AX.25 version 2.2 State Diagrams

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Legend

State

Signal Reception

DL-RELEASE Request

SABM

Signal Generator

DL-UNIT-DATA

UI command

(p - 0)

Internal Signal

Generator & Reception

push on I frame queue

I frame pops off queue

Processing Description

stop T2

start T1

Test

peer receiver busy?

Subroutine Call

establish data link

Subroutine Start

start transmitter

Return from Subroutine
Data Link Disconnected State — State 0

- 0 disconnected
- control field error
- info not permitted in frame
- Incorrect U or S frame length
- UA
- DM
- UI
- DL-CONNECT request
- DL-DISCONNECT request
- all other commands
- all other primitives
- DL-ERROR indication (L)
- DL-ERROR indication (M)
- DL-ERROR indication (N)
- DL-ERROR indication (C, D)

- UI Check
- P = 1 ?
- Yes
- DM \( F = 1 \) (expedited)
- No

- SAT \(<--\) initial default
- TIV \(<--\) 2 * SAT
- able to establish ?
- Yes
- UA (expedited)
- clear exception conditions
- No
- DM (expedited)
- set layer 3 initiated
- V(s) \(<--\) 0
- V(a) \(<--\) 0
- V(r) \(<--\) 0
- DL-CONNECT indication
- SAT \(<--\) initial default
- TIV \(<--\) 2 * SAT
- start T3

- 1 awaiting connection
- 3 connected
Data Link Connected State — State 3 (page 1 of 3)
Data Link Timer Recovery State — State 4 (1 of 3)

1 awaiting connection

2 awaiting release

4 timer recovery

4 timer recovery

4 timer recovery

O disconnected
Data Link Subroutines (1 of 2)
Data Link Subroutines (2 of 2)

- check need for response
  - command & P = 1?
    - Yes
    - No
      - enquiry response & F = 1?
        - Yes
        - No
          - DL-ERROR indication (A)
  - info field length <= N1 and content is octet aligned
    - Yes
    - No
      - DL-UNIT-DATA indication

UI check

- command?
  - Yes
  - No
    - select T1 value
      - AC = 0?
        - Yes
        - No
          - DL-ERROR indication (Q)
      - new SAT <- (7/8*SAT) + (1/8*old T1 value) - (1/8*remaining time on T1 when last stopped)
      - T1 expired?
        - Yes
        - No
          - next T1 value * 2**(AC + 1) times SAT
          - next T1 value * 2**(AC + 1) times SAT

- DL-ERROR indication (K)
Link Multiplexor Idle State — State 0

Note -- Only the awaiting queue is served in this state

0 idle

LM-EXPEDITED-DATA request

any other LM primitive

LM-DATA request

LM-SEIZE request

LM-RELEASE request

queue empty

PH-SEIZE request

queue event

PH-EXPEDITED-DATA request

PH-EXPEDITED-DATA request

current DL < requesting DL

move all events submitted by current date link to the current queue

PH-SEIZE request

move all events which are now in the served queue onto the awaiting queue

PH-SEIZE request

PH-SEIZE request

PH-RELEASE request

frame received

PH-BUSY indication

suspend all link layer timing

PH-QUIET indication

resume all link layer timing

0 idle

0 idle

0 idle

1 seize pending

0 idle

0 idle

0 idle

0 idle

0 idle

0 idle

0 idle
Link Multiplexor Seize Pending State — State 1

Note -- Only the current queue is served in this state

- 1 seize pending
- LM-EXPEDITED-DATA request
- any other LM primitive
- LM-DATA request
- LM-SEIZE request
- LM-RELEASE request
- queue empty
- PH-SEIZE confirm
- PH-DATA indication
- PH-BUSY indication
- PH-QUIET indication
- PH-EXPEDITED-DATA request
- queue event
- replace on current queue
- finish current transmission
- LM-SEIZE confirm
- frame received
- suspend all link layer timing
- resume all link layer timing
- halt processing of the current queue until a new state is reached

- 0 idle
- 1 seize pending
- 1 seize pending
- 1 seize pending
- 0 idle
- 1 seize pending
- 2 seized
- 1 seize pending
- 1 seize pending
- 1 seize pending
Link Multiplexor Seize State — State 2

Note — Only the current queue is served in this state.

