APPENDIX D

(ENGLISH ONLY)

DRAFT

MANUAL

ON

HF DATA LINK (HFDL)

TECHNICAL DETAILS

TABLE OF CONTENTS

1. INTRODUCTION

1.1 The purpose of this manual is to provide additional technical details for the link and subnetwork layers of the HF data link (HFDL) system. These specifications were developed by the AMCP in conjunction with the Standards and Recommended Practices (SARPs) which are incorporated in Annex 10, Volume III, Part I, Chapter 11. States should ensure that, in the interest of interoperability, HFDL systems are operated in accordance with these specifications.

1.2 ICAO will continue to develop the material in this manual through the appropriate channels. Due account will be taken of the need to ensure, to the maximum extent practical, compatibility with the current specifications with a view to avoid the requirement to retrofit aircraft with new systems.

2. LINK LAYER PROTOCOLS

2.1 Reliable link service (RLS) protocol

Table 2-1. Information held by the HFDL aircraft and ground station sub-systems

HFDL aircraft station sub-system	HFDL ground station sub-system
D(A) - oldest sequence number not acknowledged by the HFDL ground station sub-system	**U(A)** - oldest sequence number not acknowledged by the HFDL aircraft station sub-system
D(A)vect - flags indicating if D(A)+1..D(A)+8 has been acknowledged	**U(A)vect** - flags indicating if U(A)+1..U(A)+8 has been acknowledged
D(N)vect - flags indicating if the HFDL ground station sub-system has negatively acknowledged D(A)+1..D(A)+8	**D(N)vect -** flags indicating if the HFDL aircraft station sub-system has negatively acknowledged U(A)+1..U(A)+8
D(S) - next to send	**U(S)** - next to send
U(R) - oldest not received	**D(R)** - oldest not received
U(R)vect - flags indicating if U(R)+1..U(R)+8 has been received	**D(R)vect** - flags indicating if D(R)+1..D(R)+8 has been received

2.1.1 Segmentation of HFNPDUs into BDUs and flow control

a) HFNPDUs of up to 424 octets shall be segmented into smaller basic data units (BDUs). Each BDU shall be encapsulated into a Numbered Data LPDU (as shown in Attachments 1 and 2 to the appendix to the SARPs). An HFNPDU may be segmented into no more than 8 BDUs.

b) An 8-bit BDU header, defined in Figure 11 (Attachment 1 to the appendix to the SARPs), shall be added to each BDU prior to encapsulation into a Numbered Data LPDU.

c) When building an MPDU for transmission, Numbered Data LPDUs shall be used. BDUs having the highest priority shall be chosen first for insertion into the Numbered Data LPDUs being sent. The relationship between a BDU and the Numbered LPDU that contains it shall only exist until the Numbered LPDU is either ACKed or NACKed. If the BDU is ACKed then it shall be reported as successfully transmitted to the segmentation sublayer. If the BDU is NACKed, then it shall be placed into a prioritized BDU queue for retransmission. When a BDU is required to be retransmitted, it shall be placed into a Numbered LPDU for transmission. The BDU fields RN, Q, M-bit, and BSN shall remain the same as the initial transmission. Because of the possibility of introduction of BDUs at a higher priority, the U(S)/D(S) field of the Numbered LPDU may not have the same value as the Numbered LPDU that contained the BDU in the initial transmission.

d) When choosing sequence numbers (U(S)/D(S)) in Numbered LPDUs, the following shall be applied:

1) A sequence number (U(S)/D(S)) is not eligible for use in a Numbered LPDU transmission until the Numbered LPDU that last used the sequence number is either ACKed or NACKed.

2) For a Numbered LPDU to be ACKed, a SPDU or an U(R)/U(R)vect, (D(R)/D(R)vect) if the ACKed is a downlink, must be received providing positive acknowledgment of the Numbered LPDU.

3) For a Numbered LPDU to be NACKed, a SPDU or an U(R)/U(R)vect, (D(R)/D(R)vect) if the NACKed is a downlink, must be received at least two slots after the transmission of the Numbered LPDU providing a negative acknowledgment.

4) If the Numbered LPDU is ACKed, then the sequence number (U(S)/D(S)) used is unavailable for use until the window rotation includes it again.

5) If the Numbered LPDU is NACKed, then the sequence number (U(S)/D(S)) used is made available for transmission in another Numbered LPDU.

e) At any one time the link layer shall have no more than four HFNPDUs per priority level, pending acknowledgment from its peer layer.

2.1.2 **Reassembly of BDUs into HFNPDUs, flow control and routing**

a) Reassembly of BDUs into an HFNPDU shall be initiated when a BDU with a new (RN,Q) and Aircraft ID not previously active in the reassembly process is received.

b) The HFNPDU reassembly shall be completed when the BDU with the M bit set to 0 and all other BDUs with the same (RN, Q) and Aircraft IDs are received.

1) The transmitting HFDL station sub-system shall start a timer for each HFNPDU which is received from the user layer. The duration of this timer shall be [180] seconds. When this timer expires, the transmitting HFDL station sub-system shall discard the HFNPDU, and indicate a NACK to the higher layer entity for the discarded HFNPDU. If that HFNPDU was introduced for transmission as BDUs, then those BDUs shall be discarded, and a new BDU shall be introduced for transmission. This new BDU shall have the same RN and Q values, BSN=0, M=0, and no user data. This new BDU is used to indicate to the receiving HFDL station sub-system that the transmitting HFDL station sub-system has discarded the HFNPDU. Once the new BDU is acknowledged by the receive side, the (RN, Q) can be reused for a new HFNPDU.

2) Upon receiving a BDU with no user data, the receiving HFDL station sub-system shall discard all BDUs having that (RN, Q) pair. The receiving HFDL station sub-system shall then, upon receiving a BDU with the same (RN, Q) pair, consider those BDUs to be part of a new HFNPDU.

c) When receiving BDUs and reassembling them into HFNPDUs, the RN, Q, M-bit, and BSN fields shall be used to correlate the BDUs. The U(S)/D(S) field of the Numbered LPDU containing the BDU shall not be used as a reference to correlate BDUs.

d) For each priority level, the receiving link layer shall deliver in-order reassembled HFNPDUs which have been received using the RLS mode to the higher layer. HFNPDUs received and reassembled out-of-order shall be queued until the missing HFNPDUs have been received or the timer expires.

e) When routing a complete reassembled HFNPDU using the RLS mode, the first octet in the HFNPDU shall be examined. If the first octet is not set to FF_h, then the HFNPDU shall be routed to the HF Subnetwork layer.

f) If the first octet is set to FF_h, then the HFNPDU shall be routed to the function that processes non-HFDL subnetwork layer packets.

2.1.3 **Uplink transmission of LPDUs and flow control**

a) All U(S) sequence number operations shall use modulo 32 arithmetic. To describe the RLS uplink transmission protocol, terms and parameters shall be defined as follows:

1) U(S) U(S) is the 5-bit uplink sequence number embedded in the LPDU Type field of the uplink Numbered Data LPDUs.

2) U(A) U(A) is the oldest uplink sequence number which has not yet been acknowledged by the HFDL aircraft station sub-system.

3) U(A)vect U(A)vect is a field of 8 bits, each of which represents whether or not each of the LPDUs starting from the sequence number U(A)+1 to U(A)+k has been acknowledged by the HFDL aircraft station sub-system, where k is the transmit window size. A bit set to one (1) indicates that the LPDU has been positively acknowledged.

4) U(N)vect U(N)vect is a field of bits, each of which represents whether or not each of the LPDUs starting from the sequence number U(A) + 1 to U(A) + k has been negatively acknowledged by the HFDL aircraft station sub-system, where k is the transmit window size. For an LPDU to be considered negatively acknowledged, a U(R)/U(R)vect must be received at least three slots after the transmission of the LPDU. A bit set to one (1) indicates that the LPDU has been negatively acknowledged.

Note.— The window size k can be larger than the eight bits of the U(R)vect. Those LPDUs transmitted in the window, but not included in the U(R)vect, cannot be considered as either ACKed or NACKed.

5) U(R) U(R) is the 5-bit uplink sequence number of the oldest uplink LPDU not yet received by the HFDL aircraft station sub-system. This is the uplink sequence number embedded in the Uplink Acknowledgment Field of downlink MPDUs.

6) U(R)vect U(R)vect is an 8-bit Boolean array embedded in the Uplink Acknowledgment Field of downlink MPDUs. Each bit indicates whether or not each of the LPDUs starting from the sequence number U(R)+1 to U(R)+8 has been received by the HFDL aircraft station sub-system. Each bit shall be set to one if its corresponding LPDU having sequence number U(R)+ i, where i=1 to 8, has been received; otherwise, it is set to zero.

b) Whenever an HFDL aircraft station sub-system receives a Numbered Data LPDU from the ground, the sequence number of the received LPDU shall be compared to U(R). If the sequence number is equal to U(R), the HFDL aircraft station sub-system shall:

1) Increment U(R).

2) If U(R)vect modulo 2 equals 1, then divide U(R)vect by 2 discarding the remainder and repeat steps 1 and 2.

3) If U(R)vect modulo 2 equals 0, then divide U(R)vect by 2.

c) If the sequence number is greater than U(R), and less than U(R)+k, where k is the transmit window size specified by the HFDL ground station sub-system in the Log-On Confirm, the HFDL aircraft station sub-system shall set the appropriate bit in U(R)vect. If that bit in U(R) vect was previously zero (0), then the LPDU shall be accepted for reassembly. If that bit in the U(R) vect is one (1), then the LPDU is a duplicate and shall be discarded.

d) If the sequence number is less than U(R), but greater than or equal to U(R)-k, the HFDL aircraft station sub-system shall consider the received Numbered Data LPDU as a repeat and discard it. If there are no outstanding LPDU downlinks waiting to be sent, then the HFDL aircraft station sub-system shall send an empty downlink with the appropriate Uplink Acknowledgment Field indicating the next expected uplink sequence number U(R). Otherwise, the U(R) value shall be sent in the next downlink LPDU.

e) If the sequence number is less than U(R)-k or greater than or equal to U(R)+k, the HFDL aircraft station sub-system shall consider itself logged off and initiate a frequency search and log on.

