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4.2 *Primitive procedures*

4.2.1 *General*

Primitive procedures specify the interactions between adjacent layers to invoke and provide a service. The service primitives represent the elements of the procedures.

In the scope of this Recommendation the interactions between layer 3 and the data link layer are specified.

4.2.2 *Layer 3 — Data link layer interactions*

The states of a data link connection endpoint may be derived from the internal states of the data link layer entity supporting this type of a data link connection.

Data link connection endpoint states are defined as follows:

a) Broadcast data link connection endpoint:

— *information transfer* state.

b) Point-to-point data link connection endpoint:

— *link connection released* state;

— *awaiting establish* state;

— *awaiting release* state;

— *link connection established* state.

The primitives provide the procedural means to specify conceptually how a data link service user can invoke a service.

This section defines the constraints on the sequences in which the primitives may occur. The sequences are related to the states at one point-to-point data link connection endpoint.

The possible overall sequences of primitives at a point-to-point data link connection endpoint are defined in the state transition diagram, Figure 8/Q.921. The *link connection released* and *link connection established* states are stable states whilst the *awaiting establish* and *awaiting release* states are transition states.

The model illustrates the behaviour of layer 2 as seen by layer 3. This model assumes that the primitives passed between layers is implemented by a first in first out queue. In this model, ''collisions'' of REQUEST and INDICATION primitives can occur thereby illustrating actions that seem to be in conflict with the actual layer 2 protocol description. In some implementations, these collisions could occur.

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Figure 8/Q.921, p.

Figure 8/Q.921 (Notes), p.

5 Definition of the peer-to-peer procedures of the data link layer

The procedures for use by the data link layer are specified in the following sections.

The elements of procedure (frame types) which apply are:

a) for unacknowledged information transfer (§ 5.2):

UI-command;

b) for multiple frame acknowledged information transfer (§§ 5.5 to 5.8):

SABME-command,

UA-response,

DM-response,

DISC-command,

RR-command/response,

RNR-command/response,

REJ-command/response,

I-command,

FRMR-response;

c) for connection management entity information transfer:

XID-command/response.

5.1 *Procedure for the use of the P/F bit*

5.1.1 *Unacknowledged information transfer*

For unacknowledged information transfer the P/F bit is not used and shall be set to 0.

5.1.2 *Acknowledged multiple frame information transfer*

A data link layer entity receiving an SABME, DISC, RR, RNR, REJ or I frame, with the P bit set to 1, shall set the F bit to 1 in the next response frame it transmits, as defined in Table 7/Q.921.

H.T. [T13.921]

TABLE 7/Q.921

Immediate response operation of P/F bit

{
Command received with P bit = 1
}
Response transmitted with F bit = 1
}
	{

SABME, DISC	UA, DM
I, RR, RNR, REJ RR, RNR, REJ (note) }	{

Note — A LAPB data link layer entity may transmit an FRMR or DM response with the F bit set to 1 in response to an I frame or supervisory command with the P bit set to 1.

Table 7/Q.921 [T13.921] + Note, p.

5.2 *Procedures for unacknowledged information transfer*

5.2.1 *General*

The procedures which apply to the transmission of information in unacknowledged operation are defined below.

No data link layer error recovery procedures are defined for unacknowledged operation.

5.2.2 *Transmission of unacknowledged information*

Note — The term ‘‘transmission of a UI frame’’ refers to the delivery of a UI frame by the data link layer to the physical layer.

Unacknowledged information is passed to the data link layer by layer 3 or management entities using the primitives DL-UNIT DATA-REQUEST or MDL-UNIT DATA-REQUEST, respectively. The layer 3 or management message unit shall be transmitted in a UI command frame.

For broadcast operation, the TEI value in the UI command address field shall be set to 127 (binary 111 1111, the group value).

For point-to-point operation, the appropriate TEI value shall be used.

The P bit shall be set to 0.

In the case of persistent layer 1 deactivation, the data link layer will be informed by an appropriate indication. Upon receipt of this indication, all UI transmission queues shall be discarded.

Note — The network side system management deactivation procedures should ensure that layer 1 is not deactivated before all UI data transfer is completed.

5.2.3 *Receipt of unacknowledged information*

On receipt of a UI command frame with a SAPI and TEI which are supported by the receiver, the contents of the information field shall be passed to the layer 3 or management entity using the data link layer to layer 3 primitive DL-UNIT DATA-INDICATION or the data link layer to management primitive MDL-UNIT DATA-INDICATION, respectively. Otherwise, the UI command frame shall be discarded.

5.3 *Terminal endpoint identifier (TEI) management procedures*

5.3.1 *General*

TEI management is based on the following procedural means:

— TEI assignment procedures (see § 5.3.2);

— TEI check procedures (see § 5.3.3);

— TEI removal procedures (see § 5.3.4);

— optional user equipment initiated TEI Identity verify procedures (see § 5.3.5).

A user equipment in the *TEI-unassigned* state shall use the TEI assignment procedures to enter the *TEI-assigned* state. Conceptually, these procedures exist in the layer management entity. The layer management entity on the network side is referred to as the Assignment Source Point (ASP) in this Recommendation.

The purpose of these procedures is to:

a) allow automatic TEI equipment to request the network to assign a TEI value that the data link layer entities within the requesting user equipment will use in their subsequent communications;

b) allow a network to remove a previously assigned TEI value from specific or all user equipments;

c) allow a network to check:

— whether or not a TEI value is in use, or

— whether multiple TEI assignment has occurred;

d) allow user equipment the option to request that the network invoke TEI check procedures.

The user side layer management entity shall instruct the user data link layer entities to remove all TEI values when it is notified that the terminal is disconnected at the interface (as defined in Recommendation I.430).

Additionally, the user side layer management entity should instruct the user data link layer entity to remove a TEI value for its own internal reasons (for example, losing the ability to communicate with the network). The layer management entity shall use the MDL-REMOVE-REQUEST primitive for these purposes.

§ 5.3.4.1 includes the actions taken by a data link layer entity receiving an MDL-REMOVE-REQUEST primitive.

Typically, one TEI value would be used by the user equipment (for example, a data link layer entity which has been assigned a TEI value could use that value for all SAPs which it supports). If required, a number of TEI values may be requested by multiple use of the procedures defined in § 5.3.2. It shall be the responsibility of the user to maintain the association between TEI and SAPI values.

The initiation of TEI assignment procedures occurs on the receipt of a request for establishment or unacknowledged information transfer while in the TEI-unassigned state. The data link layer entity shall inform the layer management entity using the MDL-ASSIGN-INDICATION primitive. Alternatively, the user side layer management entity may initiate the TEI assignment procedures for its own reasons.

Note — In the case of initialization from a no power condition, the user equipment should postpone the start of the TEI assignment procedure until a layer 2 service that needs a TEI is to be provided.

All layer management entity messages used for these TEI management procedures are transmitted to, or received from, the data link layer entity using the MDL-UNIT DATA-REQUEST primitive, or the MDL-UNIT DATA-INDICATION primitive, respectively. The data link layer entity shall transmit management entity messages in UI command frames. The SAPI value shall be 63. The TEI value shall be 127.

5.3.2 *TEI assignment procedure*

If the user equipment is of the non-automatic TEI assignment category, the user side layer management entity shall deliver the TEI value to be used to the data link layer entity(s) via the MDL-ASSIGN-REQUEST primitive.

