To: INCITS T10 Committee
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Subject: ADT Link service error recovery

1   Revision History

Revision 3:
Incorporate input from March 8, 2004 meeting. Restructured section 4.7.2 and added error recovery for link service frames besides Port Login IUs.

Revision 2:
Updated the error recovery tables. Incorporate input from February 23, 2004 teleconference.

Revision 1:
Incorporate input from February 9, 2004 teleconference.

Revision 0:
Initial proposal

2   Discussion

The current error recovery section does not address error recovery of link service frames. The following table summarizes the intended recovery procedures for each frame type and port state. "Corrupted" errors become retryable errors and are not listed in the table. Symbol framing errors don't relate to frames and always have the same recovery procedure and therefore are not listed in the table.

Legend: retryable (sender detected error)   protocol – should never happen
              resource limitation   recoverable (only possible for non-link service frames)

              none: no error recovery method is currently defined
              impossible: can't happen
              illegal: not valid to send the frame type in the corresponding state

Transmitter error recovery

Frame State	Port Login	Port Logout	NOP	Pause	Initiate Recovery	Other frame types
P0 Initial	Illegal (port login is always sent from p1 login) None None Impossible	Resend None None Impossible	Resend None None Impossible	Illegal	Illegal	Illegal
P1 Login	Initiate new login exchange – transition to P1 None None Impossible	Resend None None Impossible	Resend None None Impossible	Illegal	Illegal	Illegal
P2 Logged-in / TS Active	Illegal	Resend None None Impossible	Resend None None Impossible	Resend None None Impossible	N/A None None Impossible	Transition to T1 Resend None None Transition to T1

						Resend
P2 Logged-in / TS Paused	Illegal	Illegal	Illegal	Illegal	Illegal	Illegal
P4 Logged Out	Illegal	Illegal	Illegal	Illegal	Illegal	Illegal
T1 Initiate Recovery	Illegal	Resend None None Impossible	Resend None None Impossible	Resend None None Impossible	Transition to T2 and Resend Resend Resend Impossible	Illegal
T2 Retry Initiate Recovery	Illegal	Resend None None Impossible	Resend None None Impossible	Resend None None Impossible	Abort open exchanges & initiate Login exchange with default params (AOE = 1) " " Impossible	Illegal