2.1.3.1 **Uplink acknowledgment**

Each downlink MPDU shall contain a five-bit U(R) and an eight-bit U(R)vect. When the HFDL ground station sub-system receives a downlink transmission, it shall update the U(A)vect with the acknowledgment bits in U(R)vect and update the U(N)vect with the negative acknowledgment bits in U(R)vect. Those BDUs in the Numbered LPDUs that are not acknowledged in U(A)vect, and are negatively acknowledged in U(N)vect, shall be scheduled for retransmission.

2.1.3.2 **Uplink LPDU sequence number assignment**

A sequence number shall be assigned to each Numbered LPDU queued for transmission by the HFDL ground station sub-system. The assigned sequence number shall be either a previously used sequence number or a new sequence number equal to U(S) (the next available unused sequence number). A previously used sequence number shall be used when there is a bit in a U(A)vect that is zero and a bit in U(N)vect that is one (indicating a sequence number has been sent, but the HFDL aircraft station sub-system has indicated it was not received). If a previously used number is chosen, then the aforementioned bit in U(N)vect shall be set to zero. A new number can be used when U(S) < U(A) + k, where k is the transmit window size specified in the Log-On Confirm uplink LPDU. If a new sequence number is used, then U(S) shall be incremented. If U(S) = U(A) + k, then a new sequence number shall not be assigned until U(A) is increased (note that U(S) > U(A) + k is not allowed).

Recommendation.— *In order to expedite delivery of uplink LPDUs, the HFDL ground station sub-system should assign a downlink slot to an HFDL aircraft station sub-system to allow acknowledgment of the uplink Numbered Data LPDUs. If the HFDL ground station sub-system does not receive a reply from the HFDL aircraft station sub-system, it may further elicit an acknowledgment by assigning another downlink slot.*

2.1.4 **Downlink transmission of LPDUs and flow control**

a) All D(S) sequence number operations shall use modulo 32 arithmetic. To describe the RLS downlink transmission protocol, terms and parameters shall be defined as follows:

1) D(S) D(S) is the 5-bit downlink sequence number embedded in the LPDU Type field of the downlink Numbered Data LPDUs.

2) D(A) D(A) is oldest downlink sequence number that has not yet been acknowledged by the HFDL ground station sub-system.

3) D(A)vect D(A)vect is a field of 8 bits, each of which represents whether or not each of the LPDUs starting from the sequence number D(A)+1 to D(A)+k has been acknowledged by the HFDL ground station sub-system, where k is the transmit window size. A bit set to one (1) indicates that the LPDU has been positively acknowledged.

4) (N)vect D(N)vect is a field of 8 bits, each of which represents whether or not each of the LPDUs starting from the sequence number D(A) + 1 to D(A) + k has been negatively acknowledged by the HFDL aircraft station sub-system, where k is the transmit window size. For an LPDU to be considered negatively acknowledged, a D(R)/D(R)vect must be received at least three slots after the transmission of the LPDU. A bit set to one (1) indicates that the LPDU has been negatively acknowledged.

5) D(R) D(R) is the 5-bit downlink sequence number of the oldest downlink LPDU not yet received by the HFDL ground station substation.

6) D(R)vect D(R)vect is an 8-bit Boolean array used by the HFDL ground station sub-system to determine which LPDUs have been received and which have been lost in transit. Each bit indicates whether or not each of the LPDUs starting from the sequence number D(R)+1 to D(R)+8 has been received by the HFDL ground station sub-system. Each bit shall be set to one if its corresponding LPDU having sequence number D(R)+ i, where i=1 to 8, has been received; otherwise, it is set to zero.

b) Whenever an HFDL ground station sub-system receives a Numbered Data LPDU, the sequence number of the received LPDU shall be compared to D(R). If the sequence number is equal to D(R), the HFDL ground station sub-system shall:

1) Increment D(R).

2) If D(R)vect modulo 2 equals 1, then divide D(R)vect by 2 discarding the remainder and repeat steps 1 and 2.

3) If D(R)vect modulo 2 equals 0, then divide D(R)vect by 2.

c) If the sequence number is greater than D(R), and less than D(R)+k, where k is the transmit window size used by the HFDL ground station sub-system, the HFDL ground station sub-system shall set the appropriate bit in D(R)vect. If that bit in U(R) vect was previously zero (0), then the LPDU shall be accepted for reassembly. If that bit in the U(R) vect is one (1), then the LPDU is a duplicate and shall be discarded.

d) If the sequence number is less than D(R), but greater than or equal to D(R)-k, the HFDL ground station sub-system shall consider the received Numbered Data LPDU as a repeat and discard it.

e) If the sequence number is less than D(R)-k or greater than or equal to D(R)+k, the HFDL ground station sub-system shall send a Log-Off Request LPDU with the reason code set to 'RLS Protocol Error'.

2.1.4.1 **Downlink acknowledgment field**

a) The slot acknowledgment definition is shown in Attachments 1 and 2 to the appendix to the SARPs.

b) Any Numbered Data LPDU that is not acknowledged in a correctly received SPDU shall be retransmitted. If the first SPDU following a downlink is not received correctly, the HFDL aircraft station sub-system shall wait for the second SPDU.

c) Whenever a downlink Numbered Data LPDU is acknowledged by the SPDU, the HFDL aircraft station sub-system compares the sequence number of the acknowledged LPDU to D(A). If the sequence number is equal to D(A), the HFDL aircraft station sub-system shall:

1) Increment D(A), and delete the LPDU from its queue.

2) If D(A)vect modulo 2 equals 1, then divide D(A)vect by 2 discarding the remainder and repeat steps 1 and 2.

3) If D(A)vect modulo 2 equals 0, then divide D(A)vect by 2.

d) If the sequence number is greater than D(A), and less than D(A)+k, where k is the transmit window size specified by the ground station in the Log-On Confirm, the HFDL aircraft station sub-system shall set the appropriate bit in D(A)vect.

e) If the sequence number is less than D(A) or greater than D(A) + k, then the HFDL aircraft station sub-system shall consider itself logged-off and initiate a frequency search and log-on procedure.

2.1.4.2 **Downlink MPDU sequence number assignment**

A sequence number shall be assigned to each Numbered LPDU queued for transmission by the HFDL aircraft station sub-system. The assigned sequence number shall be either a previously used sequence number or a new sequence number equal to D(S) (the next available unused sequence number). A previously used sequence number shall be used when there is a bit in a D(A)vect that is zero and a bit in D(N)vect that is one (indicating that a sequence number has been sent, but the HFDL ground station sub-system has indicated that it was not received). If a previously used number is chosen then the bit in D(N)vect shall be set to zero. A new number can be used when D(S) < D(A) + k, where k is the transmit window size specified in the Log-On Confirm uplink LPDU. If a new sequence number is used, then D(S) shall be incremented. If D(S) = D(A) + k, then a new sequence number cannot be assigned until D(A) is increased (note that D(S) > D(A) + k is not allowed).

2.2 **Direct link service (DLS) protocol**

The DLS protocol shall only be used to transfer the following types of HFNPDUs between the HFDL aircraft station sub-system and an HFDL ground station sub-system:

System Table,

Performance Data,

System Table Request,

Frequency Data,

Delayed Echo Application (Uplink and Downlink) (Optional), and

Enveloped Data.

In the DLS mode, uplink or downlink HFNPDUs shall not be segmented by the link layer.

3. **LINK LAYER MANAGEMENT**

3.1 **Channel access protocol**

The channel access protocol to be used in the HF Data Link system shall be a combination of Frequency Division Multiple Access (FDMA) and Time Division Multiple Access (TDMA).

3.1.1 **Assignment of slots by the HFDL ground station sub-system**

HFDL ground station sub-systems shall assign uplink slots, reserved downlink slots, and random access downlink slots taking into account message priority and maintenance of communications.

Recommendation.— *When assigning multiple slots to an HFDL aircraft station sub-system the HFDL ground station sub-system should assign adjacent slots.*

3.1.2 **Selection of downlink slot by HFDL aircraft station sub-system**

a) If an HFDL aircraft station sub-system has one or more downlink LPDUs queued for transmission and the HFDL ground station sub-system has assigned one or more slots to the HFDL aircraft station sub-system, the HFDL aircraft station sub-system shall send as many of the downlink LPDUs in the assigned slot or slots as possible. If a slot is assigned to an HFDL aircraft station sub-system and the HFDL aircraft station sub-system has nothing in its queue to send, the HFDL aircraft station sub-system shall send an MPDU without any LPDUs, or with one Performance Data HFNPDUs as in Attachments 1 and 2 to the appendix to the SARPs.

b) If the HFDL ground station sub-system has not assigned the HFDL aircraft station sub-system a slot, the HFDL aircraft station sub-system shall select and use a random access slot to send as many LPDUs as possible. The random access slot to be used shall be selected at random from all available access slots identified in the SPDU. If the HFDL aircraft station sub-system acquires one or more LPDUs for downlinking, after the SPDU is received, then the HFDL aircraft station sub-system shall randomly select a contention slot from the remaining available contention slots. If no contention slots are available, the HFDL aircraft station sub-system shall wait for a TDMA frame in which there are slot(s) available.

c) If an HFDL aircraft station sub-system transmits one or more LPDUs in a random access slot and none of the LPDUs are acknowledged in the next SPDU, where an acknowledgement is expected, the HFDL aircraft station sub-system shall perform the contention back-off algorithm in Figure A.1.

d) When operating in the Back-Off Mode, the HFDL aircraft station sub-system shall exit the Back-Off Mode when

1) at least one LPDU that was transmitted in a random access slot is positively acknowledged;

2) the SPDU which assigns a downlink slot to the HFDL aircraft station sub-system is received, or;

3) a condition that necessitates a new frequency search is detected.