If the user equipment is of the automatic TEI assignment category, upon initiation of the automatic TEI assignment procedure, the user side layer management entity shall transmit to its peer a message containing the following elements:

a) message type = Identity request;

b) Reference number (Ri); and

c) Action indicator (Ai).

The Reference number, Ri, shall be used to differentiate between a number of user equipments which may simultaneously request assignment of a TEI value. The Ri shall be 2 octets in length and shall be randomly generated for each request message by the user equipments.

All values in the range 0 to 65535 shall be available from the random number generator.

Note — The design of the random number generator should minimize the probability of identical reference numbers being generated by terminals which initiate their TEI assignment procedures simultaneously.

The single-octet Action indicator, Ai, shall be used to indicate a request to the ASP for the assignment of any TEI value available.

The coding of the Ai shall be Ai = Group address TEI = 127. This Ai value requests the ASP to assign any TEI value.

A timer T202 shall be started.

The ASP, on receipt of the Identity request message, shall either:

— select a TEI value;

— deny Identity requests with Ai values in the range 64-126, or ignore Identity requests with the Ai value in the range 0-63; or

— ignore the Identity request message if a previous Identity request message that contains an identical Ri has been received and no response has been issued. In this case, the ASP shall not assign a TEI value to either request.

Selection of a TEI value shall be on the basis of information stored at the ASP. This may consist of:

— a map of the full range of automatic TEI values; or

— an updated list of all automatic TEI values available for assignment, or a smaller subset.

The ASP, after having selected the TEI value, shall inform the network data link entities by means of the MDL-ASSIGN-REQUEST primitive and transmit to its peer a message containing the following elements:

a) message type = Identity assigned;

b) Reference number (Ri); and

c) the assigned TEI value in the Ai field.

If the available TEI information/resources are exhausted, a TEI check procedure should be initiated.

A user side layer management entity receiving this Identity assigned message shall compare the TEI value to its own to see if it is already allocated if an Identity request message is outstanding. Additionally, the TEI value may be compared on the receipt of all Identity assigned messages.

If there is a match, the management entity shall either:

— initiate TEI removal; or

— initiate the TEI identity verify procedures.

If there is no match, the user side layer management entity shall:

— compare the Ri value with any outstanding Identity request message and if it matches, consider the TEI value assigned to the user equipment, discard the value of Ri, inform the user side data link layer entities by means of the MDL-ASSIGN-REQUEST primitive and stop timer T202;

— compare the Ri value with any outstanding Identity request message and if there is no match, do nothing;

— if there is no outstanding Identity request message, do nothing.

When the data link layer receives the MDL-ASSIGN-REQUEST primitive from the layer management entity, the data link layer entity shall:

— enter the TEI-assigned state; and

— proceed with data link establishment procedures if a DL-ESTABLISH-REQUEST primitive is outstanding, or proceed with the transmission of a UI command frame if a DL-UNIT DATA-REQUEST primitive is outstanding.

To deny an Identity request message, the ASP shall transmit to its peer a message containing the following elements:

a) message type = Identity denied;

b) Reference number (Ri); and

c) the value of TEI which is denied in the Ai field (a value of 127 indicates that no TEI values are available).

5.3.2.1 *Expiry of timer T202*

If the user receives either no response or an Identity denied message to its Identity request message, then on expiry of timer T202, the timer shall be restarted and the Identity request message shall be retransmitted with a new value of Ri.

After N202 unsuccessful attempts to acquire a TEI value, the layer management entity shall inform the data link layer entity using the MDL-ERROR-RESPONSE primitive. The data link layer entity receiving the MDL-ERROR-RESPONSE primitive shall respond with the DL-RELEASE-INDICATION primitive if a request for establishment had previously occurred, and shall discard all unserviced DL-UNIT DATA-REQUEST primitives.

The values of T202 and N202 are specified in § 5.9.

The TEI assignment procedure is illustrated in Figure 9/Q.921.

Figure 9/Q.921, p.

5.3.3 *TEI check procedure*

5.3.3.1 *Use of the TEI check procedure*

The TEI check procedure shall be used in the TEI audit and recovery procedures. The TEI check procedure allows the network side layer management entity either:

— to establish that a TEI value is in use; or

— to verify multiple TEI assignment

The TEI check procedure for verifying multiple TEI assignment may also optionally be invoked as a response to an Identity verify request message from the user equipment.

5.3.3.2 *Operation of the TEI check procedure*

The TEI check procedure is illustrated in Figure 10/Q.921.

Figure 10/Q.921, p.

The ASP shall transmit a message containing the following elements:

a) message type = Identity check request; and

b) Ai field which contains the TEI value to be checked or the value 127 when all TEI values are to be checked.

Timer T201 shall be started.

If any user equipment has been assigned the TEI value specified in the identity check request message, it shall respond by transmitting a message containing the following elements:

a) message type = Identity check response;

b) the TEI value in the Ai field; and

c) Reference number (Ri).

Note — The randomly-generated Ri is present in the Identity check response to ensure that in the case where more than one user equipment happens to commence transmission of the Identity check response at precisely the same time (i.e., the first ‘‘0’’ bit of the opening flag coincides) due to different Ri values a collision at layer 1 (see ISDN user-network interfaces; layer 1 Recommendations [I.43x series] for clarification) occurs. The resolution of this collision results in multiple Identity check responses.

When the TEI check procedure is used to verify multiple TEI assignment:

— if more than one Identity check response is received within T201, then multiple TEI assignment shall be considered present; otherwise the request shall be repeated once and timer T201 restarted;

— if more than one Identity check response is received within the second T201 period, multiple TEI assignment shall be considered present;

— if no Identity check response is received after both T201 periods, the TEI value shall be assumed to be free and available for (re)assignment;

— if one Identity check response is received in one or both T201 periods, the TEI value shall be assumed to be in use.

When the TEI check procedure is used to test whether a TEI value is in use, it is completed upon the receipt of the first TEI Identity check response message , and the TEI value is assumed to be in use. Otherwise:

— if no Identity check response is received within T201, the identity check request shall be repeated once and timer T201 restarted;

— if no Identity check response is received after the second Identity check request, the TEI value shall be assumed to be free and available for reassignment.

If the Ai value in the Identity check request is equal to 127, it is preferred that the receiving user side layer management entity respond with a single Identity check response message that contains all of the TEI values in use within that user equipment (see § 5.3.5.5). If an Identity check request with Ai equal to 127 is transmitted and an Identity check response is received making use of the extension facility, each Ai variable in the Ai field shall be processed as if received in separate Identity check responses for parallel Identity check requests.

5.3.4 *TEI removal procedure*

When the network side layer management entity determines that the removal of a TEI value (see § 5.3.4.2) is necessary, the ASP shall transmit a message containing the following elements and issue an MDL-REMOVE-REQUEST primitive:

a) message type = Identity remove; and

b) TEI value which is to be removed, as indicated in the Ai field (the value 127 indicates that all user equipments should remove their TEI values; otherwise, the specific TEI value should be removed).

The Identity remove message shall be sent twice in succession, to overcome possible message loss.

When the user side layer management entity determines that the removal of a TEI value is necessary (see § 5.3.4.2), it shall instruct the data link layer entity to enter the *TEI-unassigned* state, using the MDL-REMOVE-REQUEST primitive. This action would also be taken for all TEI values when the Ai field contains the value of 127.

