T10/04-350r0

To	From	Subject	Date
INCITS T10 Committee	Michael Banther, HP	ADT Guidance on state machines	25 October, 2004

Revision history

Revision 0 – Initial document.

Background

During resolution of ADT letter ballot comments at the 3 May 2004 ADI meeting, the working group noticed inconsistencies in the state machine descriptions (see ADTr13, 4.3). Specifically statements that describe how transition from one state to another causes the port to send an information unit appear in different places depending on the transition. Sometimes an IU statement appears in the description of the state entered into (e.g., 4.3.3.4.1 *State description*), sometimes it appears in the description of the transition (e.g., 4.3.3.4.3 *Transition N1: Negotiating to N2: Accept Sent*), and sometimes no statement appears at all (e.g., 4.3.2.5 *P3: Logged-out state* compare with Port Login IU Received message in figure 4).

After some discussion, the working group concluded that the standard should use a consistent approach regarding the placement of statements that send an IU. Previously we had attempted to place all action statements in state descriptions and the State machine conventions overview (see 3.6.1) reflects this desire. The group decided to place statements that specify the sending of an IU in the description of the state receiving the transition (i.e., the next state).

Investigation into a proposal has revealed:

- Conditional behaviour when sending information units that complicates placing these statements in the next state description, and
- Additional problems with the state machine diagrams and text.

This document explains the various problems and requests guidance from the working group for my subsequent proposal.

Problem #1 – Conditional behaviour when sending information units

Clause 4.3.3.3.2 *Transition N0: Idle to N1: Negotiating* illustrates this problem:

> This transition shall occur if a Port Login IU Received message is received and the parameters within the Port Login IU are unacceptable, [sic] the port shall transition to N1: Negotiating and send a Port Login IU with ACCEPT bit set to zero and parameters changed.

> Additionally, this transition shall occur when an Initiate Login message is received. The port shall transition to N1: Negotiating and send a Port Login IU with ACCEPT bit set to zero and starting parameters.

In the current text, the sending of the IU is (I believe) never conditional. The conditional statements in the text pertain to the setting of parameters.

Ideally a state machine takes the same action upon entry into a state regardless of the transition into the state. Five possibilities exist for handling conditional IU statements:

a. Modify the goal to place only non-conditional IU statements in the next state descriptions, placing conditional IU statements in the corresponding transition description;

4.3.3.3.2 Transition N0: Idle to N1: Negotiating

This transition shall occur if a Port Login IU Received message is received and the parameters within the Port Login IU are unacceptable. The port shall transition to N1: Negotiating and send a Port Login IU with the ACCEPT bit set to zero and parameters changed.

Additionally, this transition shall occur when an Initiate Login message is received. The port shall transition to N1: Negotiating and send a Port Login IU in a new exchange with the ACCEPT bit set to zero and starting parameters.

4.3.3.4.1 State description

~~If the port transitioned to this state as the result of an Initiate Login message, the port shall send a Port Login IU in a new exchange.~~

If the port transitioned to this state as a result of a negotiation error, the port shall send a Port Login IU in a new exchange. The Port Login IU shall contain starting parameters. The ACCEPT bit shall be set to zero.[1]

b. Invert the goal so that all IU statements are placed in the transition description;

See results for (a) above.

c. Move the entire IU statement, including the conditional phrase, to the next state description;

4.3.3.3.2 Transition N0: Idle to N1: Negotiating

A port shall transition from N0: Idle to N1: Negotiating upon receiving ~~This transition shall occur if~~ a Port Login IU Received message ~~is received and~~ when the parameters within the corresponding Port Login IU are unacceptable. ~~The port shall transition to N1: Negotiating and send a Port Login IU with ACCEPT bit set to zero and parameters changed.~~

Additionally, a port shall transition from N0: Idle to N1: Negotiating upon receiving ~~this transition shall occur when~~ an Initiate Login message ~~is received~~. ~~The port shall transition to N1: Negotiating and send a Port Login IU with ACCEPT bit set to zero and starting parameters.~~

4.3.3.4.1 State description

If the port transitioned to this state as the result of a Port Login IU Received message, the port shall send a Port Login IU with the ACCEPT bit set to zero and changed parameters.

If the port transitioned to this state as the result of an Initiate Login message, the port shall send a Port Login IU in a new exchange with the ACCEPT bit set to zero and starting parameters.

