

To: INCITS T10 Committee
From: Paul Entzel, Quantum
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Document: T10/03-163r1
Subject: Add content to model section of ADT.

1. Revision History

Revision 1:

Changes agreed to at the 6 May 2003 ADI Working Group meeting in Nashua, NH

Revision 0:

Posted to the T10 web site 14 April 2003.

2. General

This proposal finally adds some content to the model clause of ADT. Much of this content is cut out of other areas in the standard and moved into the model since it is general in nature.

This proposal also addresses the following editors notes in ADTr03.

- ◆ Editors note 4 in clause 4.
- ◆ Editors note 5 in sub-clause 6.5.4.
- ◆ Editors note 6 in sub-clause 6.5.4.
- ◆ Editors note 7 is sub-clause 6.5.6.

3. Proposal

3.1 *Changes to the General Clause (4)*

Add the following sub-clauses in the General clause (4):

4.1 Default operating parameters for the link

From section 6.6.2.2 move the sentence that reads "The default operating parameters for the port are": and the list a parameters that follows it to this section. In section 6.6.2.2 replace the removed text with "See sub-clause 4.Y for the default operating parameters."

4.2 ADT Port states

Table A defines the states that a port shall support. See section 6.5 for a description of the link layer information units described in this table.

Table A – ADT Port States

State	Description
P0:Initial	This is the state that a port shall take after hard reset events or receiving acknowledgment for a Port Logout IU.
P1:Login	A port shall enter this state upon sending or receiving a Port Login IU. See sub-clause 4.3 for a description of the link negotiation states.
P2:Active	A port shall enter this state after successfully completing port login negotiation.
P3:Recovering	A port shall enter this state when it has received an Initiate Recovery IU that

	indicates the other port will resend frames that have already been received and acknowledged by the port. See subclause (reference Link Error subclause).
P4:Paused	A port shall enter this state after acknowledging a Pause IU. A port in this state shall not transmit until a frame other than an acknowledgment frame is received or a hard reset event.
P5:Logged-Out	A port shall enter this state after acknowledging a Logout IU. A port in this state shall not transmit until a Port Login IU is received or a hard reset occurs. All other frames received while in this state shall be ignored.

4.3 ADT Link Negotiation States

Table B shows the states a port involved in the Port Login negotiation process.

State	Description
N0:Initiate	Entered when a port initiates a Port Login exchange until an ACK IU is received.
N1:Negotiating	This state is used by a port when sending Port Login IUs with the ACCEPT bit set to zero.
N2:Accept	A port shall enter this state after sending a Port Login IU with the ACCEPT filed set to one.
N3:Complete	A port shall enter this state after sending a Port Login IU with the ACCEPT filed set to one after receiving a Port Login IU with the ACCEPT bit set to one.

Move all of the text from section 6.5.4 through editors note 5 to this section. Edit it as shown:

Port Login IUs are used to establish or change link parameters used by both ports on the link. The login process is a negotiation between the ports that shall result in the determination of a set of operating parameters that are acceptable to both ports. Following hard reset or a Port Logout condition, the Port Login IU shall be sent using default parameters (see 4.1). If the port is already logged in, the Port Login IU shall be sent using current operating parameters unless the port initiating the exchange as part of a link error recovery as described in sub-clause 4.6. A port in P0:Initial state shall NAK any frame containing a protocol other than link service until the login process has completed. The login process consists of the following states, all within a single exchange containing a series of Port Login IUs containing the same X-Origin and Exchange ID values:

N0:Initiate - A port shall enter this state upon initiating a Port Login exchange. Any frames received by the port after it sends a Port Login IU shall be discarded and a NAK IU shall be sent containing a Status field of "Login in progress". Upon receiving a ACK frame in response to the Port Login IU that port shall enter Link Negotiation State N1:Negotiating.

To avoid a deadlock condition when both ports in a link attempt to initiate a Port Login exchange at the same time, the following rules shall apply to Port Login exchanges. An automation device port that receives a Port Login IU with an exchange originated by the other port shall:

- a) If the automation device port has initiated a Port Login Exchange that has not yet completed, it shall ACK and discard the Port Login IU from the other port.
- b) If no other Port Login exchange is open, it shall either discard the Port Login IU and initiate a Port Login exchange, or it shall negotiate the Port Login using the exchange originated by the other port.

A Data Transfer Device that receives a Port Login IU in a new exchange shall abort all other Port Login exchanges, transition to N1:Negotiating state, and process the Port Login IU as specified by that state.

N1:Negotiating – If a port is not in Port State P1:Login state when it receives a Port Login IU, it shall set its Port State to P1:Login and its Link Negotiation State to N1:Negotiating. After acknowledging a Port Login IU, transmission of frames for other exchanges shall either be suspended or aborted based on the setting of the AOE bit in the Port Login IU. The port shall inspect the parameters in the received Port Login IU and:

- 1) If the ACCEPT bit is set to one and the parameters are unchanged from the values sent in the last Port Login IU, the port shall send a Port Login IU with the same values and transition to N3:Complete state.
- 2) If the port receives a Port Login IU with the ACCEPT bit set to one and with parameter values that are different from the last Port Login IU sent, the port shall send a NAK IU with status of Negotiation Error (new error type). The port shall transition to N0:Initiate state and initiate a new Port Login exchange with default starting parameters
- 3) If the ACCEPT bit is set to zero and parameters in the Port Login IU are acceptable, the port shall send a Port Login IU with the parameters unchanged and the ACCEPT bit set to one and transition to N2:Accept state.
- 4) Otherwise, the port shall adjust all parameters that are unacceptable down to values that are acceptable to the port, and respond with a Port Login IU that contains these values. The ACCEPT bit shall be set to zero.

