To: INCITS T10 Committee From: Susan Gray, Quantum Date: December 16, 2003 Document Number: T10/03-369r1 Subject: ADT State Diagrams

2 Revision History

Revision 1:

Incorporated comments from group meeting on November 3rd. Break it into 4 separate state machines. The text should only describe what the diagrams do not describe.

Revision 0: Initial proposal

3 Discussion

Section 4.3 and 4.4 can be made more readable by providing state diagrams and describing the transitions.

This proposal applies to ADT Revision 8 plus stuff from 03-355r5.

4.3 Changes

Globally change P4:Paused to P3:Paused. Globally change P5:Logged-out to P4:Logged-out. Globally change P3:Recovering to R2:Recovering.

Replace the entire contents of section 4.3 and 4.4 with the following sections.

4.3 ADT state machines

The ADT transport layer contains four state machines to manage a connection between two ADT ports. These state machines reside in ADC devices. The state machines are as follows:

- a) Port
- b) Link negotiation
- c) Transmitter error recovery; and
- d) Receiver error recovery

4.3.1 Port state machine

The port state machine consists of the following port states:

- a) P0:Initial;
- b) P1:Login;

- c) P2:Active;
- d) P3:Paused; and
- e) P4:Logged-out.

Figure x describes the port state transitions and the following sub clauses describe the actions while in each state. See clause 6.5 for a description of the link layer information units.



Figure X Port State Machine Diagram

4.3.1.1 P0:Initial state description

A port in P0:Initial state shall send a NAK IU with status value of REJECTED, PORT IS LOGGED OUT in response to any frame other than Port Login IU, Port Logout IU, NOP IU or acknowledgement IU. Upon entering this state, all other state machines are set to their initial states.

Since only an automation port can send a Logout IU, only an automation port can transition to this state after completing a port logout (see 6.5.5).

4.3.1.2 P1:Login state description

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 a hard reset or a Port Logout condition, the Port Login IU shall be sent using default parameters (see 4.2). If the port is already logged in, the Port Login IU shall be sent using current operating parameters unless the port is initiating the exchange as part of link error recovery as described in clause 4.7.2. The login process consists of a series of Port Login IUs all within a single exchange. The same X-Origin and Exchange ID values are used in all frames throughout the process (see 6.3).

A port in this state shall send a NAK IU with a status value of LOGIN IN PROCESS in response to any frame other than Port Login IU, Port Logout IU, NOP IU or acknowledgement IU.

4.3.1.3 P2:Active state description

This is the only state in which non-link service frames are valid.

4.3.1.4 P3:Paused state description

A port in P3:Paused state shall not transmit.

4.3.1.5 P4:Logged-out state description

A port in P4:Logged-out state shall not initiate an exchange. While in this state, upon receiving any frame other than a Port Login IU, the port shall send a NAK IU with a status value of REJECTED, PORT IS LOGGED OUT.

Since only a drive port can receive a Logout IU, only a drive port can transition to this state after completing a port logout.

4.3.2 Link negotiation state machine

The link negotiation state machine is used to manage the login process. The states are as follows:

- a) N0:Idle
- b) N1:Initiate;
- c) N2:Negotiating;
- d) N3:Accept; and
- e) N4:Complete.

This state machine becomes active when the port enters the P1:Login state.

Figure x + 1 describes the link negotiation state transitions and the following sub clauses describe the actions while in each state. See clause 6.5 for a description of the link layer information units.



Figure x + 1 Link Negotiation State Diagram

4.3.2.1 Precedence of port login exchanges

To avoid a deadlock condition when both ports are attempting to initiate a Port Login exchange at the same time, the following rules shall apply. 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 send an ACK IU and discard the Port Login IU from the other port.
- b) If no other Port Login exchange is open, it shall either send an ACK IU and discard the Port Login IU and initiate a Port Login exchange, or it shall complete the port login process 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 N2:Negotiating, and process the Port Login IU as specified by that state.

4.3.2.2 N0:Idle state description

The N0:Idle states waits for the port to transition to P1:Login state.