If the port transitioned to this state as a result of a negotiation error, the port shall send a Port Login IU in a new exchange. The Port Login IU shall contain starting parameters. The ACCEPT bit shall be set to zero.

d. Move the unconditional portion of the IU statement to the next state description and leave the conditional portion in the corresponding transition description;

4.3.3.3.2 Transition N0: Idle to N1: Negotiating

A port shall transition from N0: Idle to N1: Negotiating upon receiving ~~This transition shall occur if~~ a Port Login IU Received message ~~is received and~~ when the parameters within the corresponding Port Login IU are unacceptable. The port shall ~~transition to N1: Negotiating and send a Port Login IU with~~ set the ACCEPT bit ~~set~~ to zero and parameters changed for the next Port Login IU it sends.

Additionally, a port shall transition from N0: Idle to N1: Negotiating upon receiving ~~this transition shall occur when~~ an Initiate Login message ~~is received~~. The port shall ~~transition to N1: Negotiating and send a Port Login IU with~~ set the ACCEPT bit ~~set~~ to zero and starting parameters for the next Port Login IU it sends.

4.3.3.4.1 State description

If the port transitioned to this state as the result of a Port Login IU Received message, the port shall send a Port Login IU.

If the port transitioned to this state as the result of an Initiate Login message, the port shall send a Port Login IU in a new exchange.

If the port transitioned to this state as a result of a negotiation error, the port shall send a Port Login IU in a new exchange. The Port Login IU shall contain starting parameters. The ACCEPT bit shall be set to zero.

e. Move the unconditional portion of the IU statement to the next state description and move the conditional portion to the current state description.

4.3.3.3.1 State description

The N0: Idle state waits for the port to receive a Port Login IU Received message of an Initiate Login message.

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[1] Using solutions (a) or (b) will also require removing this statement. As it does not pertain to the example under consideration, I've left it alone. Also I've removed the last two paragraphs of 4.3.3.4.1 only to keep the examples short. I do not propose changing them.

If a port in the N0: Idle state receives a Port Login IU Received message, the port shall both set the ACCEPT bit to zero and set the other parameters to changed values for the next Port Login IU it sends.

If a port in the N0: Idle state receives an Initiate Login message, the port shall both set the ACCEPT bit to zero and set the other parameters to staring parameter values for the next Port Login IU it sends.

4.3.3.3.2 Transition N0: Idle to N1: Negotiating

A port shall transition from N0: Idle to N1: Negotiating upon receiving ~~This transition shall occur if~~ a Port Login IU Received message ~~is received and~~ when the parameters within the corresponding Port Login IU are unacceptable. ~~The port shall transition to N1: Negotiating and send a Port Login IU with ACCEPT bit set to zero and parameters changed.~~

Additionally, a port shall transition from N0: Idle to N1: Negotiating upon receiving ~~this transition shall occur when~~ an Initiate Login message ~~is received~~. ~~The port shall transition to N1: Negotiating and send a Port Login IU with ACCEPT bit set to zero and starting parameters.~~

4.3.3.4.1 State description

If the port transitioned to this state as the result of a Port Login IU Received message, the port shall send a Port Login IU.

If the port transitioned to this state as the result of an Initiate Login message, the port shall send a Port Login IU in a new exchange.

If the port transitioned to this state as a result of a negotiation error, the port shall send a Port Login IU in a new exchange. The Port Login IU shall contain starting parameters. The ACCEPT bit shall be set to zero.

Which solution does the working group want me to use?

Problem #2 – Sending acknowledgement information units

Several transition clauses state the transition event as the receipt of an IU of a particular type followed by sending he corresponding acknowledgement IU. 4.3.4.3.2 *Transition T1: Active to T2: Paused* provides a good example:

A port shall transition to T2: Paused state after it receives a Pause IU and sends the corresponding ACK IU.

I don't want to move acknowledgement IU phrases of this type to the corresponding next state description even though a strict reading of the action item implies that I should. Amongst other problems, moving them causes substantial changes to the way the state machines work. Does the group agree?

Problem #3 – Incorrect labels

Figure 5 in 4.3.3.1 *Link negotiation state machine overview* gives an example of some of the labelling problems with the current text. The Login IU Received message in the upper left-hand corner should be Port Login IU Received. The N4: Complete state label should be N4: Agreed. Unless someone objects, I intend to correct labelling mistakes of this sort in the subsequent proposal.