Further action to be taken shall be either initiation of automatic TEI assignment for a new TEI value or notification to the equipment user for the need for corrective action (that is, when equipment uses a non-automatic TEI value and does not support the automatic TEI assignment procedure.)

5.3.4.1 *Action taken by the data link layer entity receiving the MDL-REMOVE-REQUEST primitive*

A data link layer entity receiving an MDL-REMOVE-REQUEST primitive shall:

a) if no DL-RELEASE-REQUEST primitive is outstanding and the user equipment is not in the *TEI-assigned* state, issue a DL-RELEASE-INDICATION primitive; or

b) if a DL-RELEASE-REQUEST primitive is outstanding, issue a DL-RELEASE-CONFIRM primitive.

The data link layer entity shall then enter the *TEI-unassigned* state after discarding the contents of both UI and I queues.

5.3.4.2 *Conditions for TEI removal*

At the user equipment, automatic TEI values shall be removed, and in the case of non-automatic TEI values, an appropriate indication shall be made to the user under the following conditions:

— on request from the ASP by an Identity remove message;

— on receipt of an MPH-INFORMATION-INDICATION (disconnected) primitive;

— on receipt of an MDL-ERROR-INDICATION primitive indicating that the data link layer entity has assumed possible multiple assignment of a TEI value, rather than requesting a TEI check procedure by the transmission of an Identity verify request message; or

— optionally on receipt of an Identity assigned message containing a TEI value in the Ai field, which is already in use within the user equipment (see § 5.3.2).

At the network side, TEI values should be removed:

— following a TEI audit procedure showing that a TEI value is no longer in use or that multiple TEI assignment has occurred; or

— on receipt of an MDL-ERROR-INDICATION primitive indicating a possible multiple TEI assignment, which may be confirmed by the invocation of the TEI check procedures.

5.3.5 *TEI identity verify procedure*

5.3.5.1 *General*

The TEI identity verify procedure allows the user side layer management entity to have the capability to request that the network invoke the identity check procedure for verification of multiple TEI assignment.

The TEI identity verify procedure is optional for both the network and user equipment.

5.3.5.2 *Operation of the TEI identity verify procedure*

The TEI identity verify procedure is illustrated in Figure 11/Q.921.

Figure 11/Q.921 + Notes, p.

The user equipment shall transmit an Identity verify message containing the following elements:

a) message type = Identity verify request;

b) the TEI value to be checked in the Ai field; and

c) the Ri field, which is not processed by the network and is coded 0.

Timer T202 is started.

The ASP, on receipt of the TEI Identity verify message shall, if implemented, invoke the TEI check procedure as defined in § 5.3.3. This will result in the ASP sending an Identity check request message to the user equipment.

5.3.5.3 *Expiry of Timer T202*

If the user equipment receives no Identity check request message with an A_i equal to its TEI or an A_i equal to 127 before the expiry of timer T202, the user side layer management entity shall restart the timer and the Identity verify message shall be retransmitted. If no Identity check request message is received from the ASP after the second Identity verify request, the TEI shall be removed.

5.3.6 *Formats and codes*

5.3.6.1 *General*

All messages used for TEI management procedures are carried in the information field of UI command frames with a SAPI value set to 63 (binary 11 1111) and TEI value set to 127 (binary 111 1111).

All messages have the structure shown in Figure 12/Q.921.

Figure 12/Q.921 [T14.921], p. (A traiter comme tableau MEP)

Fields that are not used in a specific message are coded all zeros, and are not to be processed by either side.

The coding of each field for the various messages is specified in Table 8/Q.921.

E is the Action indicator field extension bit (see § 5.3.6.5).

H.T. [T15.921]

TABLE 8/Q.921

Codes for messages concerning TEI management procedures

Message name { Management entity identifier }	Reference number Ri	Message type	Action indicator Ai	
{ Identity request (user to network) } Ai = 127, Any TEI value acceptable }	0000 1111	0-65535	0000 0001	{
{ Identity assigned (network to user) } Ai = 64-126, Assigned TEI value }	0000 1111	0-65535	0000 0010	{
{				{ {
{				{ {
{ Identity check response (user to network) } Ai = 0-126, TEI value in use }	0000 1111	0-65535	0000 0101	{
{				{ {
{ Identity verify				

(user to network) } Ai = 0-126, TEI value to be checked }	0000 1111	Not used (coded 0)	0000 0111	{

Table 8/Q.921 [T15.921], p.

5.3.6.2 *Layer management entity identifier*

For TEI administration procedures, the layer management entity identifier octet is 0000 | 111. Other values are reserved for further standardization.

5.3.6.3 *Reference number (Ri)*

Octets 2 and 3 contain Ri. When used, it can assume any value between 0 and 65535.

5.3.6.4 *Message type*

Octet 4 contains the message type. The purpose of the message type is to identify the function of the message being sent.

5.3.6.5 *Action indicator (Ai)*

The Ai field is extended by reserving the first transmitted bit of the Ai field octets to indicate the final octet of the Ai field.

Ai variables in the Ai field are coded as follows:

a) bit 1 is the extension bit and is coded as follows:

— 0 to indicate an extension, and

— 1 to indicate the final octet;

b) bits 2 to 8 contain the Action indicator.

The purpose of the Action indicator is to identify the concerned TEI value(s).

5.4 *Automatic negotiation of data link layer parameters*

This procedure is defined in Appendix IV.

5.5 *Procedures for establishment and release of multiple frame operation*

5.5.1 *Establishment of multiple frame operation*

The provision of extended multiple frame operation (modulo 128 sequencing) is recommended.

5.5.1.1 *General*

These procedures shall be used to establish multiple frame operation between the network and a designated user entity.

Layer 3 will request establishment of the multiple frame operation by the use of the DL-ESTABLISH-REQUEST primitives. Re-establishment may be initiated as a result of the data link layer procedures defined in § 5.7. All frames other than unnumbered frame formats received during the establishment procedures shall be ignored.

5.5.1.2 *Establishment procedures*

A data link layer entity shall initiate a request for the multiple frame operation to be set by transmitting the SABME command. All existing exception conditions shall be cleared, the retransmission counter shall be reset, and timer T200 shall then be started (timer T200 is defined in § 5.9.1). All mode setting commands shall be transmitted with the P bit set to 1.

Layer 3 initiated establishment procedures imply the discard of all outstanding DL-DATA-REQUEST primitives and all I frames in queue.

A data link layer entity receiving an SABME command, if it is able to enter the *multiple-frame-established* state , shall:

— respond with a UA response with the F bit set to the same binary value as the P bit in the received SABME command;

— set V(S), V(R) and V(A) to 0;

— enter the *multiple-frame-established* state and inform layer 3 using the DL-ESTABLISH-INDICATION primitive;

— clear all existing exception conditions;

— clear any existing peer receiver busy condition; and

— start timer T203 (timer T203 is defined in § 5.9.8), if implemented.

If the data link layer entity is unable to enter the *multiple-frame-established* state, it shall respond to the SABME command with a DM response with the F bit set to the same binary value as the P bit in the received SABME command.

Upon reception of the UA response with the F bit set to 1, the originator of the SABME command shall:

— reset timer T200;

— start timer T203 if implemented;

— set V(S), V(R), and V(A) to 0; and

— enter the *multiple-frame-established* state and inform layer 3 using the DL-ESTABLISH-CONFIRM primitive.

