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The number of repeater addresses is variable. All but the last repeater address will have the address extension bits of all octets set to zero, as will all but the last octet (SSID octet) of the last repeater address. The last octet of the last repeater address will have the address extension bit set to one, indicating the end of the address field.

It should be noted that various timers (see 2.4.7, below) may have to be adjusted to accommodate the additional delays encountered when a frame must pass through a multiple-repeater chain, and the return acknowledgement must travel through the same path before reaching the source device.

It is anticipated that multiple-repeater operation is a temporary method of interconnecting stations over large distances until such time that a layer 3 protocol is in use. Once this layer 3 protocol becomes operational, repeater chaining should be phased out.

2.3 Elements of Procedure

2.3.1 The elements of procedure are defined in terms of actions that occur on receipt of frames.

2.3.2 Control-Field Formats and State Variables

2.3.2.1 Control-Field Formats

The control field is responsible for identifying the type of frame being sent, and is also used to convey commands and responses from one end of the link to the other in order to maintain proper link control.

The control fields used in AX.25 use the CCITT X.25 control fields for balanced operation (LAPB), with an additional control field taken from ADCCP to allow connectionless and round-table operation.

There are three general types of AX.25 frames. They are the Information frame (I frame), the Supervisory frame (S frame), and the Unnumbered frame (U frame). Fig. 5 shows the basic format of the control field associated with these types of frames.

Control-Field Type	Control-Field Bits				
	7 6 5	4	3 2	1	0
I Frame	N(R)	P	N(S)		0
S Frame	N(R)	P/F	S S	0	1
U Frame	M M M	P/F	M M	1	1

Fig. 5 -- Control-field formats

Where:

1. Bit 0 is the first bit sent and bit 7 is the last bit sent of the control field.

[2. N(S) is the send sequence number (bit 1 is the LSB).

3. N(R) is the receive sequence number (bit 5 is the LSB).]

4. The "S" bits are the supervisory function bits, and their encoding is discussed in 2.3.4.2.

5. The "M" bits are the unnumbered frame modifier bits and their encoding is discussed in 2.3.4.3.

[6. The P/F bit is the Poll/Final bit. Its function is described in 2.3.3. The distinction between command and response, and therefore the distinction between P bit and F bit, is made by addressing rules discussed in 2.4.1.2.]

2.3.2.1.1 Information-Transfer Format

All I frames have bit 0 of the control field set to zero. N(S) is the sender's send sequence number (the send sequence number of this frame). N(R) is the sender's receive sequence number (the sequence number of the next expected received frame). These numbers are described in 2.3.2.4. In addition, the P/F bit is be used as described in 2.4.2.

2.3.2.1.2 Supervisory Format

Supervisory frames are denoted by having bit 0 of the control field set to one, and bit 1 of the control field set to zero. S frames provide supervisory link control such as acknowledging or requesting retransmission of I frames, and link-level window control. Since S frames do not have an information field, the sender's send variable and the receiver's receive variable are not incremented for S frames. In addition, the P/F bit is used as described in 2.4.2.

2.3.2.1.3 Unnumbered Format

Unnumbered frames are distinguished by having both bits 0 and 1 of the control field set to one. U frames are responsible for maintaining additional control over the link beyond what is accomplished with S frames. They are also responsible for establishing and terminating link connections. U frames also allow for the transmission and reception of information outside of the normal flow control. Some U frames may contain information and PID fields. The P/F bit is used as described in 2.4.2.

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2.3.2.2 Control-Field Parameters

2.3.2.3 Sequence Numbers

Every AX.25 I frame shall be assigned, modulo 8, a sequential number from 0 to 7. This will allow up to seven outstanding I frames per level 2 connection at a time.

2.3.2.4 Frame Variables and Sequence Numbers

2.3.2.4.1 Send State Variable V(S)

The send state variable is a variable that is internal to the DXE and is never sent. It contains the next sequential number to be assigned to the next transmitted I frame. This variable is updated upon the transmission of each I frame.

2.3.2.4.2 Send Sequence Number N(S)

The send sequence number is found in the control field of all I frames. It contains the sequence number of the I frame being sent. Just prior to the transmission of the I frame, N(S) is updated to equal the send state variable.

2.3.2.4.3 Receive State Variable V(R)

The receive state variable is a variable that is internal to the DXE. It contains the sequence number of the next expected received I frame. This variable is updated upon the reception of an error-free I frame whose send sequence number equals the present received state variable value.

