

To: INCITS T10 Committee
From: Susan Gray, Quantum
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Document Number: T10/03-355r5
Subject: ADT Section 4.7.1.3

1 Revision History

Revision 5: **Red text**

Incorporate comments from December 15, 2003 conference call. Break out non-retryable errors as resource limitation and protocol errors and change unexpected frame error to recoverable error (from the receivers point of view).

Revision 4: **Red text**

Incorporate comments from November 17th conference call. Make changes to address the issue that link service IUs are handled differently in error recovery.

Revision 3: **Blue text**

Incorporate comments from November 3rd meeting.

Revision 1/2:

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:

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 before it 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 Initiate Recovery IU. While in this state, a port shall send no frames other than acknowledgement IUs, Port Login IUs, Initiate Recovery IUs , or Port Logout IUs until an ACK IU is received for the Initiate 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 **PR bit set to one**.

4.7.1.3 Error detection by the frame receiver

There are **four types of errors detectable by the frame receiver; corrupted frame, protocol error, resource limitation error, and recoverable error**.

Corruption of a received frame is indicated by an incorrect checksum or by the occurrence of a hardware framing error or hardware over-run.

A resource limitation error is one that is due to lack of resources and retransmission may succeed when resource usage has changed.

The term protocol error is used to describe the class of detectable errors for which no retry process is defined.

A recoverable error is one that may be recovered by retransmission of one or more frames (e.g. when the port receives a frame that is not a link service frame and the frame number does not match the Expected Frame Number counter).

4.7.2 Error recovery for non link service frames

4.7.2.1 Differentiating transmission errors

Remove the current section and replace with the following.

~~4.7.2.2 Error recovery while in P1:Login~~

~~If an error as defined in 4.7.1 is detected on a Port Login IU, the recovery process is accomplished by remaining in P1:Login 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.~~

~~Remove this section. Some form of it will be added back in a separate proposal.~~

4.7.2.1 Retryable error

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 a 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.

4.7.2.2 Corrupted frame

When a port detects corruption of a received frame, it shall discard the frame and shall not send an acknowledgement IU. The sender of the frame shall detect a retryable error due to a timeout

without receipt of an acknowledgement IU and perform error recovery as defined in section 4.7.2.1.

4.7.2.3 Protocol error

When a port detects a **protocol** 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 PENDING RECOVERY (PR) bit set to zero. 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.

4.7.2.4 Resource limitation error

When a port detects a **resource limitation** 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 PENDING RECOVERY (PR) bit set to zero. 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.

Error recovery may be accomplished by retransmitting the frame at a later time. If the frame is retransmitted, the frame number shall be set to the Next Frame To Send counter (see 4.6.2).

4.7.2.5 Recoverable error

When a port detects a **recoverable** 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 (PR) bit set to one 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.

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 and the port is in **P2:Active** state, the port shall remain in its current state. If the frame numbers match and the port is in **P3:Pending Recovery**, the port shall transition to **P2:Active** and continue with normal operations.
- 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	7	6	5	4	3	2	1	0
Byte								

0	PR	STATUS CODE
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The Pending Recovery (PR) bit shall be set to one if the port is in P3:Pending Recovery state. The bit shall be set to zero otherwise.

The STATUS CODE field values are shown in table x + 1.

Table x+1 – NAK IU status code values

Status Code	Description
00h	Over-length (more bytes received than PAYLOAD SIZE field indicates)
01h	Under-length (fewer bytes received than PAYLOAD SIZE field indicates)
02h	Unexpected Frame Number ¹
03h	Awaiting Initiate Recovery IU ¹
04h	Header reserved bit set (for the version of ADT the receiving device supports)
05h – 2Fh	Reserved
30h – 3Fh	Vendor specific
40h	Unsupported protocol
41h	Out of resources. The receiving port has run out of buffers to store the frame. ²
42h	Login in progress
43h	Invalid or illegal IU received
44h	Illegal operation for current operating parameters
45h	Rejected, port is logged out
46h	Maximum ACK offset exceeded ²
47h	Maximum payload size exceeded
48h	Unsupported frame type for selected protocol
49h	Negotiation Error
4Ah – 6Fh	Reserved
70h – 7Fh	Vendor specific protocol error
Note:	1) These errors are recoverable. 2) These errors are due to lack of resources.