Annex I: Messages and Procedures for Frequency Change (information only)

This annex defines protocol data units (PDUs) and procedures to allow the use of automatic link establishment (ALE) systems to select a new operating frequency. It could also be used to support manual frequency change; however the required coordination procedures are not defined here.

For some systems it may be desirable to adapt the data rate along with the frequency change. Three cases may be considered:

1. Leave data rate at current settings
2. Return to default data rate
3. Set to new values

Initially, a simple procedure that implemented case 1 or 2 was envisioned. However, it turned out that the "simple procedure" was so similar to the DRC procedure defined in Annex C that it seemed overall a good idea to extend the DRC PDUs and procedures to the ALM procedure. This would cover all three cases above and is defined as option 1 below; the "simple procedure" is defined in option 2 below. Only one will be present in the final version of the STANAG.

I.1 Option 1: Combined Frequency and Data Rate Change (Automatic Link Maintenance - ALM)

This section defines PDUs and procedures for automatic link maintenance that combines data rate and operating frequency changes. This is an extension to the DRC PDUs and procedures defined in Annex C. Table I-1 defines the additional MANGEMENT message types that are used to implement this function.

Table I-1. ALM MANAGEMENT Messages

Message Type	Function	Contents
5	Automatic Link Maintenance Request (ALM_Req)	New HF modem transmit data rate and interleaving setting for ALM master
6	Automatic Link Maintenance Response (ALM_Resp)	Positive or negative response (including reason if negative)

The format and contents of the type 5 message shall be as defined for the type 1 message in C.3.8. The format and contents of the type 6 message will be as defined for the type 2 message in C.3.8, with a new reason as shown in table I-2.

Since the procedures defined in this Annex are extensions of the Annex C DRC procedures, they allow either

1. the ALM master tx parameters may be changed and the rx parameters left unchanged
2. the tx and rx parameters can be changed to identical new values

As the procedures stand now, there is no capability to specify during ALM new tx and rx parameters that are asymmetric. Another change that should be considered is to add a data rate

parameter (extension of table C-7) which explicitly indicates that the parameters on the new frequency will be determined externally (i.e., policy, or an ALE system).

Table I-2. Contents for Type 6 Message (Reason)

MSB - LSB	Interpretation
0 0 0 0 0	no reason (used to indicate unconditional acceptance of ALM_Request)
0 0 0 0 1	Tx and Rx parameters must be the same (conditionally accept)
0 0 0 1 0	Not possible to change modem data rate
0 0 0 1 1	Not possible to change modem interleaving
0 0 1 0 0	Not possible to change modem data rate or interleaving
0 0 1 0 1	Not consistent with local conditions
0 0 1 1 0	Not possible to change frequency

Procedures

Following a decision to change frequency, a node shall use type 6 D_PDUs containing type 5 and type 6 MANAGEMENT messages to coordinate the change. The node initiating the frequency change is referred to as the ALM master for this ALM procedure. The data rate and interleaving fields shall carry the data rate and interleaving for the ALM Confirm phase of the procedure (see Figure I-1). The data rate and interleave parameters to be used on the new frequency may be selected based on some external information (i.e., a sounding or ALE system) or by policy (i.e., existing or default parameters shall be used on the new frequency).

An advisory EOW message has not been defined which requests a frequency change, because the need to change frequencies will generally be caused by link conditions which have deteriorated below some threshold, and active measures are more appropriate than advisory measures in that situation.

