To: INCITS T10 Committee
From: Susan Gray, Quantum
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Subject: ADT Section 4.7.1.3

1   Revision History

Revision 1: Red Text
Incorporate comments from October 20th conference call and revised text for 03-318. In general the errors need to be defined as retryable and non-retryable instead of link level and upper-level protocol. Added new state, Initiating Recovery.

Revision 0: Blue Text
Initial proposal

2   Discussion

In ADT revision 7, section 4.7.1.3 refers to a list of "link level" errors, yet the list includes both link level and upper-layer protocol errors.

This proposal applies to ADT Revision 7.

2.1   Changes

Current Text:

4.7.1.3 Error detection by the frame receiver

The port that receives a frame shall detect and report the following link level errors:

   a) Checksum, over-length, under-length, or improperly formatted frames.
   b) Unsupported PROTOCOL or FRAME TYPE values.
   c) Frames with protocol other than link server when logged out.
   d) Frames with non-sequential Frame Numbers (see 4.6.3)

   When a port detects an error on a frame it receives it shall send a NAK IU to the other port with the appropriate status so that the port that sent the frame in error can initiate recover steps. The FRAME NUMBER field of the NAK IU shall be set to the Expected Frame Number counter value (see 4.6.3) when the error was detected.

4.7.2 Error recovery for transmission error
4.7.2.1 Differentiating transmission errors

The Status codes for NAK IUs are group into two categories:
   a) Link level problems (01h through 7Fh)
   b) Formatting or upper-layer protocol problems (80h through FFh)

Transmission errors are those that are reported with the link level statue codes. A time-out on an acknowledgement IU also qualifies as a transmission error. Some of the problems in the

formatting or upper-layer protocol category may also be recovered using techniques from this clause, when a retry is called for.

Proposed text:

Global change:

Renumber all existing occurrences of P3 – P5 to P5 – P7, respectively.

4.3 ADT Port States

Add the following rows to Table 1, ADT Port States:

State	Description
P3:Pending Recovery	A port shall enter this state when it has detected an error during the reception of a frame and has transmitted a NAK IU. While in this state, a port shall return a NAK IU with STATUS CODE of Awaiting Initiate Recovery IU and RECEXP of 0 for any NOP IU, Pause IU, or non-link service IU.
P4:Initiating Recovery	A port shall enter this state after transmitting an Initiating Recovery IU. While in this state, a port shall send no frames other than acknowledgement IUs, Port Login IUs, or Port Logout IUs until an ACK IU is received for the Initiating Recovery IU.

4.7.1.2 Error detection by the frame sender

Retryable errors are detected by the sending port by either:

    a)   a timeout without receipt of an acknowledgement IU; or

    b)   receipt of a NAK IU with the RECEXP field set to 1

4.7.1.3 Error detection by the frame receiver

The port that receives a frame shall detect and report an error if the frame can not be processed. Some errors may be caused by errors during transmission and the recovery process may allow the ports to resynchronize and proceed with normal operation. Other errors can not be recovered by simply re-transmitting the same frames and therefore shall not initiate the recovery process.

4.7.1.3.1 Corrupted frames

Corruption of a received frame is indicated by an incorrect checksum or by the occurrence of a hardware framing error or hardware over-run. When a port detects corruption of a received frame, it shall discard the frame and shall not send an acknowledgement IU.

4.7.1.3.2 Retryable errors

Retryable errors are those that may be recovered if the frame(s) were to be re-transmitted. Following is a list of retryable errors:

    a)   More or fewer bytes received than specified in PAYLOAD SIZE field.
    b)   Improperly formatted frame.
    c)   Frame with non-sequential Frame Number (see 4.6.3).

When a port detects a retryable error on a frame it receives it shall send a NAK IU to the other port with the appropriate status (see table 15) and the recovery expected (RecExp) field set to 1 so that the port that sent the frame in error can initiate recovery steps. The FRAME NUMBER field of the NAK IU shall be set to the Expected Frame Number counter value (see 4.6.3) when the error was detected. The port shall transition to the P3:Pending Recovery state unless otherwise specified in this standard.

4.7.1.3.3 Non-retryable errors

Non-retryable errors are those can not be recovered by simply re-transmitting the same frame. Following is a list of non-retryable errors:

a) Unsupported PROTOCOL value.
b) Unsupported FRAME TYPE value.
c) Frames with protocol other than link service when logged out.
d) Receipt of a frame other than Initiate Recovery IU when in P3:Pending Recovery state.
e) Payload size larger than maximum
f) ACK offset too large
g) Illegal operation
h) Out of resources

When a port detects a non-retryable error on a frame it receives it shall send a NAK IU to the other port with the appropriate status (see table 15) and the recovery expected (RECEXP) field set to 0. The FRAME NUMBER field of the NAK IU shall be set to the Expected Frame Number counter value (see 4.6.3) when the error was detected. For items f) and h) above, retransmission may succeed when resource usage has changed, but the frame must be retransmitted with an updated frame number.