Problem #4 – Missing transitions

One transition is missing from the port state machine (see 4.3.2). The Port Login IU Received message in the upper left-hand corner states that receiving it causes a transition to P1: Login. The clauses for the P0: Initial and P2: Logged-In states include explicit transitions when a port receives a Port Login IU (see 4.3.2.2.2 *Transition P0: Initial to P1: Login* and 4.3.2.4.3 *Transition P2: Logged-In to P1: Login* respectively). However the P3: Logged-Out state does not include a transition.

The link negotiation state machine has a similar but more complex problem (see 4.3.3). The Login IU Received [sic] message in the upper left-hand corner of figure 5 causes a transition to N1: Negotiating state under a variety of conditions. ADT letter ballot comment IBM 33 identified this problem and sought to correct it by adding a general transition statement to 4.3.3.1 *Link negotiation state machine overview*. However the text does not cover pathological cases. Consider for instance what happens with a long ACK timeout (e.g., the ports are running at 9600 baud) when a DT device port is in N4: Agreed state and the Automation device port silently resets. With 2.28 seconds to wait for the ACK, the DT device port is likely to receive a Port Login IU with ACCEPT set to zero before anything else. None of the text in 4.3.3.7 *N4: Agreed state* addresses receiving a Port Login IU. The text in 4.3.3.1 only covers receiving a Port Login IU with ACCEPT set to one. The link negotiation state machine contains several missing transitions of this type.

The State machine conventions (see 3.6) do not mention how the text describes a transition from any state to a specific state. The closest statement I could find for this situation occurs in 3.6.4 *Messages, requests, and event notifications*. The statement allows placement in the general state machine description of the 'meaning' of an event that affects all states.

What does the group want me to do about these transitions? Numerous possibilities exist, among them:

a. Do nothing, i.e., leave the standard silent on some transitions;

b. Change the state machine conventions to clarify that general transitions can occur, add a general statement for the port state machine, and beef-up the statement in the link negotiation state machine;

c. Add explicit text for each missing transition in both the port and link negotiation state machines; or

d. Add explicit text for the missing port state machine transition, since it's pretty straightforward to fix, and leave the link negotiation state machine alone.

Problem #5 – "A port" versus "The port"

This is one of those niggling little problems. Sub-clauses in 4.3.6 *Receiver error recovery state machine* illustrate it well. All of the sub-clauses in 4.3.6.2 *R0: Idle state* refer to "The port …." All of the sub-clauses in 4.3.6.3 *R1: Pending recovery state* refer to "A port …." Which would the group like me to use with new or changed text? I prefer "a port" except for the formulation:

> If a port in M1: Myopic state, receives/detects/intuits <blah>, the port shall <blah blah>.

Some other phrase inconsistencies exist as well. For instance some clauses use "on receiving" while others use "after it receives". For the clauses that I touch, I intend to change the text to a consistent usage across all of the state machines unless someone objects.

Problem #6 – Non-IU actions in transition clauses

My action item specifies moving statements about sending information units to the state description. I've found some transition clauses that state other actions. A good example is 4.3.2.3.3 Transition P1: Login to P2: Logged-In:

> A port shall *set its operating parameters to the negotiated values* and transition to P2: Logged-In state after receiving a Login Process Complete message. [Emphasis mine]

The same options (and problems) exist for non-IU action statements as for IU statements. What does the group want me to do with them? If we move them to their corresponding next state, the transition statements will only contain the event that causes the transition and the description of the transition itself.

Problem #7 – Non-IU action dependent on multiple previous states in P1: Login state description

The state description for P1: Login state (see 4.3.2.3.1) contains a pair of problematic sentences:

> Following a hard reset or a transition to P3: Logged Out state, the port shall set its operating parameters to default values before sending the Port Login IU (see 4.2). If the port is already logged in, the operating parameters shall not be changed before sending the Port Login IU, unless otherwise specified.

Two problems (at least) exist here:

a. This text doesn't cover resetting operating parameters to default values on transition from P1: Login to P0: Initial due to the port initiating a successful port logout;

b. In conjunction with 4.3.2.4.3 *Transition P2: Logged-In to P1: Login*, the second sentence only allows retention of the current operating parameter values in the case of receiving a Port Login IU whilst in P2: Logged-In state. The other event that causes a P2 to P1 transition, the receipt of a Recovery Failed message from the Transmitter Error Recovery sub-state machine, requires setting the operating parameters to default values. This text is the only case I have found of a non-IU action that depends on the event causing the transition. At present the reader has to take both 4.3.2.3.1 and 4.3.2.4.3 into account in order to understand the correct behaviour.