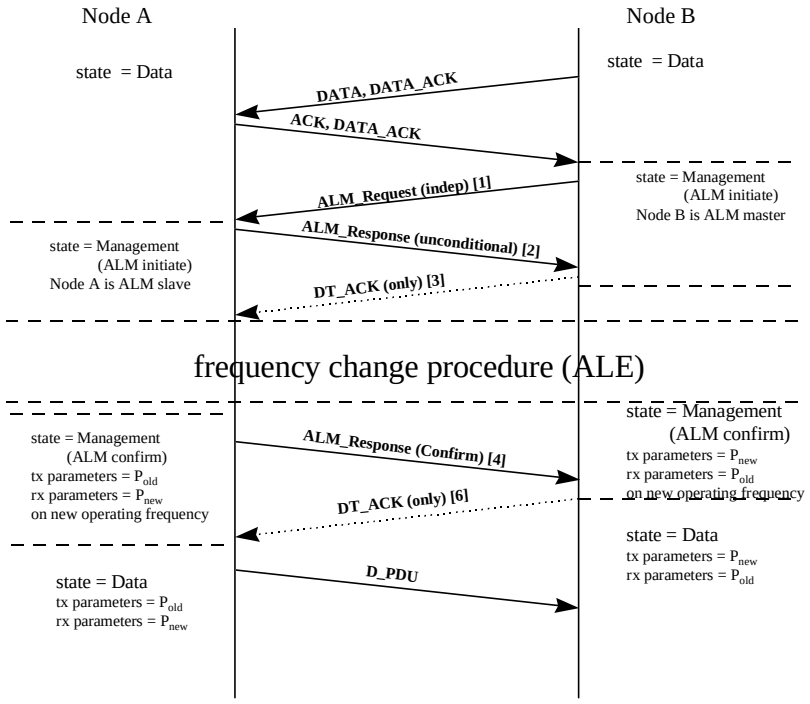

Figure I-1: Automatic Link Maintenance Procedure (Data Rate and Frequency Change)

The node initiating the ALM procedure by sending a ALM Request (type 5) management message (shown at [1] in figure I-1) will be referred to as an "ALM master" (node B in figure I-1). When a node recognizes a MANAGEMENT D_PDU addressed to it, containing a ALM_Request message, the node (referred to as the ALM slave, node A in Figure I-1) shall transition to the management state. The ALM slave shall respond to the ALM_Request D_PDU with a ALM_Response (type 6) message (shown at [2] in Figure I-1). The ALM Response message shall indicate either "accept" or "refuse", in accordance with Table I-2. If the ALM slave accepts the ALM_Request, the "reason" field shall indicate either "unconditional acceptance" or "Tx and Rx parameters must be the same". If the ALM slave refuses the request, the reason field shall indicate the reason for the refusal. Only the five reasons defined in the table are valid reasons for refusing a ALM_Request.

The figure shows an example in which the modem at the ALM slave also has independent transmit and receive data rate.

In order to increase reliability, the ALM message should be repeated. Table I-3 gives a minimum suggested number of times that a message should be transmitted, based on minimizing the use of stuff bits in the interleaver. Other considerations could make a larger number of repetitions desirable.

Table I-3. Suggested minimum number of ALM messages to be transmitted at various data rates using STANAG 4285 modem

Data rate	repetitions (short interleave)	repetitions (long interleave)
75	1	9
150	1	18
300	1	37
600	3	75
1200	7	150
2400	15	300

The number of retransmissions is selected to (nearly) fill the modem interleave buffer. For waveforms and interleaver settings not shown, the number of repetitions should be selected as required to minimize the use of "stuff bits" to fill the modem interleave buffer.

After receiving the ALM_Response message the ALM master shall review its contents and determine the appropriate response [4]. The various ALM_Response messages, and the allowed responses from the ALM master, are shown in table I-4.

Table I-4. Possible ALM_Responses and Allowed ALM Master Actions

ALM_Response	ALM_Response reason	allowed from ALM master
accept	unconditional	DT_ACK only
accept	transmit and receive parameters must be the same	DT_ACK only, or ALM_Response (cancel, or ALM Request)[note 1]
refuse	not possible to change modem data rate	ALM_Response (cancel)[note 2] or ALM_Request [note 3] (with DT_ACK)
refuse	not possible to change modem interleave	ALM_Response (cancel)[note 2] or ALM_Request [note 4](with DT_ACK)
refuse	not possible to change modem data rate or interleave	ALM_Response (cancel)[note 2](with DT_ACK)
refuse	not consistent with local conditions (see note 5)	ALM_Response (cancel)[note 2] or ALM_Request [note 6](with DT_ACK)

Notes to Table:

1. If EOW messages have been sent before the ALM procedure is initiated, the ALM master should already know that the ALM slave's transmit and receive parameters must be the same. Therefore, the ALM master should generally reply with a DT_ACK, accepting that the new parameters will apply to both transmit and receive.
2. ALM Slave shall acknowledge the cancel message with DT_ACK only; then the ALM procedure is discontinued. Note that this situation may frequently lead to failure of the link.
3. ALM_Request may be sent by master to request a different interleave setting at the same data rate.