Upon reception of a DM response with the F bit set to 1, the originator of the SABME command shall indicate this to layer 3 by means of the DL-RELEASE-INDICATION primitive, and reset timer T200. It shall then enter the *TEI-assigned* state. DM responses with the F bit set to 0 shall be ignored in this case.

A DL-RELEASE-REQUEST primitive received during data link layer initiated re-establishment shall be serviced on completion of the establishment mode-setting operation.

5.5.1.3 *Procedure on expiry of timer T200*

If timer T200 expires before the UA or DM response with the F bit set to 1 is received, the data link layer entity shall:

— retransmit the SABME command as above;

— restart timer T200; and

— increment the retransmission counter

After retransmission of the SABME command N200 times, the data link layer entity shall indicate this to layer 3 and the connection management entity by means of the DL-RELEASE-INDICATION and MDL-ERROR-INDICATION primitives, respectively, and enter the *TEI-assigned* state, after discarding all outstanding DL-DATA-REQUEST primitives and all I frames in queue.

The value of N200 is defined in § 5.9.2.

5.5.2 *Information transfer*

Having either transmitted the UA response to a received SABME command or received the UA response to a transmitted SABME command, I frames and supervisory frames shall be transmitted and received according to the procedures described in § 5.6.

If an SABME command is received while in the *multiple-frame-established* state, the data link layer entity shall conform to the re-establishment procedure described in § 5.7.

On receipt of a UI command, the procedures defined in § 5.2 shall be followed.

5.5.3 *Termination of multiple frame operation*

5.5.3.1 *General*

These procedures shall be used to terminate the multiple frame operation between the network and a designated user entity.

Layer 3 will request termination of the multiple frame operation by use of the DL-RELEASE-REQUEST primitive.

All frames other than unnumbered frames received during the release procedures shall be ignored.

All outstanding DL-DATA-REQUEST primitives and all I frames in queue shall be discarded.

In the case of persistant layer 1 deactivation the data link layer entity shall discard all I queues and deliver to layer 3 a DL-RELEASE-CONFIRM primitive if a DL-RELEASE-REQUEST primitive is outstanding, or otherwise a DL-RELEASE-INDICATION primitive.

5.5.3.2 *Release procedure*

A data link layer entity shall initiate a request for release of the multiple frame operation by transmitting the Disconnect (DISC) command with the P bit set to 1. Timer T200 shall then be started and the retransmission counter reset.

A data link layer entity receiving a DISC command while in the *multiple-frame-established* or *timer recovery* state shall transmit a UA response with the F bit set to the same binary value as the P bit in the received DISC command. A DL-RELEASE-INDICATION primitive shall be passed to layer 3, and the *TEI-assigned* state shall be entered.

If the originator of the DISC command receives either:

— a UA response with the F bit set to 1; or

— a DM response with the F bit set to 1, indicating that the peer data link layer entity is already in the *TEI-assigned* state, it shall enter the *TEI-assigned* state and reset timer T200.

The data link layer entity which issued the DISC command is now in the *TEI-assigned* state and will notify layer 3 by means of the DL-RELEASE-CONFIRM primitive. The conditions relating to this state are defined in § 5.5.4.

5.5.3.3 *Procedure on expiry of timer T200*

If timer T200 expires before a UA or DM response with the F bit set to 1 is received, the originator of the DISC command shall:

— retransmit the DISC command as defined in § 5.5.3.2;

— restart timer T200; and

— increment the retransmission counter.

If the data link layer entity has not received the correct response as defined in § 5.5.3.2, after N200 attempts to recover, the data link layer entity shall indicate this to the connection management entity by means of the MDL-ERROR-INDICATION primitive, enter the *TEI-assigned* state and notify layer 3 by means of the DL-RELEASE-CONFIRM primitive.

5.5.4 *TEI-assigned state*

While in the *TEI-assigned* state:

— the receipt of a DISC command shall result in the transmission of a DM response with F bit set to the value of the received P bit;

— on receipt of an SABME command, the procedures defined in § 5.5.1 shall be followed;

— on receipt of an unsolicited DM response with the F bit set to 0, the data link layer entity shall, if it is able to, initiate the establishment procedures by the transmission of an SABME (see § 5.5.1.2). Otherwise, the DM shall be ignored;

— on receipt of UI commands, the procedures defined in § 5.2 shall be followed; and

— on receipt of any unsolicited UA response an MDL-ERROR-INDICATION primitive indicating a possible double assignment of a TEI value shall be issued; and

— all other frame types shall be discarded.

5.5.5 *Collision of unnumbered commands and responses*

5.5.5.1 *Identical transmitted and received commands*

If the transmitted and received unnumbered commands (SABME or DISC) are the same, the data link layer entities shall send the UA response at the earliest possible opportunity. The indicated state shall be entered after receiving the UA response. The data link layer entity shall notify layer 3 by means of the appropriate confirm primitive.

5.5.5.2 *Different transmitted and received commands*

If the transmitted and received unnumbered commands (SABME or DISC) are different, the data link layer entities shall issue a DM response at the earliest possible opportunity. Upon receipt of a DM response with the F bit set to 1, the data link layer shall enter the *TEI-assigned* state and notify layer 3 by means of the appropriate primitive. The entity receiving the DISC command will issue a DL-RELEASE-INDICATION primitive, while the other entity will issue a DL-RELEASE-CONFIRM primitive.

5.5.6 *Unsolicited DM response and SABME or DISC command*

When a DM response with the F bit set to 0 is received by a data link layer entity, a collision between a transmitted SABME or DISC command and the unsolicited DM response may have occurred. This is typically caused by a user equipment applying a protocol procedure according to X.25 LAPB [9] to ask for a mode-setting command.

In order to avoid misinterpretation of the DM response received, a data link layer entity shall always send its SABME or DISC command with the P bit set to 1.

A DM response with the F bit set to 0 colliding with an SABME or DISC command shall be ignored.

5.6 *Procedures for information transfer in multiple frame operation*

The procedures which apply to the transmission of I frames are defined below.

Note — The term ‘‘transmission of an I frame’’ refers to the delivery of an I frame by the data link layer to the physical layer.

5.6.1 *Transmitting I frames*

Information received by the data link layer entity from layer 3 by means of a DL-DATA-REQUEST primitive shall be transmitted in an I frame. The control field parameters N(S) and N(R) shall be assigned the values of V(S) and V(R), respectively. V(S) shall be incremented by 1 at the end of the transmission of the I frame.

If timer T200 is not running at the time of transmission of an I frame, it shall be started. If time T200 expires, the procedures defined in § 5.6.7 shall be followed.

If V(S) is equal to V(A) plus *k* (where *k* is the maximum number of outstanding I frames — see § 5.9.5), the data link layer entity shall not transmit any new I frames, but may retransmit an I frame as a result of the error recovery procedures as described in §§ 5.6.4 and 5.6.7.

When the network side or user side is in the own receiver busy condition, it may still transmit I frames, provided that a peer receiver busy condition does not exist.

Note — Any DL-DATA-REQUEST primitives received whilst in the timer recovery condition shall be queued.

5.6.2 *Receiving I frames*

Independant of a timer recovery condition, when a data link layer entity is not in an own receiver busy condition and receives a valid I frame whose N(S) is equal to the current V(R), the data link layer entity shall:

— pass the information field of this frame to layer 3 using the DL-DATA-INDICATION primitive;

— increment by 1 its V(R) and act as indicated below.