2.3.2.4.4 Received Sequence Number N(R)

The received sequence number is in both I and S frames. Prior to sending an I or S frame, this variable is updated to equal that of the received state variable, thus implictly acknowledging the proper reception of all I frames up to and including N(R)-1.

2.3.3 Functions of Poll/Final (P/F) Bit

[The P/F bit is used in all types of frames. It is used in a command (poll) mode to request an immediate reply to a frame. The reply to this poll is indicated by setting the response (final) bit in the appropriate frame. Only one outstanding poll condition per direction is allowed at a time. The procedure for P/F bit operation is described in 2.4.2.]

2.3.4 Control Field Coding for Commands and Responses

The following commands and responses, indicated by their control field encoding, are to be used by the DXE:

2.3.4.1   Information Command Frame Control Field

[The function of the information (I) command is to transfer across a
data link sequentially numbered frames containing an information field.   ]

          The information-frame control field is encoded as shown in Fig. 6.
These frames are sequentially numbered by the N(S) subfield to maintain
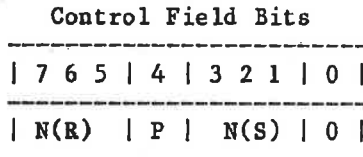control of their passage over the link-layer connection.

```
              Control Field Bits
         ---------------------------
         | 7 6 5 | 4 | 3 2 1 | 0 |
         ---------------------------
         | N(R)  | P |  N(S) | 0 |
         ---------------------------
```
Fig. 6 -- I frame control field

2.3.4.2   Supervisory Frame Control Field

          The supervisory frame control fields are encoded as shown in Fig. 7.

```
-----------------------------------------------------------
|  Control Field Bits  | 7 6 5 | 4 | 3 2 | 1 0 |
|----------------------------------------------------------|
|Receive Ready      RR | N(R)  |P/F| 0 0 | 0 1 |
|Receive Not Ready RNR | N(R)  |P/F| 0 1 | 0 1 |
|Reject            REJ | N(R)  |P/F| 1 0 | 0 1 |
-----------------------------------------------------------
```
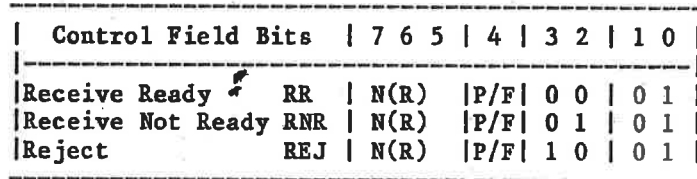Fig. 7 -- S frame control fields

2.3.4.2.1   Receive Ready (RR) Command and Response

          Receive Ready is used to do the following:

1.   to indicate that the sender of the RR is now able to receive more I
     frames,

2.   to acknowledge properly received I frames up to, and including
     N(R)-1, and

3.   to clear a previously set busy condition created by an RNR command
     having been sent.

The status of the DXE at the other end of the link can be requested by sending a RR command frame with the P-bit set to one.

2.3.4.2.2 Receive Not Ready (RNR) Command and Response

Receive Not Ready is used to indicate to the sender of I frames that the receiving DXE is temporarily busy and cannot accept any more I frames. Frames up to N(R)-1 are acknowledged. Any I frames numbered N(R) and higher that might have been caught between states and not acknowledged when the RNR command was sent are <u>not</u> acknowledged.

The RNR condition can be cleared by the sending of a UA, RR, REJ, or SABM frame.

The status of the DXE at the other end of the link can be requested by sending a RNR command frame with the P bit set to one.

2.3.4.2.3 Reject (REJ) Command and Response

The reject frame is used to request retransmission of I frames starting with N(R). Any frames that were sent with a sequence number of N(R)-1 or less are acknowledged. Additional I frames may be appended to the retransmission of the N(R) frame if there are any.

Only one reject frame condition is allowed in each direction at a time. The reject condition is cleared by the proper reception of I frames up to the I frame that caused the reject condition to be initiated.

The status of the DXE at the other end of the link can be requested by sending a REJ command frame with the P bit set to one.

2.3.4.3 Unnumbered Frame Control Fields

Unnumbered frame control fields are either commands or responses.

Fig. 8 shows the layout of U frames implemented within this protocol.

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