FLOWCHART:

- LM-EXPEDITED-DATA request
  - any other LM primitive
  - LM-DATA request
  - LM-SEIZE request
  - M-RELEASE request
  - queue empty
  - LM-RELEASE request
    - PH-DATA request
    - PH-SEIZE confirm
    - PH-BUSY indication
    - PH-QUIET indication
    - frame received
    - suspend all link layer timing
    - resume all link layer timing

- PH-EXPEDITED-DATA request
  - queue event
  - PH-DATA request
  - PH-SEIZE confirm
  - PH-QUIET indication
  - PH-RELEASE request
  - PH-QUIET indication

- 0 idle
- 2 seized

- finish current transmission
- 2 seized
- 0 idle
- 2 seized
- 2 seized
- 2 seized
- 2 seized
- 2 seized
- 2 seized
Link Multiplexor Subroutines

Note - The LM-DATA indication primitive is sent to the data link machine which is responsible for communications with the indicated remote (source) station.
Management Data Link Ready State — State 0

- 0 ready
- MDL-NEGOTIATE request
  - initiate classes of procedures negotiation
  - initiate optional functions negotiation
  - initiate N1 notification
  - initiate window notification
  - initiate retry negotiation
  - initiate T1 negotiation

Management Data Link Negotiating State — State 1

- 1 negotiating
- MDL-NEGOTIATE request
  - XID command
  - XID response
  - initiate classes of procedures negotiation
  - initiate optional functions negotiation
  - initiate N1 notification
  - initiate window notification
  - initiate retry negotiation
  - initiate T1 negotiation

- AC < 0; P < 1; start TM201
- XID command
  - XID response (expedited)

- 1 negotiating
  - XID command
  - XID response
  - TM201 expiry
  - XID response
  - complete classes of procedures negotiation
  - complete optional functions negotiation
  - complete N1 notification
  - complete window notification

- AC < AC+1
  - N1 notification response
  - window notification response
  - retry negotiation response
  - negotiation response

- XID rejected
  - FMR response
  - set segmentor off set version 2.0 defaults

- AC = AC+1
  - XID request
    - initiate classes of procedures negotiation
    - initiate optional functions negotiation
    - initiate N1 notification
    - initiate window notification
    - initiate retry negotiation
    - initiate T1 negotiation

- XID command
  - XID response
  - TM201
  - F = 1?
    - Yes
      - AC = AC+1
      - XID request
        - initiate classes of procedures negotiation
        - initiate optional functions negotiation
        - initiate N1 notification
        - initiate window notification
        - initiate retry negotiation
        - initiate T1 negotiation
      - XID command
        - XID response
        - set segmentor off set version 2.0 defaults
  - No
    - initiate retry negotiation

- AC > AC+1
  - AC = AC+1
  - XID command
    - XID response
    - initiate retry negotiation
    - initiate T1 negotiation

- XID command
  - XID response
  - TM201
  - stop TM201
  - MDL-NEGOTIATE confirm

- 0 ready
- 0 ready
- 0 ready
- 0 ready
- 0 ready
- 0 ready
- 0 ready
- 0 ready
- 0 ready
- 0 ready
Parameter Negotiation N1 Notification Subroutines

1. **initiate N1 notification**
   - N1 notification requested?
     - Yes
     - **add RX N1 parameter field to XID command**
     - N1 parameter field present?
       - Yes
       - TX N1 acceptable?
         - Yes
         - change to new TX N1 from XID command
         - set TX N1 to default
         - **add RX N1 parameter field to XID response**
         - complete N1 notification
       - Yes
       - **set TX N1 to default**
       - **add RX N1 parameter field to XID response**
       - complete N1 notification
     - Yes
     - **add RX N1 parameter field to XID command**
     - complete N1 notification
   - No
   - N1 parameter field present?
     - Yes
     - TX N1 acceptable?
       - Yes
       - change to new TX N1 from XID command
       - set TX N1 to default
       - **add RX N1 parameter field to XID response**
       - complete N1 notification
     - No
     - **add RX N1 parameter field to XID command**
     - complete N1 notification
   - complete N1 notification

Parameter Negotiation Window Notification Subroutines

1. **initiate window notification**
   - window parameter field present?
     - Yes
     - window parameter field requested?
       - Yes
       - add RX k parameter field to XID command
       - window parameter field present?
         - Yes
         - new k acceptable?
           - Yes
           - change to new TX k from XID command
           - set TX k to default
           - **add RX k parameter field to XID response**
           - change to new TX k from XID response
         - No
         - **change to default k**
         - **add RX k parameter field to XID response**
         - complete window notification
       - No
       - **change to default TX k**
       - **add RX k parameter field to XID response**
       - complete window notification
     - Yes
     - **add RX k parameter field to XID command**
     - complete window notification
   - No
   - window parameter field requested?
     - Yes
     - **add RX k parameter field to XID command**
     - complete window notification
     - complete window notification
   - complete window notification
Parameter Negotiation Retry Negotiation Subroutines