5.6.2.1 *P bit set to 1*

If the P bit of the received I frame was set to 1, the data link layer entity shall respond to its peer in one of the following ways:

— if the data link layer entity receiving the I frame is still not in an own receiver busy condition , it shall send an RR response with the F bit set to 1;

— if the data link layer entity receiving the I frame enters the own receiver busy condition upon receipt of the I frame, it shall send an RNR response with the F bit set to 1.

5.6.2.2 *P bit set to 0*

If the P bit of the received I frame was set to 0 and:

a) if the data link layer entity is still not in an own receiver busy condition:

— if no I frame is available for transmission or if an I frame is available for transmission but a peer receiver busy condition exists, the data link layer entity shall transmit an RR response with the F bit set to 0; or

— if an I frame is available for transmission and no peer receiver busy condition exists, the data link layer entity shall transmit the I frame with the value of N(R) set to the current value of V(R) as defined in § 5.6.1; or

b) if, on receipt of this I frame, the data link layer entity is now in an own receiver busy condition, it shall transmit an RNR response with the F bit set to 0.

When the data link layer entity is in an own receiver busy condition, it shall process any received I frame according to § 5.6.6.

5.6.3 *Sending and receiving acknowledgements*

5.6.3.1 *Sending acknowledgements*

Whenever a data link layer entity transmits an I frame or a supervisory frame, N(R) shall be set equal to V(R).

5.6.3.2 *Receiving acknowledgements*

On receipt of a valid I frame or supervisory frame (RR, RNR, or REJ), even in the own receiver busy, or timer recovery conditions, the data link layer entity shall treat the N(R) contained in this frame as an acknowledgement for all the I frames it has transmitted with an N(S) up to and including the received N(R) — 1. V(A) shall be set to N(R). The data link layer entity shall reset the timer T200 on receipt of a valid I frame or supervisory frame with the N(R) higher than V(A) (actually acknowledging some I frames), or an REJ frame with an N(R) equal to V(A).

Note 1 — If a supervisory frame with the P bit set to 1 has been transmitted and not acknowledged, timer T200 shall not be reset.

Note 2 — Upon receipt of a valid I frame, timer T200 shall not be reset if the data link layer entity is in the peer receiver busy condition.

If timer T200 has been reset by the receipt of an I, RR, or RNR frame, and if there are outstanding I frames still unacknowledged, the data link layer entity shall restart timer T200. If timer T200 then expires, the data link layer entity shall follow the recovery procedure as defined in § 5.6.7 with respect to the unacknowledged I frames.

If timer T200 has been reset by the receipt of an REJ frame, the data link layer entity shall follow the retransmission procedures in § 5.6.4.

5.6.4 *Receiving REJ frames*

On receipt of a valid REJ frame, the data link layer entity shall act as follows:

a) if it is not in the timer recovery condition:

— clear an existing peer receiver busy condition;

— set its V(S) and its V(A) to the value of the N(R) contained in the REJ frame control field;

— stop timer T200;

— start timer T203 if implemented;

— if it was an REJ command frame with the P bit set to 1, transmit an appropriate supervisory response frame (see Note 2, § 5.6.5) with the F bit set to 1.

— transmit the corresponding I frame as soon as possible, as defined in § 5.6.1, taking into account the items 1) to 3) below and the paragraph following items 1) to 3) and

— notify a protocol violation to the connection management entity by means of the MDL-ERROR-INDICATION primitive, if it was an REJ response frame with the F bit set to 1.

b) if it is in the timer recovery condition and it was an REJ response frame with the F bit set to 1:

— clear an existing peer receiver busy condition;

— set its V(S) and its V(A) to the value N(R) contained in the REJ frame control field;

— stop timer T200;

— start timer T203 if implemented;

— enter the multiple-frame-established state; and

— transmit the corresponding I frame as soon as possible, as defined in § 5.6.1, taking into account the items 1) to 3) below and the paragraph following items 1) to 3).

c) if it is in the timer recovery condition and it was an REJ frame other than an REJ response frame with the F bit set to 1:

— clear an existing peer receiver busy condition;

— set its V(A) to the value of the N(R) contained in the REJ frame control field; and

— if it was an REJ command frame with the P bit set to 1, transmit an appropriate supervisory response frame with the F bit set to 1 (see Note 2 in § 5.6.5).

Transmission of I frames shall take account of the following:

1) if the data link layer entity is transmitting a supervisory frame when it receives the REJ frame, it shall complete that transmission before commencing transmission of the requested I frame;

2) if the data link layer entity is transmitting an SABME command, a DISC command, a UA response or a DM response when it receives the REJ frame, it shall ignore the request for retransmission; and

3) if the data link layer entity is not transmitting a frame when the REJ is received, it shall immediately commence transmission of the requested I frame.

All outstanding unacknowledged I frames, commencing with the I frame identified in the received REJ frame, shall be transmitted. Other I frames not yet transmitted may be transmitted following the retransmitted I frames.

5.6.5 *Receiving RNR frames*

After receiving a valid RNR command or response, if the data link layer entity is not engaged in a mode-setting operation, it shall set a peer receiver busy condition and then:

— if it was an RNR command with the P bit set to 1, it shall respond with an RR response with the F bit set to 1 if the data link layer entity is not in an own receiver busy condition, and shall respond with an RNR response with the F bit set to 1 if the data link layer entity is in an own receiver busy condition; and

— if it was an RNR response with the F bit set to 1, an existing timer recovery condition shall be cleared and the N(R) contained in this RNR response shall be used to update V(S).

The data link layer entity shall take note of the peer receiver busy condition and not transmit any I frames to the peer which has indicated the busy condition.

Note 1 — The N(R) in any RR or RNR command frame (irrespective of the setting of the P bit) will not be used to update the V(S).

The data link layer entity shall then:

— treat the N(R) contained in the received RNR frame as an acknowledgement for all the I frames that have been (re)transmitted with an N(S) up to and including N(R) minus 1, and set its V(A) to the value of the N(R) contained in the RNR frame; and

— restart timer T200 unless a supervisory response frame with the F bit set to 1 is still expected.

If timer T200 expires, the data link layer entity shall:

— if it is not yet in a timer recovery condition, enter the timer recovery condition and reset the retransmission count variable; or

— if it is already in a timer recovery condition, add one to its retransmission count variable.

The data link layer entity shall then:

a) if the value of the retransmission count variable is less than N200:

— transmit an appropriate supervisory command (see Note 2) with a P bit set to 1;

— restart timer T200; and

b) if the value of the retransmission count variable is equal to N200, initiate a re-establishment procedure as defined in § 5.7, and indicate this by means of the MDL-ERROR-INDICATION primitive to the connection management entity.

The data link layer entity receiving the supervisory frame with the P bit set to 1 shall respond, at the earliest opportunity, with a supervisory response frame (see Note 2) with the F bit set to 1, to indicate whether or not its own receiver busy condition still exists.

Upon receipt of the supervisory response with the F bit set to 1, the data link layer entity shall reset timer T200, and:

— if the response is an RR or REJ response, the peer receiver busy condition is cleared and the data link layer entity may transmit new I frames or retransmit I frames as defined in §§ 5.6.1 or 5.6.4, respectively; or

— if the response is an RNR response, the data link layer entity receiving the response shall proceed according to this § 5.6.5, first paragraph.