4.3.2.3 N1:Initiate state description

While in N1:Initiate state, the port shall send a NAK IU containing a status value of LOGIN IN PROGRESS in response to any frame other than Port Login IU, Port Logout IU, NOP IU or acknowledgement IU.

4.3.2.4 N2:Negotiating state description

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 value and transition to N4:Complete.
- 2) If the port receives a Port Login IU with the ACCEPT bit set to one with parameter values that are different from the last Port Login IU sent, the port shall send a NAK IU with a status value of NEGOTIATION ERROR. The port shall transition to N1:Intiate state and initiate a new Port Login exchange with default starting parameters.
- 3) If the accept bit is set to zero and the 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 N3: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 IU that it has sent, the port shall consider this condition an error. It shall abort the Port Login exchange, set the port operating parameters to default, initiate a new Port Login exchange and transition to N1:Initate state.

4.3.2.5 N3:Accept state description

If a 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 a status value of NEGOTIATION ERROR.

If a 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 the port state machine to the P2:Active state and the link negotiation state machine to N0:Idle state.

4.3.2.6 N4:Complete state description

A port shall transition to this state after sending a Port Login IU with the ACCEPT bit set to one after receiving a valid Port Login IU with unchanged parameters and ACCEPT bit set to one.

A port shall set its operating parameters to the negotiated values and transition the port state machine to the P2:Active state and the link negotiation state machine to N0:Idle state after receiving an ACK IU for the Port Login IU it sent.

If a port receives a NAK IU it shall initiate a new Port Login exchange with default starting parameters and transition to N1:Initiate state.

4.3.3 Transmitter error recovery state machine

The transmitter error recovery state machine consists of the following states:

- a) T0:Idle; and
- b) T1:Initiating recovery.

This state machine becomes active when the port is the sender of a frame and a retryable error is detected.

Figure x + 2 describes the state transitions and the following sub clauses describe the actions while in each state. See clause 6.5 for a description of the link layer information units.



Figure x + 2 Transmitter Error Recovery State Diagram

4.3.3.1 T0:Idle state description

The T0:Idle states waits for the port to detect a retryable error as defined in section 4.7.1.2.

4.3.3.2 T1:Intiating Recovery state description

A port in T1:Initiating Recovery state shall not send any frames other than acknowledgement IUs, Port Login IUs, or Port Logout IUs.

4.3.4 Receiver error recovery state machine

The receiver error recovery state machine consists of the following states:

- a) R0:Idle;
- b) R1:Pending recovery; and
- c) R2:Recovering.

This state machine becomes active when the port is the receiver and

Figure x + 3 describes the state transitions and the following sub clauses describe the actions while in each state. See clause 6.5 for a description of the link layer information units.



Figure x + 3 Receiver Error Recovery State Diagram

4.3.3.3 R0: Idle state description

The R0:Idle states waits for the port to detect a recoverable error as defined in section 4.7.1.3, or receipt of an Initiate Recovery IU indicating that the transmitter has detected a retryable error (see 4.7.1.2).

4.3.3.4 R1:Pending recovery state description

A port shall transition to R1:Pending recovery state when it has detected a recoverable error during the reception of a frame (see 4.7.1.3).

While a port in R1:Pending recovery state, receipt of a frame other than an Initiate Recovery IU is an error and the port shall send a NAK IU with a status of AWAITING INITIATE RECOVERY IU.

A port shall transition to R2:Recovering state after it receives a valid Initiate Recovery IU with a FRAME NUMBER field value that does not match the Expected Frame Number counter.

A port shall transition to R0:Idle state after it receives a valid Initiate Recovery IU with a FRAME NUMBER field value that matches the Expected Frame Number counter.

4.3.3.5 R2:Recovering state description

A port shall transition to R2:Recovering state when it receives a valid Initiate Recovery IU with a FRAME NUMBER field value that does not match the Expected Frame Number counter indicating that the other port will re-send frames that have already been received and acknowledged by this port. See clause 4.7.

A port in this state shall acknowledge and discard all frames that were previously processed. This is all frames with a FRAME NUMBER field value that does not match the Expected Frame Number counter.

When a frame with a FRAME NUMBER field value that matches the Expected Frame Number counter is received, the port shall transition to the R0:Idle state and continue with normal operations.