Receiver error recovery

Frame State	Port Login	Port Logout	NOP	Pause	Initiate Recovery	Other frame types
P0 Initial	Nak w/ PR 0 Nak w/ PR 0 Nak w/ PR 0	Nak w/ PR 0 Nak w/ PR 0 Nak w/ PR 0	Nak w/ PR 0 Nak w/ PR 0 Nak w/ PR 0	Nak w/ PR 0 Nak w/ PR 0 Nak w/ PR 0	Nak w/ PR 0 Nak w/ PR 0 Nak w/ PR 0	Nak w/ PR 0 Nak w/ PR 0 Nak w/ PR 0
P1 Login	Nak w/ PR 0 – Transition to N1 Nak w/ PR 0 Transition to N1 Nak w/ PR 0 Transition to N1	Nak w/ PR 0 Nak w/ PR 0 Nak w/ PR 0	Nak w/ PR 0 Nak w/ PR 0 Nak w/ PR 0	Nak w/ PR 0 Nak w/ PR 0 Nak w/ PR 0	Nak w/ PR 0 Nak w/ PR 0 Nak w/ PR 0	Nak w/ PR 0 Nak w/ PR 0 Nak w/ PR 0
P2 Logged-in / T0 Active	Nak w/ PR 0 Nak w/ PR 0 Nak w/ PR 0	Nak w/ PR 0 Nak w/ PR 0 Nak w/ PR 0	Nak w/ PR 0 Nak w/ PR 0 Nak w/ PR 0	Nak w/ PR 0 Nak w/ PR 0 Nak w/ PR 0	Nak w/ PR 0 Nak w/ PR 0 Nak w/ PR 0	Nak w/ PR 0 Nak w/ PR 0 Nak w/ PR 1 Transition to R1
P2 Logged-in / T1 Paused	Nak w/ PR 0 Nak w/ PR 0 Nak w/ PR 0	Nak w/ PR 0 Nak w/ PR 0 Nak w/ PR 0	Nak w/ PR 0 Nak w/ PR 0 Nak w/ PR 0	Nak w/ PR 0 Nak w/ PR 0 Nak w/ PR 0	Nak w/ PR 0 Nak w/ PR 0 Nak w/ PR 0	Nak w/ PR 0 Nak w/ PR 0 Nak w/ PR 1 Transition to R1
P4 Logged Out	Nak w/ PR 0 Nak w/ PR 0 Nak w/ PR 0	Nak w/ PR 0 Nak w/ PR 0 Nak w/ PR 0	Nak w/ PR 0 Nak w/ PR 0 Nak w/ PR 0	Nak w/ PR 0 Nak w/ PR 0 Nak w/ PR 0	Nak w/ PR 0 Nak w/ PR 0 Nak w/ PR 0	Nak w/ PR 0 Nak w/ PR 0 Nak w/ PR 1 Transition to R1
R1 Pending Recovery	Nak w/ PR 0 Nak w/ PR 0 Nak w/ PR 0	Nak w/ PR 0 Nak w/ PR 0 Nak w/ PR 0	Nak w/ PR 0 Nak w/ PR 0 Nak w/ PR 0	Nak w/ PR 0 Nak w/ PR 0 Nak w/ PR 0	Nak w/ PR 0 Nak w/ PR 0 Nak w/ PR 0	Nak w/ PR 0 Nak w/ PR 0 Nak w/ PR 1
R2 Recovering	Nak w/ PR 0 Nak w/ PR 0 Nak w/ PR 0	Nak w/ PR 0 Nak w/ PR 0 Nak w/ PR 0	Nak w/ PR 0 Nak w/ PR 0 Nak w/ PR 0	Nak w/ PR 0 Nak w/ PR 0 Nak w/ PR 0	Nak w/ PR 0 Nak w/ PR 0 Nak w/ PR 0	Nak w/ PR 0 Nak w/ PR 0 Nak w/ PR 1

ADT Revision 10 currently includes the following error recovery subclauses:

4.7 link layer error recovery

4.7.1 Error detection
4.7.1.1 Error detection overview
4.7.1.2 Error detection by the frame sender
4.7.1.3 Error detection by the frame receiver

3 Proposed changes

These changes apply to ADT revision 10.

