, then this state shall send a Transmission Status confirmation as defined in table 68.

Table 68 — Confirmations from Unable To Connect or Retry Open messages

Message received	Confirmation to be sent to transport layer
Retry Open (No Destination)	Transmission Status (I_T Nexus Loss) if the I_T Nexus Loss timer for the SAS address has expired, or Transmission Status (No Destination) if it has not
Retry Open (Open Timeout Occurred)	Transmission Status (I_T Nexus Loss) if the I_T Nexus Loss timer for the SAS address has expired, or Transmission Status (Open Timeout Occurred) if it has not
Retry Open (Pathway Blocked)	Transmission Status (I_T Nexus Loss) if the I_T Nexus Loss timer for the SAS address has expired
Unable To Connect (Break Received)	Transmission Status (Break Received)
Unable To Connect (Port Layer Request)	Transmission Status (Cancel Acknowledge)
Unable to Connect (Bad Destination)	Transmission Status (Bad Destination)
Unable To Connect (Connection Rate Not Supported)	Transmission Status (Connection Rate Not Supported)
Unable To Connect (Protocol Not Supported)	Transmission Status (Protocol Not Supported)
Unable To Connect (Reserved Abandon 1)	Transmission Status (Reserved Abandon 1)
Unable To Connect (Reserved Abandon 2)	Transmission Status (Reserved Abandon 2)
Unable To Connect (Reserved Abandon 3)	Transmission Status (Reserved Abandon 3)
Unable To Connect (STP Resources Busy)	Transmission Status (STP Resources Busy)
Unable To Connect (Wrong Destination)	Transmission Status (Wrong Destination)
Unable To Connect (Zone Violation)	Transmission Status (Zone Violation)

If this state receives an Unable To Connect (Connection Rate Not Supported), Unable To Connect (Protocol Not Supported), Unable To Connect (Zone Violation), Unable To Connect (Reserved Abandon 1), Unable To Connect (Reserved Abandon 2), Unable To Connect (Reserved Abandon 3), or Unable To Connect (STP Resources Busy) message and an I_T Nexus Loss timer is running for the SAS address, then this state shall:

    a)   stop the I_T Nexus Loss timer, if the timer has been running; and
    b)   initialize the I_T Nexus Loss timer.

This state shall discard the pending Tx Frame message for which the Transmission Status confirmation was sent.

8.2.2.3.5 PL_OC2:Overall_Control state connection management

If this state receives an Accept_Reject Opens request, then this state shall send an Accept_Reject Opens request to all phys in the port.

If this state receives an SMP Transmit Break request, then this state shall send an SMP Transmit Break message to the PL_PM state machine associated with the corresponding SMP transport state machine. If there is no PL_PM state machine associated with the request, the PM_OC state shall ignore the request.

If this state receives one of the following:

    a) a Connection Closed (Close Timeout) message;
    b) a Connection Closed (Break Requested) message; or
    c) a Connection Closed (Break Received) message,

then this state shall not send a Tx Open or Tx Frame message to the PL_PM state machine that sent the message until this state receives a Connection Closed (Transition to Idle) message from that PL_PM state machine.

If this state receives a Connection Closed (Normal) message or a Connection Closed (Transition to Idle) message indicating that a connection with a destination SAS address is no longer open and this state has pending Tx Open messages, then this state may send a Tx Open message to the PL_PM state machine that sent the Connection Closed message.

If this port is a wide SSP port, then this state shall not reject an incoming connection request on one phy because it has an outgoing connection request on another phy.

If this port is an SSP port, there are no pending Tx Frame messages for a destination SAS address with which a PL_PM state machine has established a connection, and the connection was established by a message from this state, then this state should send a Close Connection message to the PL_PM state machine.

If this port is an SSP port, has no pending Tx Frame messages for a destination SAS address with which a PL_PM state machine has established a connection, and the connection was established by the destination, then this state may wait a vendor-specific time and then shall send a Close Connection message to the PL_PM state machine.

If this state has received a Disable Tx Frame message from a PL_PM state machine, then this state should send a Close Connection message to the PL_PM state machine.

> NOTE 23 - The PL_PM state machine sends a Close Connection request to the link layer upon receipt of a
> Close Connection message or on expiration of the Bus Inactivity Time Limit timer (see 8.2.3.4.1).

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).

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).

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).

Frames with the Non-Interlocked argument for the same I_T_L_Q nexus may be transmitted and received simultaneously on the same or different phys.

If this port is an SMP initiator port, then this state shall send the Tx Frame message containing the SMP REQUEST frame to the PL_PM state machine on which the connection was established for the Tx Open message. If this port is an SMP target port, then this state shall send the Tx Frame message containing the SMP RESPONSE frame to the PL_PM state machine on which the connection was established for the Tx Open message. See 7.18 for additional information about SMP connections.

Characteristics of STP connections are defined by SATA (also see 7.17).

The following arguments shall be included with the Tx Frame message:

    a) the frame to be transmitted; and
    b) Balance Required or Balance Not Required.

A Balance Not Required argument shall only be included if:

    a) the request was a Transmit Frame (Non-Interlocked) request (i.e., the request included a DATA frame); and
    b) the last Tx Frame message sent to this PL_PM state machine while this connection has been established was for a DATA frame having the same logical unit number and tag value as the DATA frame in this Tx Frame message.

If a Balance Not Required argument is not included in the Tx Frame message, then a Balance Required argument shall be included.

If this state receives a Disable Tx Frames message from a PL_PM state machine, then this state should send no more Tx Frame messages to that state machine until a new connection is established.

8.2.2.3.7 PL_OC2:Overall_Control state frame transmission cancellations

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

    a) destination SAS address; and
    b) tag.

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

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

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

8.2.2.3.8 Transition PL_OC2:Overall_Control to PL_OC1:Idle

This transition shall occur after:

   a)   sending a HARD_RESET Received confirmation to the transport layer;
   b)   a Phy Disabled confirmation is received from all of the link layers in the port; or
   c)   sending a Notify Received (Power Loss Expected) confirmation to the transport layer.