3.1.3 **Downlink slot reservation requests**

With each downlink transmission, the HFDL aircraft station sub-system shall request slot assignments, if necessary, for future transmissions.

3.2 HFDL ground station sub-system management

3.2.1 Log-on procedure

When the HFDL ground station sub-system receives a Log-On Request, it shall check for the availability of unassigned Aircraft IDs and respond with a Log-On Confirm uplink addressed to the HFDL aircraft station sub-system with the assigned Aircraft ID and maximum downlink data rate measured. If there are no Aircraft IDs available, the HFDL ground station sub-system shall respond to the HFDL aircraft station sub-system with a Log-On Denied uplink with a reason code indicating no aircraft IDs available.

3.2.2 Log-on resume procedure

Upon receipt of a Log-On Resume request from the HFDL aircraft station sub-system, the HFDL ground station sub-system shall do one of the following:

a) If the HFDL aircraft station sub-system Log on information is contained in the HFDL ground station sub-system Log-On Status Table, then the HFDL ground station sub-system shall respond with a Log-On Resume Confirm. Delivery of any partially delivered HFNPDUs shall resume.

b) If the HFDL aircraft station sub-system Log on information is not contained in the HFDL ground station sub-system Log-On Status Table, then the HFDL ground station sub-system shall respond with a Log-On Confirm. In this case, the HFDL ground station sub-system shall respond with a Log-On Confirm LPDU to indicate to the HFDL aircraft station sub-system that the HFDL ground station sub-system cannot resume where the HFDL aircraft station sub-system left off, and that the link connection is to be reinitialized and treated as a new connection. The HFDL aircraft station sub-system shall discard any partially delivered HFNPDUs when it receives the Log-On Confirm LPDU.

3.2.3 Log-on status table

a) Each HFDL ground station sub-system shall maintain a table of HFDL aircraft station sub-systems logged on each of its operating frequencies. Each entry in the table includes the aircraft address, assigned Aircraft ID, and the last TDMA frame in which a downlink was received from the HFDL aircraft station sub-system, and slot reservation request information.

b) When the HFDL ground station sub-system receives a downlink with a slot reservation request, the HFDL ground station sub-system shall update downlink slot assignments requested.

3.2.4 **Data rate reporting**

The HFDL ground station sub-system shall report the maximum usable downlink data rate in the header of each uplink transmission addressed to the HFDL aircraft station sub-system based on the quality of the last downlink received from the HFDL aircraft station sub-system.

Recommendation.— *The maximum usable data rate reported should be based on the quality of the most recent downlinks received from the HFDL aircraft station sub-system.*

3.2.5 **Ground station synchronization (see 11.2.5)**

a) Synchronization of HFDL ground station sub-systems shall be to within +/- 25 milliseconds of UTC. If this synchronization is lost then the HFDL ground station sub-system shall indicate the condition by the use of the UTC SYNC flag within the SPDU, as described in the attachments.

b) When the HFDL ground station sub-system is synchronized to within +/- 25 milliseconds of UTC:

1) the HFDL ground station sub-system shall transmit SPDUs on its operational frequencies in a synchronized manner as defined in a master TDMA frame with Master TDMA Frame slot 0 starting at t_{ref} = 00:00:00.0 UTC

2) the HFDL ground station sub-system SPDU slot (slot 0) shall be broadcast with an offset to the Master TDMA Frame as defined within the HFDL System Table.

c) A slot shall be defined in the Master TDMA Frame for the SPDU slot (slot 0) of the TDMA frame for each assigned frequency at all HFDL ground station sub-systems (see Figure A.2).

Note.— The first slot (slot 0) is always the SPDU slot in the local TDMA frame defined for each frequency. All other slots (slots 1 through 12) are numbered relative to the SPDU slot for the purpose of assigning slots and acknowledging downlink LPDUs.

Note.— Assigning SPDU slot offsets in a staggered manner allows the HFDL aircraft station sub-system to more rapidly determine which frequencies are propagating (see Figure A-3).

3.2.6 **HFDL system table**

a) The HFDL ground station sub-system shall maintain a current HFDL System Table provided by the HFDL ground management sub-system, as defined in Attachments 1 and 2 to the appendix to the SARPs).

b) The HFDL ground station shall broadcast, as required, the HFDL System Table, partitioned into double slot HFNPDUs. The HFDL System Table shall be broadcast at 300 bps.

c) When responding to a HFDL System Table Request LPDU, the HFNPDUs shall be broadcast to all HFDL aircraft station sub-systems (Aircraft ID 00h). The HFNPDUs shall be delivered using the Unnumbered Data LPDU Type designator.

d) The number and content of the HFNPDUs used to broadcast the HFDL System Table shall be based on the size of the table and be identical for all HFDL System Table broadcasts for the same System Table Version.

3.2.7 **Ground station link monitoring**

3.2.7.1 **Procedure for logging off aircraft**

The HFDL ground station sub-system shall log off aircraft under any of the following conditions:

a) the aircraft logs on to another HFDL ground station sub-system,

b) the HFDL aircraft station sub-system does not respond to polling,

c) the downlink transmission is not within slot boundaries,

d) the downlink was sent in an uplink slot,

e) an RLS protocol error was encountered, or

f) an invalid Aircraft ID was used.

Note.— When logging off aircraft for items c) through f), the HFDL ground station sub-system shall notify the aircraft of the log off using the Log-Off Request reason codes in Attachment 2 to the appendix to the SARPs.

3.2.7.2 **Performance data**

Recommendation.— *The Performance Data HFNPDU is an optional HFNPDU that should be used to downlink system performance data collected by the HFDL aircraft station sub-system.*

a) If implemented, this function shall be as follows: During a log on session the HFDL aircraft station sub-system shall collect and send Performance Data as transmit space permits in downlink MPDUs with the exception of MPDUs containing a Log-On Request or Log-On Resume Request LPDU. The aircraft HF Data Link function shall not generate a separate downlink MPDU to send performance data unless the aircraft is assigned a downlink slot by the ground station sub-system and there is no other data to send. At the completion of each log on session, the HFDL aircraft station sub-system shall store a Performance Data HFNPDU that reflects the statistics gathered from the completed log on session. The Performance Data HFNPDU shall be held in a FIFO queue awaiting transmission. The HFDL aircraft station sub-system shall first choose the Performance Data HFNPDU at the front of the queue, otherwise a Performance Data HFNPDU reflecting the current log on session accumulate data shall be sent. Once a Performance Data HFNPDU from a previous session has been sent and acknowledged by the ground station sub-system, it shall be removed from the queue. When an insertion is made to the queue while the queue is full, the oldest HFNPDU shall be removed and the current HFNPDU inserted. The format of the Performance Data HFNPDU transmitted by the HFDL aircraft station sub-system shall be as defined in the Attachments.

3.2.7.3 **Frequency data**

Recommendation.— *The Frequency Data HFNPDU should be used to downlink system operating frequency propagation data collected by the HFDL aircraft station sub-system during the most recent frequency search.*

a) If implemented, Frequency Data shall be as follows: The Frequency Data HFNPDU shall be delivered with every Log-On Request or Log-On Resume request LPDU. The format of the Frequency Data HFNPDU transmitted by the HFDL aircraft station sub-system in the Log-On Request or Log-On Resume request LPDU shall be as defined in Figure 9 of Attachment 1 to the appendix of the SARPs.

3.3 **HFDL aircraft station sub-system management**

3.3.1 **Log-on procedure**

a) The HFDL aircraft station sub-system shall conduct a search for an operating frequency among the current assigned frequencies.

b) Once a frequency with a receivable SPDU is found, the HFDL aircraft station sub-system shall transmit a log-on LPDU on the selected frequency.

Recommendation.— *Once the frequency search algorithm is complete and the HFDL aircraft station sub-system has selected what is considered to be a good frequency, the hardware is tuned for transmit. During this initial tuning cycle, there may be a small amount of radiated energy that may be receivable by the HFDL ground station sub-system or other aircraft HF Stations. Therefore, this initial tune should take place at a time other than when the SPDU is being broadcast by the HFDL ground station sub-system.*

c) A confirmation that the HFDL ground station sub-system has received the Log-On Request shall be provided by a positive acknowledgment using FFh as the aircraft ID in the appropriate slot acknowledgment field contained in the next one or two SPDUs. A 'NACK' in this field shall indicate that the downlink was not received. The HFDL aircraft station sub-system shall then send a new Log-On Request downlink. If two consecutive Log-On Requests fail to be acknowledged, the HFDL aircraft station sub-system shall then initiate a search for another operating frequency, and re-start the log-on sequence.

d) If the HFDL aircraft station sub-system receives a Log-On Confirm uplink, it shall then begin delivery of downlink data and continue using the same frequency and assigned Aircraft ID.

e) If the HFDL aircraft station sub-system receives a Log-On Denied uplink, it shall then search for a different frequency.

f) HFDL aircraft station sub-systems shall only log-on to HFDL ground station sub-systems broadcasting an SPDU with an SPDU version compatible with the implementation of the HFDL aircraft station sub-system.