1. **initiate retry negotiation**
   - retry negotiation requested?
     - Yes: retry negotiation response
     - No: retry negotiation requested?
       - Yes: retry parameter field present?
         - Yes: add retry parameter field to XID command
         - No: new N2 acceptable?
           - Yes: change to new N2 from XID command
           - No: select and change to smaller N2
             - add N2 parameter field to XID response
     - No: new N2 acceptable?
       - Yes: change to new N2 from XID command
       - No: select and change to smaller N2
         - add N2 parameter field to XID response

Parameter Negotiation T1 Negotiation Subroutines

1. **initiate T1 negotiation**
   - T1 negotiation requested?
     - Yes: T1 parameter field present?
       - Yes: add T1 parameter field to XID command
       - No: new T1 acceptable?
         - Yes: change to new T1 from XID command
         - No: select and change to smaller T1
           - add T1 parameter field to XID response
     - No: new T1 acceptable?
       - Yes: change to new T1 from XID command
       - No: select and change to smaller T1
         - add T1 parameter field to XID response

   - complete T1 negotiation

   - T1 negotiation response
Parameter Negotiation Classes of Procedures Negotiation Subroutines

<table>
<thead>
<tr>
<th>initiate classes of procedures negotiation</th>
<th>classes of procedures negotiation response</th>
</tr>
</thead>
<tbody>
<tr>
<td>optional functions negotiation requested?</td>
<td>optional functions parameter field present?</td>
</tr>
<tr>
<td>select required functions</td>
<td>full-duplex acceptable?</td>
</tr>
<tr>
<td>add optional functions parameter field to XID command</td>
<td>set half-duplex</td>
</tr>
<tr>
<td>add optional functions parameter to XID response</td>
<td>set full-duplex</td>
</tr>
<tr>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>

Parameter Negotiation Optional Functions Negotiation Subroutines

<table>
<thead>
<tr>
<th>initiate optional functions negotiation</th>
<th>optional functions negotiation response</th>
</tr>
</thead>
<tbody>
<tr>
<td>optional functions negotiation requested?</td>
<td>optional functions parameter field present?</td>
</tr>
<tr>
<td>select required functions</td>
<td>full-duplex selected?</td>
</tr>
<tr>
<td>add optional functions parameter field to XID command</td>
<td>set half-duplex</td>
</tr>
<tr>
<td>set full-duplex</td>
<td>add optional functions parameter field to XID command</td>
</tr>
<tr>
<td>modulo 128 acceptable?</td>
<td>set normal</td>
</tr>
<tr>
<td>set extended</td>
<td></td>
</tr>
<tr>
<td>SREJ/REJ acceptable?</td>
<td>SREJ &amp; REJ selected?</td>
</tr>
<tr>
<td>SREJ selected?</td>
<td>select selective reject</td>
</tr>
<tr>
<td>select implicit reject</td>
<td></td>
</tr>
<tr>
<td>select selective reject-reject</td>
<td></td>
</tr>
<tr>
<td>add optional functions parameter field to XID response</td>
<td>modulo 128 acceptable?</td>
</tr>
<tr>
<td>set normal</td>
<td></td>
</tr>
<tr>
<td>set extended</td>
<td></td>
</tr>
<tr>
<td>SREJ &amp; REJ selected?</td>
<td>SREJ &amp; REJ rejected</td>
</tr>
<tr>
<td>SREJ rejected</td>
<td></td>
</tr>
<tr>
<td>SREJ selected?</td>
<td>select selective reject</td>
</tr>
<tr>
<td>select selective reject-reject</td>
<td></td>
</tr>
<tr>
<td>add optional functions parameter field to XID response</td>
<td>modulo 128 acceptable?</td>
</tr>
<tr>
<td>set normal</td>
<td></td>
</tr>
<tr>
<td>set extended</td>
<td></td>
</tr>
<tr>
<td>SREJ &amp; REJ selected?</td>
<td>SREJ &amp; REJ rejected</td>
</tr>
<tr>
<td>SREJ rejected</td>
<td></td>
</tr>
<tr>
<td>SREJ selected?</td>
<td>select selective reject</td>
</tr>
<tr>
<td>select selective reject-reject</td>
<td>complete classes of procedures negotiation</td>
</tr>
</tbody>
</table>
Duplex Physical Receiver Ready State — State 0