If a supervisory command (RR, RNR, or REJ) with the P bit set to 0 or 1, or a supervisory response frame (RR, RNR, or REJ) with the F bit set to 0 is received during the enquiry process , the data link layer entity shall:

— if the supervisory frame is an RR or REJ command frame or an RR or REJ response frame with the F bit set to 0, clear the peer receiver busy condition and if the supervisory frame received was a command with the P bit set to 1, transmit the appropriate supervisory response frame (see Note 2) with the F bit set to 1. However, the transmission or retransmission of I frames shall not be undertaken until the appropriate supervisory response frame with the F bit set to 1 is received or until expiry of timer T200; or

— if the supervisory frame is an RNR command frame or an RNR response frame with the F bit set to 0, retain the peer receiver busy condition and if the supervisory frame received was an RNR command with P bit set to 1, transmit the appropriate supervisory response frame (see Note 2) with the F bit set to 1.

Upon receipt of an SABME command, the data link layer entity shall clear the peer receiver busy condition.

Note 2 — If the data link layer entity is not in an own receiver busy condition and is in a Reject exception condition [that is, an N(S) sequence error has been received, and an REJ frame has been transmitted, but the requested I frame has not been received], the appropriate supervisory frame is the RR frame.

If the data link layer entity is not in an own receiver busy condition but is in an N(S) sequence error exception condition [that is, an N(S) sequence error has been received but an REJ frame has not been transmitted], the appropriate supervisory frame is the REJ frame.

If the data link layer entity is in its own receiver busy condition, the appropriate supervisory frame is the RNR frame.

Otherwise, the appropriate supervisory frame is the RR frame.

5.6.6 *Data link layer own receiver busy condition*

When the data link layer entity enters an own receiver busy condition, it shall transmit an RNR frame at the earliest opportunity.

The RNR frame may be either:

— an RNR response with the F bit set to 0; or

— if this condition is entered on receiving a command frame with the P bit set to 1, an RNR response with the F bit set to 1; or

— if this condition is entered on expiry of timer T200, an RNR command with the P bit set to 1.

All received I frames with the P bit set to 0 shall be discarded, after updating V(A).

All received supervisory frames with the P/F bit set to 0 shall be processed, including updating V(A).

All received I frames with the P bit set to 1 shall be discarded, after updating V(A). However, an RNR response frame with the F bit set to 1 shall be transmitted.

All received supervisory frames with the P bit set to 1 shall be processed including updating V(A). An RNR response with the F bit set to 1 shall be transmitted.

To indicate to the peer data link layer entity the clearance of the own receiver busy condition, the data link layer entity shall transmit an RR frame or, if a previously detected N(S) sequence error has not yet been reported, an REJ frame with the N(R) set to the current value of V(R).

The transmission of an SABME command or a UA response (in reply to an SABME command) also indicates to the peer data link layer entity the clearance of the own receiver busy condition.

5.6.7 *Waiting acknowledgement*

The data link layer entity shall maintain an internal retransmission count variable.

If timer T200 expires, the data link layer entity shall:

— if it is not yet in the timer recovery condition, enter the timer recovery condition and reset the retransmission count variable; or

— if it is already in the timer recovery condition, add one to its retransmission count variable.

The data link layer entity shall then:

a) if the value of the retransmission count variable is less than N200:

— restart timer T200; and either

— transmit an appropriate supervisory command (see Note 2 in § 5.6.5) with the P bit set to 1; or

— retransmit the last transmitted I frame [V(S) — 1] with the P bit set to 1; or

b) if the value of the retransmission count variable is equal to N200, initiate a re-establishment procedure as defined in § 5.7 and indicate this by means of the MDL-ERROR-INDICATION primitive to the connection management entity.

The timer recovery condition is cleared when the data link layer entity receives a valid supervisory frame response with the F bit set to 1. If the received supervisory frame N(R) is within the range from its current V(A) to its current V(S) inclusive, it shall set its V(S) to the value of the received N(R). Timer T200 shall be reset if the received supervisory frame response is an RR or REJ response, and then the data link layer entity shall resume with I frame transmission or retransmission, as appropriate. Timer T200 shall be reset and restarted if the received supervisory response is an RNR response, to proceed with the enquiry process according to § 5.6.5.

5.7 *Re-establishment of multiple frame operation*

5.7.1 *Criteria for re-establishment*

The criteria for re-establishing the multiple frame mode of operation are defined in this section by the following conditions:

— the receipt, while in the multiple-frame mode of operation, of an SABME;

— the receipt of a DL-ESTABLISH-REQUEST primitive from layer 3 (see § 5.5.1.1);

— the occurrence of N200 retransmission failures while in the timer recovery condition (see § 5.6.7);

— the occurrence of a frame rejection condition as identified in § 5.8.5;

— the receipt, while in the multiple-frame mode of operation, of an FRMR response frame (see § 5.8.6);

— the receipt, while in the multiple-frame mode of operation, of an unsolicited DM response with the F bit set to 0 (see § 5.8.7);

— the receipt, while in the timer-recovery condition, of a DM response with the F bit set to 1.

5.7.2 *Procedures*

In all re-establishment situations, the data link layer entity shall follow the procedures defined in § 5.5.1. All locally generated conditions for re-establishment will cause the transmission of the SABME.

In the case of data link layer and peer initiated re-establishment, the data link layer entity shall also:

— issue an MDL-ERROR-INDICATION primitive to the connection management entity; and

— if V(S) > V(A) prior to re-establishment, issue a DL-ESTABLISH-INDICATION primitive to layer 3, and discard all I queues.

In case of layer 3 initiated re-establishment or if a DL-ESTABLISH-REQUEST primitive occurs pending re-establishment, the DL-ESTABLISH-CONFIRM primitive shall be used.

5.8 *Exception condition reporting and recovery*

Exception conditions may occur as the result of physical layer errors or data link layer procedural errors.

The error recovery procedures which are available to effect recovery following the detection of an exception condition at the data link layer are defined in this section.

The actions to be taken by the connection management entity on receipt of an MDL-ERROR-INDICATION primitive are defined in Appendix II.

5.8.1 *N(S) sequence error*

An N(S) sequence error exception condition occurs in the receiver when a valid I frame is received which contains an N(S) value which is not equal to the V(R) at the receiver. The information field of all I frames whose N(S) does not equal V(R) shall be discarded.

The receiver shall not acknowledge [nor increment its V(R)] the I frame causing the sequence error, nor any I frames which may follow, until an I frame with the correct N(S) is received.

A data link layer entity which receives one or more I frames having sequence errors but otherwise error-free, or subsequent supervisory frames (RR, RNR, and REJ), shall use the control field information contained in the N(R) field and the P or F bit to perform data link control functions; for example, to receive acknowledgement of previously transmitted I frames and to cause the data link layer entity to respond if the P bit is set to 1. Therefore, the retransmitted I frame may contain an N(R) field value and P bit that are updated from, and therefore different from, the ones contained in the originally transmitted I frame.

The REJ frame is used by a receiving data link layer entity to initiate an exception condition recovery (retransmission) following the detection of an N(S) sequence error.

Only one REJ exception condition for a given direction of information transfer shall be established at a time.

A data link layer entity receiving an REJ command or response shall initiate sequential transmission (retransmission) of I frames starting with the I frame indicated by the N(R) contained in the REJ frame.

An REJ exception condition is cleared when the requested I frame is received or when an SABME or DISC command is received.

An optional procedure for the retransmission of an REJ response frame is described in Appendix I.