3.3.2 **Log-on resume procedure**

a) The link layer shall initiate a search for a new frequency when any of the following occurs:

1) The last SPDU announced a HFDL ground station sub-system frequency change, shut down or loss of ground network connection

2) The HFDL aircraft station sub-system fails to detect 2 consecutive SPDUs

3) When three consecutive downlinks are not positively acknowledged

4) Five or more out of 10 SPDUs are received with CRC error.

Note.— SPDU data information may be used to update the operating frequency list.

b) When changing frequencies, the HFDL aircraft station sub-system shall issue a Log-On Resume request, or Log-On Request to connect to a different frequency.

c) The HFDL aircraft station sub-system HFDL shall save all segments of partially reassembled uplink HFNPDUs (Basic Data Units) while a Log-On Resume procedure is pending, The partially reassembled uplink HFNPDU is discarded only if the HFDL ground station sub-system does not respond with a Log-On Resume-Confirm LPDU.

3.3.3 **Data rate reporting**

The HFDL aircraft station sub-system shall report the maximum usable uplink data rate in the header of each downlink transmission.

Recommendation.— *The maximum usable data rate reported should be based on the quality of the most recent SPDUs and uplinks received from the HFDL ground station sub-system.*

3.3.4 **HFDL system table management**

When the HFDL System Table version number, stored within the HFDL aircraft station sub-system, is less than the HFDL System Table version number broadcast in an SPDU, the link layer shall update the HFDL System Table with the newer broadcast HFDL System Table. When the HFDL System Table version number, stored within the HFDL aircraft station sub-system, is greater than the HFDL System Table version number broadcast in an SPDU, the link layer shall update the HFDL System Table with the broadcast HFDL System Table only if the version number indicates a rollover condition.

4. SUBNETWORK LAYER PROTOCOLS AND SERVICES

4.1 HFDL subnetwork layer

4.1.1 General provisions

4.1.1.1 Architecture

4.1.1.1.1 Figure 4-11 shows the HFDL subnetwork dependent (HFSND), interworking (IW) and subnetwork access (SNAc) functions and the ATN HFDL subnetwork protocol architecture.

4.1.1.1.2 The term DCE when used shall mean ISO 8208 second addition, DCE.

4.1.1.1.3 The HFDL subnetwork layer (HFSNL) shall interface with the link layer and the HFDL aircraft station sub-system/HFDL ground station sub-system management.

4.1.1.2 **Services**

The HFSNL shall provide for the transparent transfer of octet aligned HFSNL user data and/or control information.

4.1.2 **Packet data performance**

4.1.2.1 **Reserved**

Note.— The terms used with respect to packet data performance are based on the definitions in ISO 8348 (first edition). In applying these definitions to the HFDL subnetwork layer, the word "network" and its abbreviation "N" in ISO 8348 are replaced by the word "subnetwork" and its abbreviation "SN", respectively, wherever they appear.

4.1.2.2 **Speed-of-service**

Note.— Subnetwork performance depends on a number of factors, including the level of communication traffic. The performance values given here apply under maximum loading conditions.

4.1.2.2.1 **Connection establishment delay**

Note.— Connection establishment delay, as defined in ISO 8348, includes a component, attributable to the called subnetwork service user, which is the time between the SN-CONNECT indication and the SN-CONNECT response. This user component is due to actions outside the boundaries of the HFDL subnetwork and is therefore excluded from the HFDL specifications.

4.1.2.2.1.1 Connection establishment delay (95^{th} percentile) shall not exceed [70] seconds.

4.1.2.2.2 **Reserved**

4.1.2.2.3 **Reserved**

4.1.2.2.4 **Connection release delay**

The connection release delay (95 percentile) shall not exceed [30] seconds.

4.1.2.3 **Reserved**

4.1.3 **HFDL subnetwork-dependent protocol services and operations**

4.1.3.1 **General provisions**

Since the functional differences between the HFDL subnetwork dependent protocol aircraft function (HFSNDPA) and HFDL subnetwork dependent protocol ground function (HFSNDPG) are minimal,

their operations shall be described in terms of HFSNDPX where X shall stand for either A or G. Where differences do occur, the HFSNDPA and HFSNDPG functions shall be described individually.

4.1.3.2 **HFDL subnetwork-dependent protocol entities**

Note.— At least one pair of HFSNDPA and HFSNDPG entities exists between each pair of HFDL Aircraft Station Sub-system and HFDL Ground Station Sub-system. Figure 4-12 shows two pairs of HFSNDPA and HFSNDPG entities between two HFDL Aircraft Station Sub-systems and a HFDL Ground Station Sub-system.

4.1.3.2.1 The HFSNDPX defined in this section shall pertain to each HFSNDPX entity.

4.1.3.3 **Logical channels**

Note.— The connections between HFSNDPAs and HFSNDPGs are established through logical channels. Up to 255 logical channels may be established between each pair of HFSNDPX entities. Each logical channel is identified by its own logical channel number (LCN) ranging from 1 through 255. LCN 0 is reserved.

4.1.3.3.1 For a new ground-to-air connection establishment, the HFSNDPG shall allocate a logical channel number in the range 1 to 127, by choosing the lowest numbered logical channel in the ready state in that range. For a new air-to-ground connection setup, the HFSNDPA shall allocate a logical channel number in the range 128 to 255, by choosing the highest numbered logical channel in the ready state in that range.

4.1.3.4 **Operations**

The HFSNDPX virtual call (VC) service shall proceed through three distinct phases:

a) connection established;

b) data transfer; and

c) connection release.

Note.— The HFSNDPX is specified in terms of locally originated, or remotely originated operations. Locally originated specifies the procedure at the HFSNDPX for handling operations originating from a local subnetwork service (SNS) user, while remotely originated specifies the procedure at the HFSNDPX for handling operations originating from a remote SNS user.

4.1.3.5 **Connection establishment**

Note.— Up to [128] octets of user data may be transferred during connection establishment.

4.1.3.5.1 The connection establishment procedure shall apply independently to each establishment request.

4.1.3.5.2 User data shall be transparently forwarded in both directions.

4.1.3.5.3 **Locally originated**

4.1.3.5.3.1 **Normal operation**

4.1.3.5.3.1.1 When the HFSNDPX receives a call request packet from the IW, it shall allocate a logical channel which is in the ready state, forward the call request packet to the remote HFSNDPX by means of a connection request HFNPDU and place the logical channel into the IW call request state.

4.1.3.5.3.1.2 If the call is accepted at the remote HFSNDPX, a connection confirm HFDL subnetwork protocol data units (HFNPDU) is received. The HFSNDPX shall then place the logical channel in the data transfer/flow control state (flow control ready/no remote or local interrupt pending) and forward a call connected packet to the IW. The call connected packet shall use default values (if any) for the facilities which are not transmitted over the HFDL subnetwork, according to the HFNPDU to packet mapping rules defined in 4.7.3.16.

4.1.3.5.3.1.3 If the HFSNDPX does not receive either a connection confirm or connection released HFNPDU from the remote HFSNDPX before the timer (*see* tN1, Table 4-18) expires, it shall initiate a connection release procedure.

4.1.3.5.3.2 **Other operation**

If resources are not available, or a requested facility value is not allowed, then the originating HFSNDPX shall send a clear indication packet to the IW.

4.1.3.5.4 **Remotely originated**

4.1.3.5.4.1 **Normal operation**

4.1.3.5.4.1.1 When the HFSNDPX receives a connection request HFNPDU from the remote HFSNDPX, it shall place the logical channel selected in the incoming call state. The HFSNDPX shall forward an incoming call packet to the IW using default values for any facilities which are not transmitted over the HFDL subnetwork (see 4.7.3.16).

4.1.3.5.4.1.2 When the HFSNDPX receives a call accepted packet from the IW, it shall forward a connection confirm HFNPDU to the remote HFSNDPX and place the logical channel in the data transfer/flow control state (flow control ready/no remote or local interrupt pending) when it receives from the interfacing link layer the information that the connection confirm HFNPDU has been processed.

4.1.3.5.4.2 **Other operation**

4.1.3.5.4.2.1 If the receiving HFSNDPX cannot support the request, then it shall transmit a connection released HFNPDU to the originating HFSNDPX.

4.1.3.5.4.2.2 If a selected facility value is not allowed, then the receiving HFSNDPX shall initiate a connection release procedure.

4.1.3.6 **Connection release**

Note.— A subnetwork connection may be released at any time by any party once the logical channel is in the data transfer, IW call request, or incoming call states. The connection released HFNPDU may contain user data ([128] octets maximum) provided by the IW.

4.1.3.6.1 User data shall be transparently forwarded in both directions.

4.1.3.6.2 The HFSNDPX shall guarantee in-sequence transmission between data/ interrupt HFNPDUs already forwarded to the link layer and a subsequently transmitted connection released or connection release complete HFNPDU.

4.1.3.6.3 **Locally originated**

4.1.3.6.3.1 When the HFSNDPX receives a clear request packet from the IW, it shall place the logical channel in the local clear request state, generate a connection released HFNPDU, and forward it to the remote HFSNDPX. The only HFNPDUs it shall then accept, are a connection released HFNPDU or a connection release complete HFNPDU. It shall discard all other HFNPDUs. The HFSNDPX shall also consider the receipt of any packet other than a clear request packet as an error, and shall discard it.

4.1.3.6.3.2 When the HFSNDPX receives a connection release complete after the connection released has been successfully sent, it shall return the logical channel to the ready state. If the HFSNDPX receives a connection released HFNPDU from the remote HFSNDPX, it shall not expect to receive a connection release complete HFNPDU.

4.1.3.6.3.3 If the HFSNDPX does not receive a response from the remote HFSNDPX before the associated timer (see tN6, Table 4-18) expires, it shall return the logical channel to the ready state.