4. ALM_Request may be sent by master to request a different data rate setting at the same interleave.
5. This reply shall only be sent in response to a request for a less robust set of parameters, i.e., higher data rate and/or shorter interleave than currently in use. It is expected that this will
6. ALM_Request may be sent by master to request different modem parameters that may be consistent with the local conditions.

In the table above, the DT_ACK refers to a data transfer sublayer acknowledgement of the preceding MANAGEMENT message (shown at [3] in Figure I-1). The DT_ACK reply indicates that the node has nothing further to communicate. If the DT_ACK (with no further management message) is sent in reply to a ALM_Response "accept" (as shown in Figure I-1), the nodes initiate the frequency change procedure, which may be controlled by an ALE system. Following the completion of the frequency change procedure, the nodes proceed to the "confirmation" phase. The ALM slave shall NOT initiate the frequency change procedure until it has received the DT_ACK (with no further management message) from the ALM master. If the DT_ACK (with no further management message) is sent by the ALM slave in reply to a ALM_Response "cancel", both nodes abandon the procedure and return to the prior state. If node A (formerly the ALM slave) has no queued data or acknowledgements to send to node B, it shall send a data D_PDU, expedited data D_PDU, or non-ARQ D_PDU, with zero data attached.

In the figure, the slave's ALM_Response with an "accept/unconditional" message generates the allowed DT_ACK from the ALM master.

After sending the DT_ACK [3], the ALM master initiates the frequency change procedure. On completion of the frequency change procedure, the ALM master sets its modem parameters and waits to receive a ALM Confirm message (type 6 MANAGEMENT message with response set to "confirm" and reason set to "none") from node A ("confirmation phase").

After receiving the DT_ACK [3], the ALM slave changes its modem parameters and transmits a ALM Confirm message [4] to the master. On receiving the ALM Confirm message, the master shall respond with a DT_ACK and then return to the previous state. After sending the ALM Confirm message [4] to the master and receiving the DT_ACK from the master, the slave shall return to the previous state and send any queued D_PDUs to node B. If node A (formerly the ALM slave) has no queued data to send to node B, it shall send a data D_PDU or expedited data D_PDU with zero data attached.

I.2 Option 2: Frequency Change without Data Rate Change

This Annex defines a data transfer sublayer procedure that will support a pause in data transfer for purposes of link management involving a change of frequency. The procedures for selecting the new frequency are not defined here; this is included for the benefit of systems that make use of some form of ALE for that purpose.

The procedures defined here make use of additional management messages (type 6 D_PDUs).

Table I-1. MANAGEMENT Message Types

Message Type	Function	Contents
5	Frequency Change Request (FC_Req)	
6	Frequency Change Response (FC_Resp)	Positive or negative response (including reason if negative)

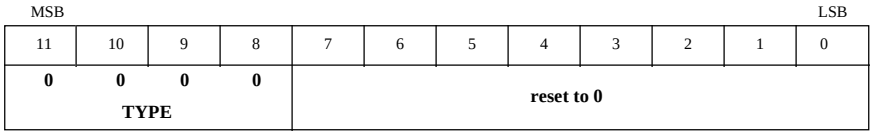

Figure I-1 (a). Message Type 5 Format

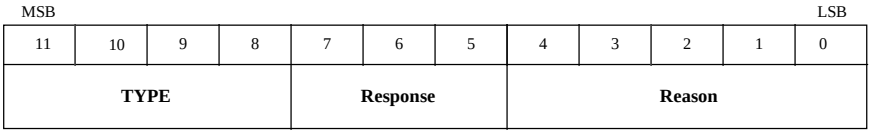

Figure I-1 (b). Message Type 6 Format

Table I-2. Contents for Type 6 Message (Response)

MSB - LSB	Interpretation
0 0 0	accept
0 0 1	refuse
0 1 0	cancel
0 1 1	confirm

Procedures

Following a decision to change frequency, a node shall use type 6 D_PDUs containing type 5 and type 6 MANAGEMENT messages to coordinate the change. The node initiating the frequency change is referred to as the frequency change master (FC master) for this FC procedure.