Add N5:Login complete state to handle the successful completion of the login process and allows N0:Idle to be used for error cases.
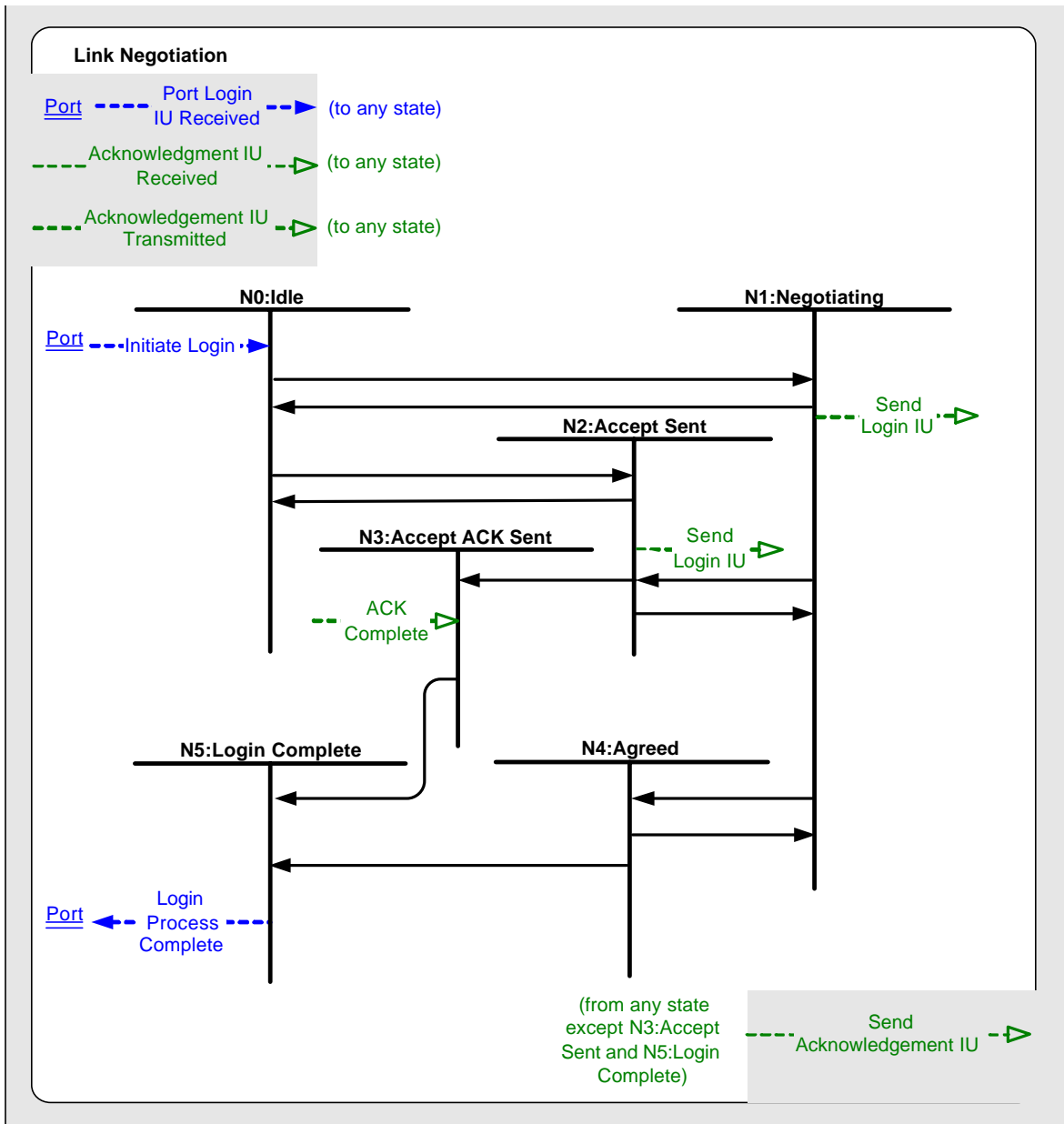
Globally change N4:Complete to N4:Agreed

4.3.3.1
add
   f) N5:Login Complete

replace existing Figure 5 Link Negotiation state diagram with the following diagram

Link Negotiation

Port - - - - Port Login IU Received - - ▶ (to any state)

- - - - Acknowledgment IU Received - -▷ (to any state)

- - - - Acknowledgement IU Transmitted - -▷ (to any state)

N0:Idle   **N1:Negotiating**

Port - - -Initiate Login - -▶

- - - - Send Login IU - -▷

N2:Accept Sent

- - - - Send Login IU - -▷

N3:Accept ACK Sent

- - ACK Complete - -▷

N5:Login Complete   **N4:Agreed**

Port ◀- - Login Process Complete - - - -

(from any state except N3:Accept Sent and N5:Login Complete) - - - - Send Acknowledgement IU - -▷

4.3.3.3.1 State Description (N0:Idle)
The N0:Idle state waits for the port to receive a Port Login IU.

4.3.3.3.2 Transition N0:Idle to N1:Negotiating
This transition shall occur when 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 ACCEPT bit set to zero and parameters changed.

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.

4.3.3.3.3 Transition N0:Idle to N2:Accept Sent
If the received Port Login IU has the ACCEPT bit is set to zero and the parameters are acceptable, the port shall transition to N2:Accept Sent and send a Port Login IU with the parameters unchanged and the ACCEPT bit set to one.

4.3.3.4.1 State description (N1)
If the port transitioned to this state due to an Initiate Login message, the port shall send a Port Login IU in a new

exchange. If the AOE bit is set, the Port Login IU shall be sent with default starting parameters as the contents.

If the port transitioned to this state due to a negotiation error, the port shall send a Port Login IU in a new exchange with default starting parameters as the contents.

When a Port Login IU message is received, the parameters shall be inspected.