0 receiver ready

- Acquisition of signal
- All other primitives

Stop all timers

- Discard erroneous primitive
- PH-BUSY indication

1 receiving

0 receiver ready

Duplex Physical Receiver Ready State — State 1

1 receiving

- Frame
- Loss of signal

PH-DATA indication

PH-QUIET indication

1 receiving

0 receiving
**Duplex Physical Transmitter Ready State — State 0**

- PH-SIEZE request
  - start T103
  - turn on transmitter
  - 0 transmitter ready
  - 1 transmitter start

- PH-RELEASE request
  - all other primitives
  - add to normal queue
  - 0 transmitter ready
  - 0 transmitter ready

**Duplex Physical Transmitter Start State — State 1**

- 1 transmitter start
  - T103 expiry
  - add to normal queue
  - 2 transmitting
  - 1 transmitter start

- PH-SEIZE confirm
  - add to normal queue
Duplex Physical Transmitter State — State 2

2 transmitting

PH-SEIZE request

PH-SEIZE confirm

PH-RELEASE request

PH-RELEASE confirm

PH-DATA request

PH-DATA request

PH-EXPEDITED-DATA request

all other primitives

turn off transmitter

2 transmitting

0 transmitter ready

2 transmitting

frame

add to normal queue

2 transmitting

2 transmitting

2 transmitting

2 transmitting
Simplex Physical Ready State — State 0

0 ready

NOTE: Normal queue processing is enabled. Digipeater queue is empty

PH-EXPEDITED-DATA request

all other primitives

PH-SEIZE request

PH-RELEASE request

PH-DATA request

T102 expiry

acquisition of signal

all other primitives

add frame to priority queue

add to normal queue

PH-SEIZE request

PH-RELEASE request

PH-DATA request

T102 expiry

acquisition of signal

all other primitives

clear digipeating

start digipeating

start transmitter

clear erroneous primitive

discard erroneous primitive

discard erroneous primitive

set digipeating

start transmitter

0 ready

3 transmitter start

3 transmitter start

0 ready

0 ready

0 ready

0 ready

1 receiving

0 ready
Simplex Physical Receiving State — State 1

- **1 receiving**

  **NOTE** - Normal queue and digipeating queue processing is suspended

- **PH-EXPEDITED-DATA request**
  - add frame to priority queue

- **all other primitives**
  - add to normal queue

- **PH-SEIZE request**
  - PH-DATA indication
  - loss of signal

  - start T100
  - start T101
  - PH-QUIET indication

- **priority queue empty?**
  - Yes
    - set digipeating
    - start transmitter

  - No
    - 3 transmitter start
    - 2 transmitter suppression
Simplex Physical Transmitter Suppression State — State 2

NOTE - Normal queue and digipeating queue processing is suspended

PH-EXPEDITED-DATA request

all other primitives

add priority frame to queue

add to normal queue

clear repater up

acquisition of signal

discard erroneous primitive

T100 expiry

T101 expiry

T102 expiry

priority queue empty?

R - p

(note 2)

interrupted?

priority queue empty?

R < random number in range 0 to 1

set digipeater

start transmitter

start transmitter

resume processing normal queue

start T102

start transmitter

start transmitter

0 ready

2 transmitter suppression

3 transmitter suppression

1 receiving

3 transmitter suppression

2 transmitter suppression

0 ready

2 transmitter suppression

3 transmitter suppression

Note 2 - p is the persistence parameter in the range 0 to 1
**Simplex Physical Transmitter Start State — State 3**

3 transmitter start

NOTE: Normal queue and digipeating queue processing are suspended

- **PH-EXPEDITED**
  - PH-EXPEDITED-EXPEDITED- DATA request
  - add frame to priority queue

- **all other primitives**
  - T100 expiry
  - add to normal queue

- **T104 expiry**
  - T103 expiry

- **T105 expiry**
  - T105 expiry
  - clear repeater up
  - T103 expiry

- **T104 expiry**
  - set repeater up

- **T106 expiry**
  - start T105
  - start T105
  - start T104

- **T107 expiry**
  - digipeating
  - start T106

- **interrupted**
  - PH-SEIZE

- **resume processing priority queue**

3 transmitter start
3 transmitter start
3 transmitter start
3 transmitter start
3 transmitter start
3 transmitter start
5 digipeating
4 transmitting
**Simplex Physical Transmitter State — State 4**

NOTE - Normal queue processing is enabled. Digipeat queue processing is suspended.