Analyzing the state machines shows that the operating parameters can reset to default values upon entry to P0: Initial state and P3: Logged-Out state. Since the port is logged out in these states, resetting the operating parameters has no negative effect on link operation.

Resetting to default values must also happen on transition from P2: Logged-In state to P1: Login state if the transition is due to receiving a Recovery Failed message from the Transmit Error Recovery sub-state machine. In this case 4.3.2.4.3 *Transition P2: Logged-In to P1: Login* already causes the transition. It also includes the actions that I'd like to move elsewhere.

I'd like permission from the group to expand the scope of the action item and change the text. I've followed the equivalent of option (e) from problem #1 in the suggested text below:

4.3.2.2.1 State description [P0: Initial state]

This is the initial state of the port state machine.

A port entering this state shall set its operating parameters to default values (see 4.2).

A port in P0:Initial state shall send a NAK IU with status code of REJECTED, PORT IS LOGGED OUT (see table 14) 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 shall be set to their initial states.

4.3.2.3.1 State description [P1: Login state]

While in the P1: Login state, 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 transition to P3: Logged Out state, the port shall set its operating parameters to default values before sending the Port Login IU (see 4.2). If the port is already logged in, the operating parameters shall not be changed before sending the Port Login IU, unless otherwise specified.~~ The login process consists of a series of Port Login IUs all within a single exchange (i.e the same X-Origin and Exchange ID values are used in all information units throughout the process (see 6.3)).

A port in this state shall send a NAK IU with a status code of LOGIN IN PROGRESS (see table 14) in response to any frame other than Port Login IU, Port Logout IU, NOP IU or acknowledgement IU.

While in this state, the port shall send a Port Login IU received message to the link negotiation state machine each time it receives a Port Login IU.

If the port enters this state as a result of an Initiate Login request, it shall send an Initiate Login message to the link negotiation state machine. If the port enters this state as a result of a Recovery Failed message (see 4.3.2.4.1), the port shall send an Initiate Login message to the link negotiation state machine.

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 (see 6.5.4).

4.3.2.4.1 State description [P2: Logged-In state]

If the port receives a Recovery Succeeded message, the port shall resume the transmission of frames. If the port receives a Recovery Failed message, the port shall abort all open exchanges, set its operating parameters to default values (see 4.2), and set the AOE bit to one for the next Port Login IU sent.

4.3.2.4.3 Transition P2: Logged-In to P1: Login

A port shall transition to P1: Login ~~and initiate a port login exchange~~ after receiving a Recovery Failed message (see 4.3.5.4.2) or upon receiving a Port Login IU. ~~If the transition is due to a Recovery Failed message, the port shall abort all exchanges, set its operating parameters to default, and initiate a Port Login exchange with the AOE bit set to one.~~

4.3.2.5.1 State description [P3: Logged-Out state]

A port entering this state shall set its operating parameters to default values (see 4.2).

A port in P3: 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 code of REJECTED, PORT IS LOGGED OUT (see table 14).

Problem #8 – What to do with non-acknowledgement information units after sending a Port Logout IU?

Clause 4.3.2.4.2 *Transition P2: Logged-In to P0: Initial* states:

A port shall transition to P0: Initial after receiving an ACK IU for a Port Logout IU.

It doesn't state what a port, having sent a Port Logout IU, does upon receiving a non-acknowledgement IU before the ACK IU. The text in 6.5.3.4 *Interleaving acknowledgement and other frame types* allows the receiver of a Port Logout IU to continue sending a frame in progress. Consequently the sender of a Port Logout IU may receive one non-acknowledgement IU before the ACK IU.

The same problem appears in 4.3.2.3.2 *Transition P1: Login to P0: Initial.*

Since the receiver of a Port Logout IU has to abort all open exchanges (see 6.5.5 *Port Logout information unit*), it seems reasonable for the sender of the Port Logout IU to ACK and discard any non-acknowledgement IU received. Does the group agree?

I'm not keen to add text to the state machine description to solve this problem, principally because the discarding non-acknowledgement information units in between sending the Port Logout IU and receiving the ACK IU hints at the need for a new state. I don't want to go there. A search of the text shows that we've specified discarding of frames both within the state machine specification and outside of it. I suggest we add text in 6.5.5 *Port logout information unit.*

How does the group wish to proceed with this issue?