If a port has not received a Port Login IU within 15 seconds after receiving the ACK IU for a Port Login frame that it has sent, it shall consider this condition an error. It shall abort the Port Login exchange, set the port operating parameters to default, and initiate a new Port Login exchange. The Negotiate state be set to N0:Initiate. with the parameters unchanged and

N2:Accept – If the port receives a Port Login IU with the ACCEPT bit set to zero or with parameter values that are different from the last Port Login IU sent, the port shall send a NAK IU with status of Negotiation Error (new error type). The port shall initiate a new Port Login exchange using default starting parameters and transition to the N0:Initiate state. If the port receives a Port Login IU with the ACCEPT bit set to one and unchanged parameters, the port shall acknowledge the frame. When the ACK IU has finished transmitting, the port shall set its operating parameters to the negotiated values and transition to Port State P2:Active.

N3:Complete – If the port receives a NAK IU it shall initiate a new Port Login exchange with default starting parameters and transition to N0:Initiate state. If the port receives an ACK IU for the Port Login IU it sent, it shall set its operating parameters to the negotiated values and transition to Port State P2:Active.

4.4 ACK Offset

On the ADT link, the receiving port explicitly acknowledges all frames that are transmitted. By default, the link operates such that a port must wait for an acknowledgement IU for every frame it sends before sending another frame, except for acknowledgement IUs. This mode of operation requires a minimal amount of resources in the port to buffer incoming frames. However, it imposes a throughput reduction caused by delays waiting for acknowledgement.

The MAXIMUM ACK OFFSET field in the Port Login IU allows the ports to negotiate the number of frames that may be sent without waiting for acknowledgement, based on the resources available

to the ports. Regardless of the setting of this field, all frames shall be acknowledged in the order they are received.

Each port shall keep a counter to track the unacknowledged frames that it has sent, called the unacknowledged frame count. This counter shall be set to zero at hard reset events. It shall also be set to zero before sending a Port Login IU or upon receiving an ACK IU for an Initiate Recovery IU. The counter shall be incremented by one for each frame that is sent except acknowledgement frames. It shall be decremented by one for each acknowledgement frame that is received. A port shall not transmit frames when this counter is equal to the maximum ACK offset value except for acknowledgement IUs, Port Login IUs, and Initiate Recovery IUs. If the port has not successfully completed Port Login negotiation, it shall not transmit a frame if the unacknowledged frame count is one.

4.5 Frame Number Counters

4.5.1 Frame Number Counters Overview

The ADT frame header contains a field called `FRAME NUMBER` that serves three purposes:

- a) It allows an acknowledgement IU to be associated with a specific frame.
- b) It allows a receiving port to detect missing frames.
- c) It allows a port to identify a frame in order to retry transmission of frames that fail.

To accomplish all of this, each port must keep two counters, one to keep track of the frame number in the next frame to send, and the other to track the next expected frame number.

4.5.1 Next Frame To Send counter

The next frame to send shall be calculated as follows:

- 1) It shall be set to zero before sending the first frame of a new Port Login exchange.
- 2) Upon receipt of a Port Login IU of a new exchange, it shall be set to zero.
- 3) When sending an Initiate Recovery IU, it shall be set to the frame number of the first frame detected in error (see 4.6),
- 4) When sending an acknowledgment frame it shall not be adjusted.
- 5) After sending all other frame types, it shall be set to the frame number of the last frame sent plus one. If this value is greater than seven, it shall be set to zero.

4.5.1 Expected Frame Number counter

The expected frame number shall be used to detect missing frames in the receive stream. It shall be calculated as follows:

- 1) When a Port Login IU is received, it shall be set to the value in the `FRAME NUMBER` field plus one. If this value is greater than seven, it shall be set to zero.
- 2) When receiving an acknowledge IU, it shall not be adjusted.
- 3) If an Initiate Recovery IU is received, or the port is operating in P3:Recovering state, it shall be set and used according to the rules in sub-clause 4.6.
- 4) Otherwise, if the port is operating in P2:Active state, the port shall compare the `FRAME NUMBER` field in each received frame with the expected frame number counter. If they do not

match, the port shall send a NAK IU in response to the frame with a status code of "Non-sequential frame numbers" and the expected frame number counter shall not be adjusted. If they match, the expected frame number counter shall be incremented by one. If this value is greater than seven, it shall be set to zero.

4.6 Link layer error recovery

Move sub-clause 6.6 to this section. Modify list item c) in sub-clause 6.6.2.3 as shown:

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 P3: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 frame number indicated by the Initiate Recovery IU, the port shall transition to the P2:Active state and continue with normal operations.

3.2 Changes to other sub-clauses:

In sub-clause 6.5.5:

Add a paragraph: After a port sends an ACK IU in response to a Port Logout IU it shall set its operating parameters to default and enter the P5:Logged-out state. Once the originator of a Port Logout IU receives an ACK IU for that exchange, it shall set its operating parameters to default and enter the P5:Logged-out state.

Modify the description of the FRAME NUMBER field sub-clause 6.3 as follows:

The FRAME NUMBER field is assigned by the transmitting port to uniquely identify a frame from other frames sent by that port over a small period of time. It ranges from zero to seven. ACK IUs return the FRAME NUMBER field value of the frame that they are acknowledging. The FRAME NUMBER field of a NAK IU shall contain the frame number the port expected to receive (see 6.6.1.3). A transmitting port shall assign all other types of frames the value in the next frame to send counter, independent of the traffic the port is receiving (see 4.5).

Search ADT for the term "expected" in relationship to frame number and use the Expected Frame Number counter name and reference.