An advisory EOW message has not been defined to which requests a frequency change, because the need to change frequencies will generally be caused by link conditions which have deteriorated below some threshold, and active measures are more appropriate than advisory measures in that situation.

Table I-2. Possible FC_Responses and Allowed FC Master Actions

FC_Response	allowed from FC master
accept	DT_ACK only
refuse	ALM_Response (cancel)[note1]

Notes to Table:
1. FC Slave shall acknowledge the cancel message with DT_ACK only; then the FC procedure is discontinued (as shown in Figure I-3).

In the table above, the DT_ACK refers to a data transfer sublayer acknowledgement of the preceding MANAGEMENT message (shown at [3] in Figure I-2). The DT_ACK reply indicates that the node has nothing further to communicate. If the DT_ACK (with no further management message) is sent in reply to a FC_Response "accept" (as shown in Figure I-2), the nodes switch to ALE mode in order to select a new frequency for the connection. When ALE is completed, the nodes enter the "confirmation" phase to complete the procedure.

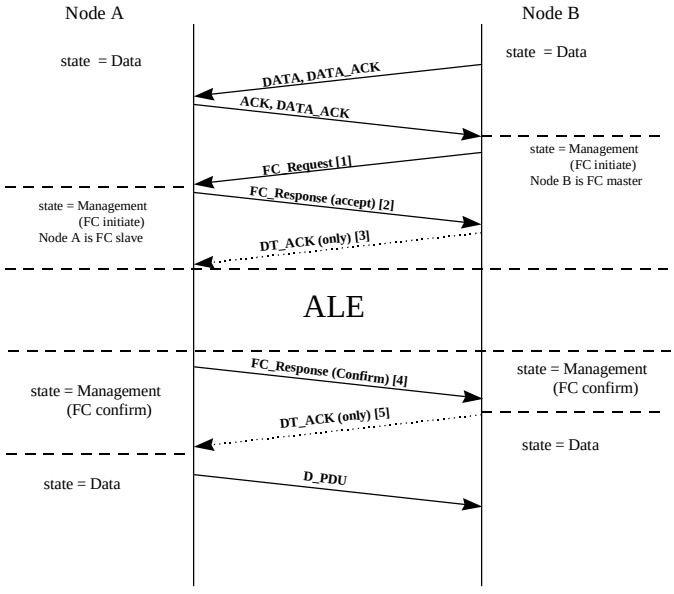

Figure I-2. Frequency Change Procedure (Example 1)

Figure I-2 presents a "normal", successful frequency change procedure. In this diagram, node B determines that a frequency change is needed. Node B then enters the management state and sends an FC_Request message to node A (shown at [1] in Figure I-2). On receiving this message, node A enters the management state and sends an FC_Response(accept) message (shown at [2]). Node B responds with a DT_ACK (shown at [3]) and enters the ALE state as the active party.

Node A enters the ALE state as the passive party, i.e., expecting to receive from node B. On completion of the ALE procedure, node A sends a FC_Response(confirm) message (shown at [4]). Node B responds with a DT_ACK (shown at [5]), unless node B wishes to initiate a ALM procedure.

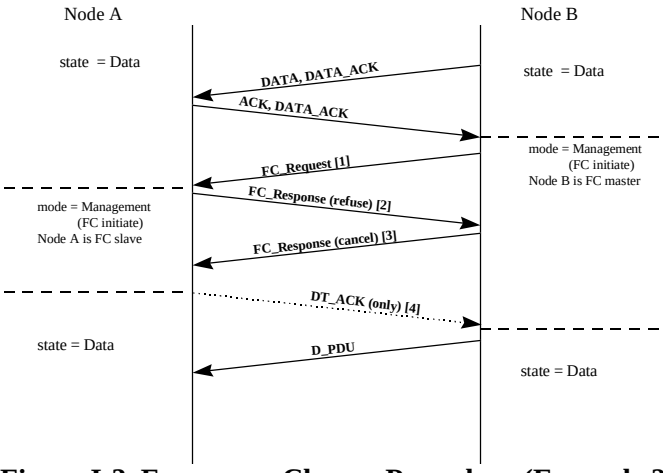

Figure I-3. Frequency Change Procedure (Example 2)