If the Port Login IU parameters are not acceptable, 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 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 initiate a new Port Login exchange with default starting parameters as the contents.~~

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, and initiate a new Port Login exchange.

4.3.3.4.2 Transition N1:Negotiating to N0:Idle (new section)
If a port receives a Port Login IU with a protocol error or resource limitation error, the port shall send a NAK IU and transition to N0:Idle.

4.3.3.5.2 Transition N2:Accept Sent to N0:Idle (new section)
If a port receives a Port Login IU with a protocol error or resource limitation error, the port shall send a NAK IU and transition to N0:Idle.

4.3.3.6.2 Transition N3:Accept ACK Sent to N5:Login Complete
When the ACK IU has finished transmitting, the port shall transition to N5:Login Complete and set its operating parameters to the negotiated values.

4.3.3.7.2 Transition N4:Agreed to N5:Login Complete
After receiving an ACK IU for the Port Login IU it sent, the port shall transition to N5:Login Complete and set its operating parameters to the negotiated values.

4.3.3.8 N5:Login Complete state
4.3.3.8.1 State description

A port enters this state when both ports have sent and received a Port Login IU with the ACCEPT bit set to one. Upon entry into this state, a Login Process Complete message shall be sent to the port state machine.

Renumber 4.7.2 subclauses to the following:

4.7.2 Error recovery
4.7.2.1 Corrupted frame
When a port detects corruption of a received frame it shall discard the frame and shall not send an acknowledgement IU.

NOTE: The sender of the frame detects a retryable error upon a timeout without receipt of an acknowledgement IU and performs error recovery as defined in section 4.6.2.2.

4.7.2.2 Error recovery for symbol framing errors

After detecting four or more symbol framing errors without the receipt of a frame, a port shall abort all exchanges, set the operating parameters of the interface to default settings, transition to P1:Login and initiate a Port Login exchange with the AOE bit set to one.

4.7.2.3 Recoverable error
Same as 4.7.2.7.

4.7.2.4 Retryable error
4.7.2.4.1 Port Login IU
A port that is in P1:Login that receives a NAK IU or detects an acknowledgment IU time-out shall restart the negotiation by transitioning to N1:Negotiating, setting operating parameters to default (see 4.2), and initiating a[0] new login exchange using starting parameters.

4.7.2.4.2 Port Logout, NOP and Pause IUs
If the port detects an acknowledgement IU time-out, the port may resend the IU. If sent, the IU shall be within a new exchange.

If the port receives a NAK IU due to a resource limitation, the port may resend the IU. If sent, the IU shall be within a new exchange.

If the port receives a NAK IU due to any other error condition, the behavior is not specified.

4.7.2.4.3 Initiate Recovery IU
For error recovery on Initiate Recovery IUs, see 4.7.2.4.4.

4.7.2.4.4 Non link service IUs
Same as current 4.7.2.2

4.7.2.5 Protocol error
4.7.2.5.1 Port Login IU
If a protocol error is detected on a Port Login IU, the port shall send a NAK IU, set the operating parameters to default (see 4.2) and transition to P1:Login, sub state N0:Idle.

4.7.2.5.2 Port Logout, NOP, Initiate Recovery and Pause IUs
If a protocol error is detected on a Port Logout IU, NOP IU, Initiate Recovery IU or Pause IU, the port shall send a NAK IU with PR bit set to zero and appropriate status code and discard the frame.

4.7.2.5.3 Non link service IUs
Same as 4.7.2.4

4.7.2.6 Resource limitation
4.7.2.5.1 Port Login IU
If a resource limitation error is detected on a Port Login IU, the port shall send a NAK IU, set the operating parameters to default (see 4.2) and transition to P1:Login, sub state N0:Idle.

4.7.2.5.2 Port Logout, NOP, Initiate Recovery and Pause IUs
If a resource limitation error is detected on a Port Logout IU, NOP IU, Initiate Recovery IU or Pause IU, the port shall send a NAK IU with PR bit set to zero and appropriate status code and discard the frame.

4.7.2.5.3 Non link service IUs
Same as 4.7.2.5