4.1.3.6.4 **Remotely originated**

When the HFSNDPX receives a connection released HFNPDU, it shall enter the remote clear request state, and forward a clear indication packet to the IW. It shall also construct a connection release complete HFNPDU, send it to the remote HFSNDPX, and return the logical channel to the ready state.

4.1.3.6.5 **HFSNDPX originated**

If the HFSNDPX entity needs to disconnect a connection, it shall place the logical channel in the local clear request state, send a clear indication packet to the IW and transmit a connection released HFNPDU to the remote HFSNDPX. It expects to receive as a response from the remote HFSNDPX a connection release complete HFNPDU or connection released HFNPDU, and shall return the logical channel to the ready state when the expected response is received or timing supervision expires (see tN6, Table 4-20).

4.1.3.7 **Data transfer**

4.1.3.7.1 The data transfer procedure shall apply independently to each logical channel which is in the data transfer/flow control state.

4.1.3.7.2 **Data transfer procedure**

4.1.3.7.2.1 Data shall be forwarded transparently and in sequence between the SNS users.

4.1.3.7.2.2 An M-bit HFNPDU sequence shall consist of a sequence of one or more data HFNPDUs. Each data HFNPDU except the last one, shall contain the maximum [503] octets of user data and its M-bit shall be set to 1. The user data field of the last HFNPDU which belongs to the sequence may have less than the maximum length and shall have its M-bit set to 0.

4.1.3.7.2.3 **Locally originated**

4.1.3.7.2.3.1 An M-bit packet sequence received from the IW shall be forwarded as an M-bit HFNPDU sequence to the remote HFSNDPX.

4.1.3.7.2.3.2 Upon receipt from the IW of one or more data packets belonging to one M-bit packet sequence, the HFSNDPX shall generate one or more data HFNPDUs, using the M-bit to indicate a following data HFNPDU of the same sequence of data HFNPDUs and shall forward them to the remote HFSNDPX.

Note.— The number of data HFNPDUs needed in the sequence depends on the amount of user data in the data packets which belong to the M-bit packet sequence.

4.1.3.7.2.3.3 The HFSNDPX shall also assign an HFNPDU number to each data HFNPDU. HFNPDU numbers shall be consecutive over a given connection. The sequence numbering of data HFNPDUs shall be performed modulo 256 and the HFNPDU numbers shall cycle through the entire range from 0 through 255. The first data HFNPDU to be transmitted over the HFDL link, when the logical channel has just entered the flow control ready state, shall have an HFNPDU number equal to 0.

4.1.3.7.2.4 **Remotely originated**

4.1.3.7.2.4.1 An M-bit HFNPDU sequence received from the remote HFSNDPX shall be forwarded as an M-bit packet sequence to the IW.

4.1.3.7.2.4.2 Upon receipt of an M-bit HFNPDU sequence, the HFSNDPX shall generate an M-bit packet sequence, using the M-bit to indicate a following packet of the same sequence as required and forward it to the IW.

Note.— The number of data packets needed in the M-bit packet sequence depends on the amount of user data in the M-bit HFNPDU sequence and the packet size.

4.1.3.7.2.4.3 If a data HFNPDU is received which contains less than the maximum size and with M-bit = 1, then the HFSNDPX shall initiate a reset procedure (see 4.7.3.8.2.1).

4.1.3.7.3 **Flow control**

4.1.3.7.3.1 Flow control shall be provided within the HFSNDPX to prevent the overflow of data buffers.

4.1.3.7.3.2 To interrupt the flow of data, the receiving HFSNDPX shall generate a flow control HFNPDU with its flow control reason field set to suspend and transmit it to the remote HFSNDPX. The HFNPDU number in the flow control (suspend) HFNPDU shall be set to the HFNPDU number of the last received and accepted data HFNPDU. If there are any out-of-sequence data HFNPDUs in the HFSNDPG, the HFNPDU number in the flow control HFNPDU with its reason field set to suspend shall be set to the HFNPDU number of the HFNPDU received and accepted before the out-of-sequence HFNPDU. When subsequently the receiving SNDPX is able to resume the data transfer, it shall transmit a flow control HFNPDU with its flow control reason field set to resume.

4.1.3.7.3.3 When the HFSNDPX receives a flow control HFNPDU with its flow control field set to suspend, it shall stop transmitting data HFNPDUs on the indicated logical channel. If the HFNPDU number in the flow control (suspend) HFNPDU is other than that of the last data HFNPDU transmitted and the data HFNPDU with HFNPDU number equal to the HFNPDU number in the flow control (suspend) HFNPDU plus one modulo 256 is no longer in the data buffer, the HFSNDPX shall initiate a reset of the logical channel. When the HFSNDPX receives a flow control HFNPDU with its control field set to resume, it shall restart transmitting data HFNPDUs on the indicated logical channel. The first (re)transmitted data HFNPDU shall have its HFNPDU number equal to the HFNPDU number of the previously received flow control HFNPDU (suspend) plus one modulo 256, unless a reset procedure has been invoked.

4.1.3.7.3.4 If the receiving HFSNDPX is not able to resume data transfer before the associated timer (see tN7 in Table 4-18 and Table 4-20) expires, it shall initiate a reset of the logical channel.

4.1.3.7.4 **Expedited data transfer**

Note.— The expedited data transfer allows an HFSNDPX to transmit user data contained in an interrupt packet to the remote HFSNDPX, bypassing any flow control that may have been applied by subnetwork layer entities.

4.1.3.7.4.1 The expedited data transfer procedure shall apply independently to each logical channel which is in the data transfer state and shall not be initiated when a release or reset procedure is in process.

4.1.3.7.4.2 Only one interrupt HFNPDU at a time, with a maximum user data length of [32] octets, shall be permitted in each direction.

4.1.3.7.4.3 **Locally originated**

4.1.3.7.4.3.1 When the originating HFSNDPX receives an interrupt packet from the IW and provided there is no pre-existing interrupt HFNPDU awaiting interrupt confirm HFNPDU, the HFSNDPX shall then

generate an interrupt HFNPDU and forward it to the remote HFSNDPX, and await an interrupt confirm HFNPDU; otherwise, the HFSNDPX shall discard the interrupt packet.

4.1.3.7.4.3.2 Upon receipt of an interrupt confirm HFNPDU, the HFSNDPX shall generate an interrupt confirmation packet and forward it to the IW.

4.1.3.7.4.3.3 If the HFSNDPX does not receive the interrupt confirm HFNPDU before the associated timer (*see* tN4 in Table 4-18 and Table 4-20) expires, it shall initiate a reset of the logical channel.

4.1.3.7.4.4 **Remotely originated**

4.1.3.7.4.4.1 When the HFSNDPX receives an interrupt HFNPDU, it shall forward an interrupt packet to the IW.

4.1.3.7.4.4.2 When the HFSNDPX receives an interrupt confirmation packet from the IW, it shall construct an interrupt confirm HFNPDU, and send it to the remote HFSNPDX.

4.1.3.8 **Connection reset**

4.1.3.8.1 When the HFSNDPX detects an error in the HFSNDPX operation for which its action is to reset the virtual circuit (see Table 4-24), then it shall place the logical channel into the local reset state, carry out the reset procedure and transmit a reset HFNPDU to the remote HFSNDPX.

Note.— The cause and diagnostic codes indicate whether the reset should be carried out within the HFDL subnetwork alone or should be extended to the IW.

4.1.3.8.2 **Reset action**

During the reset process, the following actions shall be taken by the HFSNDPX with respect to its data transfer operation:

a) The HFNPDUs which have not yet been passed to the link layer shall be discarded;

b) The HFNPDUs that have been received prior to receiving/transmitting a reset HFNPDU but which do not constitute an M-bit HFNPDU sequence shall be flushed from the reassembly area;

c) The expected (data) HFNPDU number shall be reset to 0 and subsequently transmitted data HFNPDUs shall be numbered starting from 0; and

d) Any outstanding interrupt HFNPDU to or from the remote HFSNDPX remains unconfirmed and tN4 is stopped.

4.1.3.8.3 **Reset procedures**

4.1.3.8.3.1 The reset procedures shall apply only to logical channels that are in the data transfer state.

4.1.3.8.3.2 The HFSNDPX shall guarantee in sequence transmission between data/interrupt HFNPDUs already forwarded to the link layer and a subsequently transmitted reset or reset confirm HFNPDU.

4.1.3.8.3.3 **Locally/HFSNDPX originated**

4.1.3.8.3.3.1 When the originating HFSNDPX receives a reset request packet from the IW or when it has detected an error for which its action is to reset the switched virtual circuit (SVC), it shall place the logical channel into the local reset state, execute the reset action, transmit a reset HFNPDU to the remote HFSNDPX, and start a timer tN3 (*see* Table 4-18). If required by the error procedures in 4.7.3.9, the HFSNDPX shall forward a reset indication packet to the IW.

4.1.3.8.3.3.2 Upon receipt of the reset confirm HFNPDU from the remote HFSNDPX, it shall return the logical channel to the data transfer/flow control state.

4.1.3.8.3.3.3 If the HFSNDPX does not receive a response from the HFSNDPX before the associated timer (*see* tN3 in Table 4-18) expires, it shall initiate a connection release procedure.

4.1.3.8.3.4 **Remotely originated**

4.1.3.8.3.4.1 When the HFSNDPX receives a reset HFNPDU, it shall place the logical channel into the remote reset state, execute the reset action and transmit a reset indication packet to the IW as required (*see* Table 4-24).

4.1.3.8.3.4.2 The HFSNDPX shall transmit a reset confirm HFNPDU to its remote HFSNDPX and shall return the logical channel to the data transfer state when it has received from the link layer the information that the reset confirm HFNPDU has been successfully transmitted.