5.8.2 *N(R) sequence error*

An N(R) sequence error exception condition occurs in the transmitter when a valid supervisory frame or I frame is received which contains an invalid N(R) value.

A valid N(R) is one that is in the range V(A) N(R) V(S).

The information field contained in an I frame which is correct in sequence and format may be delivered to layer 3 by means of the DL-DATA-INDICATION primitive.

The data link layer entity shall inform the connection management entity of this exception condition by means of the MDL-ERROR-INDICATION primitive, and initiate re-establishment according to § 5.7.2.

5.8.3 *Timer recovery condition*

If a data link layer entity, due to a transmission error, does not receive a single I frame or the last I frame(s) in a sequence of I frames, it will not detect an out-of-sequence exception condition and therefore will not transmit an REJ frame.

The data link layer entity which transmitted the unacknowledged I frame(s) shall, on the expiry of timer T200, take appropriate recovery action as defined in § 5.6.7 to determine at which I frame retransmission must begin.

5.8.4 *Invalid frame condition*

Any frame received which is invalid (as defined in § 2.9) shall be discarded, and no action shall be taken as a result of that frame.

5.8.5 *Frame rejection condition*

A frame rejection condition results from one of the conditions described in § 3.6.1 (third paragraph) or § 3.6.11, items b, c and d.

Upon occurrence of a frame rejection condition whilst in the multiple frame operation,the data link layer entity shall:

— issue an MDL-ERROR-INDICATION primitive; and

— initiate re-establishment (see § 5.7.2).

Note — For satisfactory operation it is essential that a receiver is able to discriminate between invalid frames, as defined in § 2.9, and frames with an I-field which exceeds the maximum established length [see d) of § 3.6.11]. An unbounded frame may be assumed, and thus discarded, if two times the longest permissible frame plus two octets are received without a flag detection.

5.8.6 *Receipt of an FRMR response frame*

Upon receipt of an FRMR response frame in the multiple-frame mode of operation, the data link layer entity shall:

— issue an MDL-ERROR-INDICATION primitive; and

— initiate re-establishment (see § 5.7.2).

5.8.7 *Unsolicited response frames*

The action to be taken on the receipt of an unsolicited response frame is defined in Table 9/Q.921.

The data link layer entity shall assume possible multiple-TEI assignment on the receipt of an unsolicited UA response and shall inform layer management.

H.T. [T16.921]

TABLE 9/Q.921

Actions taken on receipt of unsolicited response frames

Unsolicited response frame	TEI-assigned	Awaiting Establishment	Awaiting Release	{ Established mode	Time recovery condition
UA response F = 1	MDL-Error Indication	Solicited	Solicited	MDL-Error Indication	MDL-Error Indication
UA response F = 0	MDL-Error Indication	MDL-Error Indication	MDL-Error Indication	MDL-Error Indication	MDL-Error Indication
DM response F = 1 Re-establish MDL-Error Indication }	Ignore	Solicited	Solicited	MDL-Error Indication	{
DM response F = 0 Re-establish MDL-Error Indication } Re-establish MDL-Error Indication }	Establish {	Ignore	Ignore	{	
Supervisory Response F = 1	Ignore	Ignore	Ignore	MDL-Error Indication	Solicited
Supervisory Response F = 0	Ignore	Ignore	Ignore	Solicited	Solicited

Table 9/Q.921 [T16.921], p.

5.8.8 *Multiple assignment of a TEI value*

A data link layer entity shall assume multiple assignment of a TEI value and initiate recovery as specified below by:

a) the receipt of a UA response frame whilst in the *multiple-frame-established* state;

b) the receipt of a UA response frame whilst in the *timer recovery* state;

c) the receipt of a UA response frame whilst in the *TEI-assigned* state.

A data link layer entity, after assuming multiple assignment of a TEI value shall inform the connection management entity by means of the MDL-ERROR-INDICATION primitive.

5.9 *List of system parameters*

The system parameters listed below are associated with each individual SAP.

A method of assigning these parameters is defined in § 5.4.

The term default implies that the value defined should be used in the absence of any assignment or negotiation of alternative values.

5.9.1 *Timer T200*

The default value for timer T200 at the end of which transmission of a frame may be initiated according to the procedures described in § 5.6 shall be one second.

Note 1 — The proper operation of the procedure requires that timer T200 be greater than the maximum time between transmission of command frames and the reception of their corresponding response or acknowledgement frames.

Note 2 — When an implementation includes multiple terminals on the user side together with a satellite connection in the transmission path, a value of T200 greater than 1 second may be necessary. A value of 2.5 seconds is suggested.

5.9.2 *Maximum number of retransmissions (N200)*

The maximum number of retransmissions of a frame (N200) is a system parameter. The default value of N200 shall be 3.

5.9.3 *Maximum number of octets in an information field (N201)*

The maximum number of octets in an information field (N201) is a system parameter. (See also § 2.5.)

— For an SAP supporting signalling, the default value shall be 260 octets.

— For SAPs supporting packet information, the default value shall be 260 octets.

5.9.4 *Maximum number of transmissions of the TEI Identity request message (N202)*

The maximum number of transmissions of a TEI Identity request message (when the user requests a TEI) is a system parameter. The default value of N202 shall be 3.

5.9.5 *Maximum number of outstanding I frames (k)*

The maximum number (k) of sequentially numbered I frames that may be outstanding (that is, unacknowledged) at any given time is a system parameter which shall not exceed 127, for extended (modulo 128) operation.

— For an SAP supporting basic access (16 kbit/s) signalling, the default value shall be 1.

— For an SAP supporting primary rate (64 kbit/s) signalling, the default value shall be 7.

— For an SAP supporting basic access (16 kbit/s) packet information, the default value shall be 3.

— For an SAP supporting primary rate (64 kbit/s) packet information, the default value shall be 7.

5.9.6 *Timer T201*

The minimum time between retransmission of the TEI Identity check messages (T201) is a system parameter which shall be set to T200 seconds.

5.9.7 *Timer T202*

The minimum time between the transmission of TEI Identity request messages is a system parameter (T202) which shall be set to 2 seconds.

5.9.8 *Timer T203*

Timer T203 represents the maximum time allowed without frames being exchanged. The default value of timer T203 shall be 10 seconds.

5.10 *Data link layer monitor function*

5.10.1 *General*

The procedural elements defined in § 5 allow for the supervision of the data link layer resource. This section describes procedures which may be used to provide this supervision function. The use of this function is optional.

5.10.2 *Data link layer supervision in the multiple-frame-established state*

The procedures specified herein propose a solution which is already identified in the HDLC classes of procedures. The connection verification is a service provided by data link layer to layer 3. This implies that layer 3 is informed in case of a failure only. Furthermore, the procedure may be incorporated in the ‘‘normal’’ exchange of information and may become more efficient than a procedure based on the involvement of layer 3.

The procedure is based on supervisory command frames (RR command, RNR command) and timer T203, and operates in the multiple-frame-established state as follows.

If there are no frames being exchanged on the data link connection (neither new nor outstanding I frames, nor supervisory frames with a P bit set to 1), there is no means to detect a faulty data link connection condition, or a user equipment having been unplugged. Timer T203 represents the maximum time allowed without frames being exchanged.

If timer T203 expires, a supervisory command with a P bit set to 1 is transmitted. Such a procedure is protected against transmission errors by making use of the normal timer T200 procedure including retransmission count and N200 attempts.