4.7.2 Error recovery for retryable errors

4.7.2.1 Differentiating transmission errors
Remove this entire section and renumber 4.7.2.2 and 4.7.2.3.

4.7.2.2 Error recovery for Port Login IUs

If a retryable error is detected on a Port Login IU, the recovery process is accomplished by remaining in P1 state and initiating a Port Login IU with a frame number of zero and a new exchange ID value. Values in the payload of the frame should be set to the default values for the port.

4.7.2.3 Error recovery for other protocols and frame types

After detecting that a retryable error has occurred with a frame that it sent, a port shall initiate the following error recovery process. A port that detects a retryable error on a frame that it sent shall retry sending the frame at least once and no more than four times. The frame retry sequence is:

1) The port that sent the frame in error sets Next Frame To Send to the frame number that was detected in error, enters P4:Initiating Recovery, and sends an Initiate Recovery IU. The Initiate Recovery IU contains Next Frame To Send in the FRAME NUMBER field.

2) While in P4:Initiating Recovery, the port waits for an ACK IU for that frame. No other frames shall be sent by that port except acknowledgement IUs for frames it receives until an acknowledgement IU is received for the Initiate Recovery IU, a time-out occurs on the ACK IU, or a Port Login IU is received.

3) If an ACK IU is received for the Initiate Recovery IU, the error port shall resume normal operation by entering P2:Active and re-sending the frame in error and all frames sent

after it before the error was detected, with the exception of acknowledgement IUs. The FRAME NUMBER field values for re-transmitted frames shall not be changed from the values used when they were originally transmitted.

4) If no ACK IU is received for the Initiate Recovery IU before the ACK time-out, or an NAK IU is received indicating an error on the Initiate Recovery IU, and the Initiate Recovery IU has not been retried, the port in error shall re-send the Initiate Recovery IU.

5) If the Initiate Recovery IU has been sent twice with no ACK IU returned, or a NAK IU is received indicating an error on the Initiate Recovery IU, the port in error shall abort all exchanges, set the operating parameters of the interface to default settings, and initiate a Port Login exchange with the AOE bit set to one.

When a port receives an Initiate Recovery IU it is an indication that the other port is attempting to recover from a retryable error. The following steps shall be taken by the receiving port to accommodate the recovery process.

a) An ACK IU shall be sent to acknowledge receipt of the Initiate Recovery IU.

b) The FRAME NUMBER field in the Initiate Recovery IU shall be compared to the Expected Frame Number counter (see 4.6.3). If the frame numbers match, the port shall remain in its current state.

c) If the frame number does not match, this is an indication that an ACK IU was lost in transmission. The port shall transition into P5:Recovering state. While in this state, frames that are received by the port shall be acknowledged and discarded. Once a frame is received with a frame number that matches the Expected Frame Number counter, the port shall transition to the P2:Active state and continue with normal operations.

6.5.3.3 NAK information unit

A NAK IU is sent by the transport layer to indicate that the port has detected an error during the reception of a frame. Except for acknowledgement IUs, a port shall send a NAK IU for every frame that it receives in error. The FRAME NUMBER field in the ADT Header of the NAK IU shall be set to value in the Expected Frame Number counter (see 4.6.3). The Payload of the NAK IU is shown in Table x:

Table x – NAK IU payload contents

Bit / Byte	7	6	5	4	3	2	1	0
0	RECEXP	STATUS CODE						

The Recovery Expected (RECEXP) field shall be set to 0 if the error detected is not retryable. The field shall be set to 1 if the error is retryable.

The STATUS CODE field values and whether the error is retryable are shown in Table x+1:

Table x+1 – NAK IU status code values

Status Code	Description	Retryable
00h – 01h	Reserved	n/a
02h	Over-length (more bytes received than PAYLOAD SIZE field indicates)	Y
03h	Under-length (fewer bytes received than PAYLOAD SIZE field indicates)	Y
04h – 05h	Reserved	n/a

06h	Unexpected Frame Number	N
07h	Awaiting Initiate Recovery IU	N
08h	Header reserved bit set (for the version of ADT the receiving device supports)	N
09h – 2Fh	Reserved	n/a
30h – 3Fh	Vendor specific transmission error.	1
40h	Unsupported protocol	N
41h	Out of resources, retry later. The receiving port has run out of buffers to store the frame.	N
42h	Login in progress	N
43h	Invalid or illegal ~~Pause~~ IU received	N
44h	Illegal operation for current operating parameters	N
45h	Rejected, port is logged out	N
46h	Maximum ACK offset exceeded	N
47h	Maximum payload size exceeded	N
48h	Unsupported frame type for selected protocol	N
49h	Negotiation Error	N
4Ah – 6Fh	Reserved	n/a
70h – 7Fh	Vendor specific protocol error	1
Notes 1) To be determined by vendor.		