4.1.3.8.3.5 **Simultaneous reset**

If the HFSNDPX sends a reset HFNPDU and subsequently receives a reset HFNPDU it shall:

a) Not send a reset confirm HFNPDU; and

b) Not expect to receive a reset confirm HFNPDU.

4.1.3.9 **Error procedures**

Note.— Errors which are recognized by the HFSNDPX may be the result of the following events:

a) channel degradation or loss of synchronization;

b) HFDL aircraft station sub-system log-off;

c) a HFDL ground station sub-system-to-HFDL ground station sub-system handover;

d) link congestion;

e) an uncorrected transmission error;

f) a remote HFSNDPX protocol error; and

g) a protocol error in the IW/HFSNDPX interface procedure.

4.1.3.9.1 When an error as noted in Tables 4-22 to 4-24 is detected, the HFSNDPX shall initiate either reset or release of the relevant connection.

4.1.3.9.2 Errors shall be notified to the IW by means of cause and diagnostic parameters within the relevant packet. Errors shall be notified to the remote HFSNDPX by using the corresponding fields of the HFNPDUs, i.e. reset or release cause and diagnostic code.

4.1.3.9.3 The coding of the cause fields which are generated by the HFSNDPX and passed to the remote HFSNDPX shall be as defined in Table 4-16.

4.1.3.9.4 The coding of the corresponding HFSNDPX generated diagnostic code field shall be as defined in Table 4-17.

4.1.3.9.5 **Log-on/log-off**

Note.— The procedures for log-on and log-off are covered in 4.7.6.

4.1.3.9.6 **Originating HFSNDPX error recovery**

4.1.3.9.6.1 Transmission error resulting from the loss or delay of HFNPDUs shall be detected either by time-out when a response is expected or by the fail link interface data unit (LIDU) reported by the link layer.

4.1.3.9.6.2 The actions the HFSNDPX follows upon time-out shall be as summarised in Table 4-18.

4.1.3.9.6.3 The actions the HFSNDPX shall follow when it is informed by the link layer that the transmission of an HFNPDU has failed shall be as summarised in Table 4-19. Receipt of a fail (data/interrupt) LIDU while the relevant LCN is either in local/remote reset state or local/remote clear request state, shall not cause the HFSND sub-layer entity to generate a (further) connection reset.

4.1.3.9.7 **Protocol error**

Note.— Two types of protocol error may occur at the HFSNDPX. These are:

a) a syntactical error which occurs when a received HFNPDU does not conform to the format specifications over the HFDL subnetwork; and

b) a logical error which occurs when the HFSNDPX receives from its peer entity an HFNPDU that is not an acceptable input to the current state of the logical channel.

4.1.3.9.7.1 When the HFSNDPX detects a protocol error, it shall respond as indicated in Tables 4-21 to 4-24. These tables are depicted for each logical channel state.

4.1.3.9.8 **Out-of-sequence data HFNPDU procedure**

4.1.3.9.8.1 The HFSNDPX shall process received data HFNPDUs in proper sequence, according to HFNPDU number to construct data packets to be forwarded to the IW. The HFSNDPX shall discard duplicate HFNPDUs.

Note.— The receiving link layer at the HFDL Ground Station Sub-system may deliver HFNPDUs to the HFSNDPG in altered sequence. The HFSNDPG assembles data HFNPDUs in proper sequence before forwarding them to the IW

4.1.3.9.8.2 **HFSNDPG actions for out-of-sequence data HFNPDUS**

A data HFNPDU shall be defined as out of sequence if and only if its HFNPDU number does not immediately follow the HFNPDU number of the last received data HFNPDU that has been used in creating the last data packet.

Note.— HFNPDU numbers are incremented modulo 256. Thus, HFNPDU number 0 follows HFNPDU number 255.

4.1.3.9.8.2.1 If an out-of-sequence data HFNPDU is not a duplicate, the HFSNDPG shall store the out-of-sequence data HFNPDU. If no more storage is available, the HFSNDPG shall place the logical channel in the reset state and extend the reset to the IW.

4.1.3.9.8.2.2 Stored data HFNPDUs shall be processed to create data packets whenever this can be done without creating an out-of-sequence condition. Data packets shall be forwarded to the IW as soon as possible.

4.1.3.9.8.3 **HFSNDPA actions for out-of-sequence HFNPDUs**

If a data HFNPDU is received which is not a duplicate but has an HFNPDU number not immediately following the HFNPDU number of the data HFNPDU last received, the HFSNDPA shall initiate a reset of the connection.

4.1.3.10 **HFNPDU formats**

4.1.3.10.1 **General HFNPDU format**

4.1.3.10.1.1 An HFNPDU shall consist of at least two octets. Octet 1 shall contain the D- and M-bits and the HFNPDU type identifier field. Octet 2 shall contain the logical channel number field; depending on the particular HFNPDU type, additional octets may be required. The general HFNPDU format shall be as defined in Figure 4-13.

4.1.3.10.1.2 The D-bits and M-bits shall be bits 7 and 8, respectively, in octet 1.

4.1.3.10.1.3 The M-bit shall be used in an M-bit HFNPDU sequence consisting of a sequence of data HFNPDUs; it shall be set to 0 in all other HFNPDUs.

Note.— The D-bit is not used.

4.1.3.10.1.4 The HFNPDU type identifier field shall be bits 1-6 in octet 1. The coding of the HFNPDU type identifier field shall be as defined in Table 4-15.

4.1.3.10.1.5 Octet 2 shall contain the logical channel number field.

Note.— In the following sections, fields are defined in the order they may appear in the relevant HFNPDU.

4.1.3.10.2 **Connection request HFNPDU**

4.1.3.10.2.1 The format of connection request HFNPDU shall be as defined in Figure 4-14.

4.1.3.10.2.2 **HFNPDU type identifier field**

4.1.3.10.2.2.1 Bits 1, 2, 3 and 6 shall be the following indicator bits:

a) Bit 1, facilities field present;

b) Bit 2, called NSAP address present;

c) Bit 3, calling NSAP address present; and

d) Bit 6, fast select with restriction on response.

4.1.3.10.2.2.2 Bits 1, 2 and 3 shall be set to 1 if the corresponding fields are present in the connection request HFNPDU; otherwise, they shall be set to 0. Bit 6 shall be set to 1 if fast select with restriction on response applies; otherwise, it shall be set to 0.

4.1.3.10.2.3 **DTE address length field**

Octet 3 shall consist of the calling- and called-DTE address length fields. Bits 8 to 5 shall specify the length of the calling-DTE address in semi-octets. Bits 4 to 1 shall specify the length of the called-DTE address in semi-octets. Each address-length field shall be binary coded, where bit 5 or 1 shall be the low-order bit of the indicator.

4.1.3.10.2.4 **Calling- and called-DTE fields**

4.1.3.10.2.4.1 When indicated by the DTE addresses length field, the octets following the DTE addresses length field shall contain the called-DTE address followed by the calling-DTE address.

4.1.3.10.2.4.2 Each digit of an address shall be coded in a semi-octet in binary-coded decimal, where bit 5 or bit 1 shall be the low-order bit of the digit.

4.1.3.10.2.4.3 Starting from the high-order digit, a DTE address shall be coded in consecutive octets, with two digits per octet. In each octet, the higher-order digit shall be coded in bits 8 to 5. When the total number of digits in the called- plus calling-DTE fields is odd, the combined fields shall be rounded up to an integral number of octets by inserting zeros in bits 4 to 1 of the last octet of the combined fields.

4.1.3.10.2.5 **Called- and calling-NSAP address fields**

When indicated by the called- and calling-NSAP address present indicator bits, the octets following the calling- and called-DTE fields shall contain the called-NSAP address field, then the calling-NSAP address field.

4.1.3.10.2.6 **Facility field length field**

When indicated by the facilities field present indicator bit, the next octet shall contain the length of the facilities field in octets. The facility field length field shall be binary-coded, where bit 1 shall be the low-order bit of the field.

4.1.3.10.2.7 **Facilities field**

When indicated by the facilities field present indicator bit, the octets following the facility field length field shall contain the codes and parameters for the facilities.

4.1.3.10.2.8 **Call user data field**

The next octets shall be used to carry the call user data, if any. If fast select facility is not used, not more than [16] octets of data shall be present. If fast select facility is used, not more than [128] octets of data shall be present.

4.1.3.10.3 **Connection confirm HFNPDU**

4.1.3.10.3.1 The format of the connection confirm HFNPDU shall be as specified in Figure 4-15.

4.1.3.10.3.2 **HFNPDU type identifier field**

4.1.3.10.3.2.1 Bits 1 and 2 shall be the following indicator bits:

a) Bit 1: facilities field present; and

b) Bit 2: nsap address present.

4.1.3.10.3.2.2 These bits shall be set to 1 if the corresponding fields are present; otherwise, they shall be set to 0.

4.1.3.10.3.3 **Called-NSAP address field**

When indicated by the NSAP address present indicator bit, the octets following the logical channel number field shall consist of the called-NSAP address.

4.1.3.10.3.4 **Facility length field**

When indicated by the facilities field present indicator bit, the next octet shall contain the length of the facilities field in octets. The facility length indicator shall be binary-coded, where bit 1 shall be the low-order bit of the field.

4.1.3.10.3.5 **Facilities field**

When indicated by the facilities field present indicator bit, the octets following the facilities field shall contain the codes and parameters for the facilities.

4.1.3.10.3.6 **Called user data field**

The next octets shall be used to carry the called user data, if any. If fast select facility is used, not more than [128] octets of data shall be present.