5.10.3 *Connection verification procedures*

5.10.3.1 *Start timer T203*

The timer T203 is started:

— when the *multiple-frame-established* state is entered; and

— in the *multiple-frame-established* state whenever T200 is stopped. (See Note in § 5.10.3.2.)

Upon receiving an I or supervisory frame, timer T203 will be restarted if timer T200 is not to be started.

5.10.3.2 *Stop timer T203*

The timer T203 is stopped:

— when, in the *multiple-frame-established* state, the timer T200 is started (see note); and

— upon leaving the *multiple-frame-established* state.

Note — These two conditions mean that timer T203 is only started whenever T200 is stopped and not restarted.

5.10.3.3 *Expiry of timer T203*

If timer T203 expires, the data link layer entity will act as follows (it should be noted that timer T200 is neither running nor expired):

a) set the retransmission count variable to 0;

b) enter *timer recovery* state;

c) transmit a supervisory command with the P bit set to 1 as follows:

— if there is not a receiver busy condition (own receiver not busy), transmit an RR command; or

— if there is a receiver busy condition (own receiver busy), transmit an RNR command; and

d) start timer T200; and

e) send MDL-ERROR-INDICATION primitive to connection management after N200 retransmissions.

ANNEX A
(to Recommendation Q.921)

Provision of point-to-point signalling connections

In certain applications it may be advantageous to have a single point-to-point signalling connection at layer 3; the allocation of the value 0 as a preferred TEI for that purpose is a network option. Use of the value 0 in such applications does not preclude using that value in other applications or networks.

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ANNEX B

(to Recommendation Q.921)

SDL for point-to-point procedures

B.1 *General*

The purpose of this annex is to provide one example of an SDL representation of the point-to-point procedures of the data link layer, to assist in the understanding of this Recommendation. This representation does not describe all of the possible actions of the data link layer entity, as a non-partitioned representation was selected in order to minimize its complexity. The SDL representation does not therefore constrain implementations from exploiting the full scope of the procedures as presented within the text of this Recommendation. The text description of the procedures is definitive.

The representation is a peer-to-peer model of the point-to-point procedures of the data link layer and is applicable to the data link layer entities at both the user and network sides for all ranges of TEI values. See Figure B-1/Q.921.

Figure B-1/Q.921, p.

B.2 *An overview of the states of the point-to-point data link layer entity*

The SDL representation of the point-to-point procedures are based on an expansion of the three basic states identified in § 3.4.2/Q.920 (I.440) to the following 8 states:

State 1 *TEI unassigned*

State 2 *Assign awaiting TEI*

State 3 *Establish awaiting TEI*

State 4 *TEI assigned*

State 5 *Awaiting establishment*

State 6 *Awaiting release*

State 7 *Multiple frame established*

State 8 *Timer recovery* .bp

An overview of the inter-relationship of these states is provided in Figure B-2/Q.921. This overview is incomplete, and serves only as an introduction to the SDL representation. All data link layer entities are conceptually initiated in the *TEI unassigned* state (state 1), and will interact with the layer management in order to request a TEI value. TEI assignment initiated by a Unit data request will cause the data link layer entity to move to the *TEI assigned* state (state 4) via the *assign awaiting TEI* state (state 2). Initiation by an Establishment request will cause a transition to the *awaiting establishment* state (state 5) via the *establish awaiting TEI* state (state 3). Direct TEI assignment will cause an immediate transition to the *TEI assigned* state (state 4). In states 4-8, Unit data requests can be directly serviced by the data link layer entity. The receipt of an Establish request in the *TEI assigned* state (state 4) will cause the initiation of the establishment procedures and the transition to the *awaiting establishment* state (state 5). Completion of the LAP establishment procedures takes the data link layer entity into the *multiple frame established* state (state 7). Peer initiated establishment causes a direct transition from the *TEI assigned* state (state 4) to the *multiple frame established* state (state 7). In the *multiple frame established* state (state 7), Acknowledged

data transfer requests can be serviced directly subject to the restrictions of the procedures. Expiry of timer T200, which is used in both the flow control and data transfer aspects of the data link layer entity's procedures initiates the transition to the *timer recovery* state (state 8). Completion of the timer recovery procedures will return the data link layer entity to the *multiple frame established* state (state 7). In states 7 and 8, of the SDL representation the following conditions which are identified within the Recommendation are observed:

a) peer receiver busy,

b) reject exception,

c) own receiver busy.

In addition other conditions are used in order to avoid identification of additional states. The complete combination of both of these categories of conditions with the 8 states of the SDL representation is the basis for the state transition table description of the data link layer entity. A peer initiated LAP release will take the data link layer entity directly into the *TEI assigned* state (state 4), whilst a Release request will be via the *awaiting release* state (state 6). TEI removal will cause a transition to the *TEI unassigned* state (state 1).

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Figure B-2/Q.921, p.

B.3 *Cover notes*

The following symbols and abbreviations are used within this description. A full description of the symbols and their meaning and application can be found in the Series Z Recommendations (Fascicles X.1 to X.5).

Diagrams, p.

B.4 *The use of queues*

To enable a satisfactory representation of the data link layer entity, conceptual queues for the UI frame and I frame transmission have been explicitly brought out. These conceptual queues are finite but unbounded and should in no way restrict the implementation of the point-to-point procedures. Two additional signals have been provided in order to cause the servicing of these queues to be initiated — UI frame queued up and I frame queued up

B.5 *SDL representation*

Figure B-3/Q.921 (1 of 3) + Notes, p.

Figure B-3/Q.921 (2 of 3), p.

Figure B-3/Q.921 (3 of 3), p.

Figure B-4/Q.921 (1 of 2), p.

Figure B-4/Q.921 (2 of 2), p.

Figure B-5/Q.921 (1 of 3), p.

Figure B-5/Q.921 (2 of 3), p.

Figure B-5/Q.921 (3 of 3), p.

Figure B-6/Q.921 (1 of 2), p.

Figure B-6/Q.921 (2 of 2), p.

Figure B-7/Q.921 (1 of 10), p.

Figure B-7/Q.921 (2 of 10), p.

Figure B-7/Q.921 (3 of 10), p.

Figure B-7/Q.921 (4 of 10), p.

Figure B-7/Q.921 (5 of 10), p.

Figure B-7/Q.921 (6 of 10), p.

Figure B-7/Q.921 (7 of 10), p.

Figure B-7/Q.921 (8 of 10), p.

Figure B-7/Q.921 (9 of 10), p.

Figure B-7/Q.921 (10 of 10), p.

Figure B-8/Q.921 (1 of 9), p.

Figure B-8/Q.921 (2 of 9), p.

Figure B-8/Q.921 (3 of 9), p.

Figure B-8/Q.921 (4 of 9), p.

Figure B-8/Q.921 (5 of 9), p.

Figure B-8/Q.921 (6 of 9), p.

Figure B-8/Q.921 (7 of 9), p.

Figures B-8/Q.921 (8 of 9) et (9 of 9).

Figure B-9/Q.921 (1 of 5), p.

Figure B-9/Q.921 (2 of 5), p.

Figure B-9/Q.921 (3 of 5), p.

Figure B-9/Q.921 (4 of 5), p.

Figure B-9/Q.921 (5 of 5), p.

ANNEX C
(to Recommendation Q.921)

SDL representation of the broadcast procedures

Figure C-1/Q.921, p.