- **PH-EXPEDITED DATA request**
  - add frame to priority queue
- **all other primitives**
  - PH-SEIZE request
  - add to normal queue
  - PH-SEIZE confirm
  - PH-DATA request
  - frame
  - set interrupted
  - PH-RELEASE request
  - stop T107
    - clear interrupted
    - suspend all queue processing
    - priority queue empty?
      - Yes
        - stop T106
      - No
        - resume processing, digipeat queue
        - set digipeating
        - digipeat queue
- **T106 expiry**
  - stop T107
  - set interrupted
  - suspend all queue processing
  - T106 expiry
  - stop T107
Simplex Physical Digipeating State — State 5

NOTE - Normal queue processing is suspended. Digipeat queue processing is enabled.

PH-EXPEDITED-DATA request

all other primitives

priority frame

priority queue empty

T106 expiry

add frame to priority queue

add to normal queue

frame

turn off transmitter

clear digipeating

start T108

suspend processing digipeat queue

6 receiver start
Simplex Physical Receiver Start State — State 6

NOTE - Normal queue and digipeat queue processing is suspended.

- 6 receiver start
- PH-EXPEDITED-DATA request
  - add frame to priority queue
  - PH-QUIET indication

- all other primitives
  - add to normal queue
  - T108 expiry
  - start T100
  - start T101

Simplex Physical Subroutines

- start transmitter
  - suspend priority queue processing
  - suspend all normal queue processing
  - stop all timers
  - expect T100
  - start T103
  - PH-BUSY indication
  - turn on transmitter

- acquisition
  - set repeater up
  - stop all timers
  - suspend priority queue processing
  - suspend normal queue processing
  - PH-BUSY indication
Reassembler Ready State — State 0

0 ready

all other DL primitives

send unmodified primitive

0 ready

DL-DATA indication

segment info element present?

No

Yes

DL-DATA indication

first segment?

No

Yes

allocate buffers for all segments

accumulate first segment

N ← number of segments remaining

start TR210

0 ready

0 ready

1 reassembling data

DL-DATA indication

DL-UNIT-DATA indication

segment info element present?

No

Yes

allocate buffers for all segments

accumulate first segment

DL error (Z) indication

0 ready

0 ready

1 reassembling data

0 ready

2 reassembling unit data

0 ready
Reassembler Reassembling Data State — State 1

1 reassembling data

TR210 expiry

discard all accumulated segments

DL-ERROR indication (Z)

DL-DATA indication

segment PID present?

Yes

Discard all accumulated segments

No

Subsequent segment?

Yes

Discard all accumulated segments

No

number remaining segments=N?

Yes

Discard all accumulated segments

No

N = 0 ?

Yes

Stop TR210

No

Restart TR210

assemble this segment to previous

assembly last segment to previous

DL-DATA indication

0 ready

1 reassembling data

0 ready

0 ready

Reassembler Reassembling Unit Data State — State 2

2 reassembling unit data

TR210 expiry

discard all accumulated segments

DL-ERROR indication (Z)

DL-UNIT-DATA indication

all other DL primitives

TR210 expiry

discard all accumulated segments

DL-ERROR indication (Z)

all other DL primitives

segment PID present?

Yes

Discard all accumulated segments

No

Subsequent segment?

Yes

Discard all accumulated segments

No

number remaining segments=N?

Yes

Discard all accumulated segments

No

N = 0 ?

Yes

Stop TR210

No

Restart TR210

assemble this segment to previous

assembly last segment to previous

DL-DATA indication

0 ready

2 reassembling unit data

0 ready

0 ready

0 ready
Segmenter Ready State — State 0

0 ready

DL-DATA request

longer than \(N1\) octets ?

Yes

No

DL-DATA request

longer than \((N1 \times 128)\) ?

Yes

No

DL-DATA request

divide into segments

Insert segments into elements at start of each segment

DL-DATA request

all segments sent?

Yes

No

0 ready

DL-DATA request

longer than \(N1\) octets ?

Yes

No

DL-DATA request

longer than \((N1 \times 128)\) ?

Yes

No

DL-DATA request

divide into segments

Insert segments into elements at start of each segment

DL-DATA request

all segments sent?

Yes

No

0 ready

DL-DATA request

longer than \(N1\) octets ?

Yes

No

DL-DATA request

longer than \((N1 \times 128)\) ?

Yes

No

DL-DATA request

divide into segments

Insert segments into elements at start of each segment

DL-DATA request

all segments sent?

Yes

No

0 ready

DL-DATA request

longer than \((N1 \times 128)\) ?

Yes

No

DL-DATA request

divide into segments

Insert segments into elements at start of each segment

DL-DATA request

all segments sent?

Yes

No

0 ready

DL-DATA request

longer than \((N1 \times 128)\) ?

Yes

No

DL-DATA request

divide into segments

Insert segments into elements at start of each segment

DL-DATA request

all segments sent?

Yes

No

0 ready