4.1.3.10.4 **Connection released HFNPDU**

4.1.3.10.4.1 The connection released HFNPDU format shall be as defined in Figure 4-16.

4.1.3.10.4.2 **HFNPDU type identifier field**

4.1.3.10.4.2.1 Bit 2 shall be the NSAP address present indicator bit.

4.1.3.10.4.2.2 This bit shall be set to 1 if the called-NSAP address field is present; otherwise, it shall be set to 0.

4.1.3.10.4.3 **Called-NSAP address field**

This field shall have the same coding as 4.7.3.10.3.3.

4.1.3.10.4.4 **Clearing cause field**

4.1.3.10.4.4.1 The next octet shall be the clearing cause field. It shall contain the clearing cause for the release of the connection.

4.1.3.10.4.4.2 The coding of the clearing cause which may be generated by the HFSNDPX shall be as given in Table 4-16.

4.1.3.10.4.5 **Diagnostic code field**

The octet following the clearing cause field shall be the diagnostic code field. It shall contain additional information on the reason for the release of the connection. The coding of the diagnostic code field shall be dependent on the clearing cause as in Table 4-16. The diagnostic code field codings when connection release has been initiated by the HFSNDPX shall be as defined in Table 4-17.

4.1.3.10.4.6 **Clear user data field**

The field following the diagnostic code field shall be the user data field. If present, this field shall contain not more than [128] octets of user data.

4.1.3.10.5 **Connection release complete HFNPDU**

The connection release complete HFNPDU format shall be as defined in Figure 4-17.

4.1.3.10.6 **Data HFNPDU**

4.1.3.10.6.1 The data HFNPDU format shall be as defined in Figure 4-18.

4.1.3.10.6.2 **M-bit**

The M-bit shall be set to 1 if the HFNPDU is not the last in an M-bit sequence of data HFNPDUs; otherwise, it shall be set to 0.

4.1.3.10.6.3 **HFNPDU number field**

Octet 3 shall contain the 8-bit HFNPDU number.

4.1.3.10.6.4 **User data field**

The field following the HFNPDU number field shall contain the user data. This field shall contain up to a maximum of [503] octets.

4.1.3.10.7 **Interrupt data HFNPDU**

4.1.3.10.7.1 The interrupt data HFNPDU format shall be as defined in Figure 4-19.

4.1.3.10.7.2 **Interrupt user data field**

The field following the logical channel number field shall be the interrupt user data field. This field shall contain up to a maximum of [32] octets.

4.1.3.10.8 **Interrupt confirm HFNPDU**

The interrupt confirm HFNPDU format shall be as defined in Figure 4-20.

4.1.3.10.9 **Reset HFNPDU**

4.1.3.10.9.1 The reset HFNPDU format shall be as defined in Figure 4-21.

4.1.3.10.9.2 **Resetting cause**

Octet 3 shall be the resetting cause field and shall contain the reason for the reset. When the reset has been initiated by the HFSNDPX, the coding of the resetting cause field in a reset HFNPDU shall be as given in Table 4-16.

4.1.3.10.9.3 **Diagnostic code**

4.1.3.10.9.3.1 Octet 4 shall be the diagnostic code field and shall contain additional information on the reason for the reset. The coding of the diagnostic code field shall be dependent on the resetting cause as given in Table 4-16. The diagnostic code field codings when the reset has been initiated by the HFSNDPX shall be as defined in Table 4-17.

4.1.3.10.9.3.2 If the resetting cause field indicates “IW originated”, the diagnostic code field shall have been passed unchanged from the IW as a result of its having initiated a resetting procedure.

4.1.3.10.10 **Reset confirm HFNPDU**

The reset confirm HFNPDU format shall be as defined in Figure 4-22.

4.1.3.10.11 **Flow control (suspend) HFNPDU**

4.1.3.10.11.1 The flow control (suspend) HFNPDU format shall be as defined in Figure 4-23.

4.1.3.10.11.2 **Flow control reason field**

Octet 3 shall contain the flow control reason field. This field shall be set to 11001001 (suspend).

4.1.3.10.11.3 **HFNPDU number field**

Octet 4 shall contain the 8-bit HFNPDU number of the last in-sequence received and accepted data HFNPDU.

4.1.3.10.12 **Flow control (resume) HFNPDU**

4.1.3.10.12.1 The flow control (resume) HFNPDU format shall be as defined in Figure 4-24.

4.1.3.10.12.2 **Flow control field**

Octet 3 shall contain the flow control reason field. This field shall be set to 11001011 (resume) to resume transmission from the peer.

4.1.3.10.13 **Connection request/confirm HFNPDU facilities field**

4.1.3.10.13.1 The facilities field shall be present only when the facility field present indicator bit is set to one in the connection request, and connection confirm HFNPDUs.

4.1.3.10.13.2 The facilities field shall contain one facility element for each facility or group of facilities requested. The first octet of each facility element shall be the facility code field, which shall indicate the code for the facility or facilities requested. The remaining octets of a facility element shall contain the facility parameter field.

4.1.3.10.13.3 **Recommended facilities**

Recommendation.— *The following facilities should be supported by the HFSNDPX:*

Fast select; and

Expedited data negotiation.

4.1.3.10.13.4 **Reserved**

4.1.3.10.13.5 **Reserved**

4.1.3.10.13.6 **Fast select facility format**

The fast select facility format shall be as defined in Figure 4-27.

4.1.3.10.13.7 **Expedited data negotiation**

The expedited data negotiation facility format shall be as defined in Figure 4-28.

4.1.3.10.14 **Diagnostic codes**

When connection release/reset is initiated by the HFSNDPX, the coding of the diagnostic code field in the connection released and reset HFNPDUs shall be as defined in Table 4-17.

4.1.3.11 **Timer values**

The timer values shall be as defined in Table 4-20.

4.1.3.12 **State diagrams**

State diagrams for the following states shall be given below:

a) The state diagram for connection establishment/release of a logical channel shall be as defined in Figure 4-29.

b) The state diagram for reset and flow control states within the data transfer state shall be as defined in Figure 4-30.

4.1.3.13 **State tables**

4.1.3.13.1 Action taken in any state of the HFSNDPX shall be given by Tables 4-21 to 4-24.

4.1.3.13.2 The following conventions shall be used in the state tables:

a) Action taken, which could be:

- Normal, as defined in 4.7.3.5 to 4.7.3.8;
- Discard the received HFNPDU and take no subsequent action as a result of receiving that HFNPDU;
- Error, as defined in the table;

b) The diagnostic code contained in the diagnostic code field of the appropriate HFNPDU (connection released, or reset) issued upon the detection of the indicated error.

4.1.3.14 **HFDL subnetwork dependent to link layer interface functions**

4.1.3.14.1 The interface functions to the link layer shall include the following:

a) Generation and reception of link interface data units (LIDUs);

b) Routing of received HFNPDUs according to connection;

c) Selection of further HFNPDUs for transmission according to a cyclic order of selecting among the logical channels at a given Q number and giving precedence to interrupt HFNPDUs over data HFNPDUs of the same Q number; and

d) Routing of local acknowledgement (success/fail) for RLS transmission status indication LIDUs.

4.1.3.14.2 The LIDUs passed between the HFSNDPX and the link layer shall include the LIDUs defined in Table 4-25.

4.1.3.15 **Packet to HFNPDU mapping rules**

4.1.3.15.1 The rules for mapping the ISO 8208 packet fields into the corresponding fields in HFNPDU shall be as specified in this section.

4.1.3.15.2 **DTE addresses**

4.1.3.15.2.1 The called-DTE address and the calling-DTE address fields in the ISO 8208 call request packet shall be directly mapped into the called-DTE address and the calling-DTE address fields in the connection request HFNPDU.

4.1.3.15.2.2 The calling and called DTE addresses in the ISO 8208 call accepted packet shall not be transmitted across the HFDL link.

4.1.3.15.3 **NSAP address**

4.1.3.15.3.1 The called address extension and the calling address extension parameter fields in the ISO 8208 call request packet shall be directly mapped into the called NSAP address and the calling NSAP address fields in the connection request HFNPDU.

4.1.3.15.3.2 If the called address extension parameter in either the ISO 8208 call accepted packet or clear request packet is equal to the called NSAP address of the corresponding connection request HFNPDU, then the called address extension shall not be transmitted across the HFDL link; otherwise, it shall be directly mapped into the relevant HFNPDU.

4.1.3.15.4 **Subnetwork connection priority**

4.1.3.15.4.1 The target value for the priority of data on a connection in the ISO 8208 call request packet shall be mapped to the LIDU Q number passed to the link layer as defined in Table 4-26. This value shall be used as long as the connection setup procedure HFDL Aircraft Station Sub-system not been completed.

4.1.3.15.4.2 The selected value for the priority of data on a connection in the ISO 8208 call accepted packet shall be mapped to the LIDU Q number passed to the link layer as defined in Table 4-26. This value shall be used for the remainder of the SNC.

4.1.3.15.4.3 If an invalid priority value is provided in the call request or call accepted packet, the HFSNDPX shall reject the call. The diagnostic code in the clear indication packet shall be set to “connection rejection requested quality of service not available (permanent condition)”.

4.1.3.15.4.4 If priority of data on a connection is not indicated in the call request packet, a default value (SNC priority = 0) shall be used.

4.1.3.15.5 **Reserved**

4.1.3.15.6 **Transit delay**

4.1.3.15.6.1 **Reserved**

4.1.3.15.7 **Fast select**

The fast select facility shall be treated as follows:

a) A call request packet without the fast select facility shall be mapped to a connection request with no restriction on response HFNPDU with the fast select (use not permitted) facility;

b) A call request packet with the fast select facility indicating fast select requested with no restriction on response shall be mapped to a connection request with no restriction on response HFNPDU without the fast select (use not permitted) facility; and

c) A call request packet with the fast select facility indicating fast select request with restriction on response shall be mapped to a connection request with restriction on response HFNPDU without the fast select (use not permitted) facility.

4.1.3.15.8 **Expedited data negotiation**

The expedited data negotiation facility in the call request or call accepted packet shall not be mapped to the corresponding connection request or connection confirm HFNPDU unless the facility parameter is set to “no use of expedited data”.

4.1.3.15.9 **Cause and diagnostic codes**

4.1.3.15.9.1 Clearing cause, resetting cause and diagnostic code fields shall be transferred without modification from the packets to the corresponding HFNPDUs.

4.1.3.15.9.2 If the HFSNDPX has initiated the clear or reset procedure, then the clearing cause, the resetting cause and the diagnostic code fields shall be set as defined in Tables 4-16 and 4-17.

4.1.3.15.10 **Data**

4.1.3.15.10.1 If the user data field in the data packets of an M-bit packet sequence is less than the default data HFNPDU maximum user data field length, then these fields shall be concatenated to form an M-bit HFNPDU sequence.

4.1.3.15.10.2 If the user data field in the data packets of an M-bit packet sequence is greater than the default data HFNPDU maximum user data field length, then these fields shall be segmented to form an M-bit HFNPDU sequence.

4.1.3.16 **HFNPDU to packet mapping rules**

4.1.3.16.1 This section shall specify the rules for mapping the HFNPDU fields into the corresponding fields in ISO 8208 packet.

4.1.3.16.2 **DTE address**

4.1.3.16.2.1 The called DTE address and the calling DTE address fields in the connection request HFNPDU shall be directly mapped into the called DTE address and the calling DTE address fields in the incoming call packet.

4.1.3.16.2.2 Both the calling and called DTE address fields shall be regenerated when forwarding a call connected packet, if they were present in the corresponding call request packet.

4.1.3.16.3 **NSAP address**

4.1.3.16.3.1 The called NSAP address and the calling NSAP address fields in the connection request HFNPDU shall be directly mapped into the called address extension and calling address extension parameter fields in the incoming call packet.

4.1.3.16.3.2 The called NSAP address field in the connection confirm or connection released HFNPDU shall be mapped into the called address extension field in the call connected or clear indication packet.

4.1.3.16.4 **Priority**

The Q number associated with the connection request and connection confirm HFNPDUs shall be mapped into the target and selected values of the priority of data on a connection field in the priority facility in the ISO 8208 incoming call and call connected packets.

4.1.3.16.5 **Reserved**

4.1.3.16.6 **Reserved**

4.1.3.16.7 **Fast select**

The fast select facility shall be treated as follows:

a) A connection request with no restriction on response HFNPDU with the fast select (use not permitted) facility shall be mapped into an incoming call packet without the fast select facility;

b) A connection request with no restriction on response HFNPDU without the fast select (use not permitted) facility shall be mapped into an incoming call packet with the fast select facility with the "no restriction on response" parameter;

c) A connection request with restriction on response HFNPDU without the fast select (use not permitted) facility shall be mapped into an incoming call packet with the fast select facility with the "restriction on response" parameter.

4.1.3.16.8 **Expedited data negotiation**

If the expedited data negotiation facility is not present in the connection request or connection confirm HFNPDU, this facility with its parameter set to "use of expedited data" shall be added to the corresponding incoming call or call connected packet; otherwise, this facility shall be mapped to the corresponding packet.

4.1.3.16.9 **Cause and diagnostic codes**

Clearing cause, resetting cause and diagnostic code fields shall be transferred without modification from the HFNPDUs to the corresponding packets.

4.1.3.16.10 **Data**

4.1.3.16.10.1 If the user data field in the data HFNPDUs of an M-bit HFNPDU sequence is less than the default data packet maximum user data field length, then these fields shall be concatenated to form an M-bit packet sequence.

4.1.3.16.10.2 If the user data field in the data HFNPDUs of an M-bit HFNPDU sequence is greater than the default data packet maximum user data field length, then these fields shall be segmented to form an M-bit packet sequence.

4.1.3.17 **Capacity**

The HFSNDPA shall support at least eight simultaneous, independent logical channels.

4.1.4 **ISO 8208 DCE protocol operations**

4.1.4.1 **General provisions**

4.1.4.1.1 The protocol between the ISO 8208 DCE and the ISO 8208 DTE shall comply with the ISO 8208 second edition.

4.1.4.1.2 **Packet layer entity**

Note.— *Within the ISO 8208 DCE there may be more than one DCE/DTE interface, e.g. a HFDL Ground Station Sub-system may be connected to more than one ground ATN router. One such entity exists in the DCE for each DCE/DTE interface. Deciding which entity to use to reach a particular destination is a function performed external to the protocol described here. The protocol defined in 4.7.4 pertains to each packet layer entity in the DCE.*

4.1.4.2 **Conformance requirements**

4.1.4.2.1 **Supported services and capabilities**

The following services and capabilities shall be supported:

a) Virtual call service;

b) A user data field of up to 128 octets in data packets; and

c) Expedited data delivery, i.e. the use of interrupt packets with a user data field of up to [32] octets.

4.1.4.2.2 **Supported facilities**

The following facilities shall be supported:

a) Calling address extension and called address extension; and

b) Priority.

Note.— *The target and lowest acceptable values for the priority to gain a connection and keep a connection, and the lowest acceptable value for data on a connection, need not be supported.*

4.1.4.2.3 **Recommended facilities**

Recommendation.— *The following facilities should be supported:*

a) Reserved

b) Reserved

c) Fast select;

d) Fast select acceptance.

4.1.4.3 **Operations**

4.1.4.3.1 **External interactions**

Note.— The initiation of certain DCE procedures is directed by elements outside the ISO 8208 DCE. Likewise, the occurrence of certain ISO 8208 DCE events are to be reported appropriately. These external interactions include:

a) Requesting of the link layer, transmission of outgoing packets;

b) Receiving, from the link layer, incoming packets;

c) Accepting requests from the IW to initiate certain ISO 8208 protocol procedures including:

1) Originate a virtual call;

2) Accept a virtual call;

3) Terminate a virtual call;

4) Transfer data and interrupt information; and

5) Re-initialize a logical channel.

d) Reporting to the IW the occurrence of certain ISO 8208 protocol events including:

1) Receipt of an incoming request to set up a virtual call;

2) Receipt of the acceptance of a virtual call setup;

3) Termination of a virtual call;

4) Receipt of data and interrupt information; and

5) Re-initialization of a logical channel.

4.1.4.3.1.1 The ISO 8208 DCE shall accept all ISO 8208 packets from the ISO 8208 DTE without failure.

4.1.4.3.2 **Logical channels**

Note.— *Each virtual call and permanent virtual circuit is assigned a logical channel identifier which is a number in the range from 1 through 4 095. For each virtual call, a logical channel identifier is assigned during the call setup phase from a range of previously agreed-upon logical channel identifiers. For each permanent virtual circuit, a logical channel identifier is assigned in agreement with the DTE. A DCE's use of logical channels is agreed upon for a period of time with the DTE.*

4.1.4.3.3 **State transitions**

4.1.4.3.3.1 The specifications and definitions in ISO 8208 shall apply for format definitions, diagnostic and cause codes, facility registration protocols (if used), and flow control on the ISO 8208 interface.

Note 1.— The ISO 8208 DCE is defined as a state machine. An ISO 8208 packet received from the DTE can cause state transitions, as can a packet received from IW. The next state transition (if any) that occurs when the DCE receives a packet from the DTE is specified by Tables 4-29 to 4-34. These tables are organized according to the hierarchy in Figure 4-31.

Note 2.— Upon receiving a packet, the action is classified as normal or erroneous under the entry "A =". The resulting state is shown under the entry, "S =".

4.1.4.3.3.2 If a state transition is specified, the action taken shall be as specified in Tables 4-29 to 4-34.

4.1.4.3.4 **Disposition of packets**

When a packet is received from the DTE, the expressions in parentheses in Tables 4-29 to 4-34 specify whether the packet shall be forwarded or not forwarded to the IW. If no remark in parentheses is listed or listed as not forwarded, then the packet shall be discarded. The ISO 8208 DCE shall either forward or not forward a packet from the IW to the DTE in a manner that is compatible with ISO 8208.

4.1.4.3.5 **Diagnostic and cause codes**

For certain conditions, Tables 4-29 to 4-34 indicate a diagnostic code that shall be included in the packet generated when entering the state indicated. The term, "D =", shall define the diagnostic code. When "A = DIAG", the action taken shall be to generate an ISO 8208 diagnostic packet and transfer it to the DTE; the diagnostic code indicated shall define the entry in the diagnostic field of the packet. In the cause field of any packet type, bit 8 of the cause field shall always be set to 0, indicating that the condition was recognized by the ISO 8208 interface.

Note.— *The state Tables 4-29 to 4-34 are defined so that the HFSNDPX and ISO 8208 DCE functions can operate simultaneously. While asynchronous operation is a suitable implementation strategy, it is not a requirement for the HFSNDPX and ISO 8208 DCE operations.*

4.1.4.3.6 **DCE timer**

Note.— *Under certain circumstances, the DTE must respond to a packet issued from the DCE within a given time.*

4.1.4.3.6.1 Table 4-35 covers these circumstances and the action that the DCE shall initiate upon the expiration of that time.

4.1.4.4 **Capacity**

The HFDL Aircraft Station Sub-system DCE shall support at least eight simultaneous, independent logical channels.

4.1.4.5 **VC pre-emption**

A logical channel of the lowest priority and the associated virtual call shall be cleared as necessary to accept a request for higher priority service.

Note.— Logical channels and virtual calls have a priority level of 0 unless the ISO 8208 priority facility was invoked during call set up.

4.1.5 **Interworking function**

4.1.5.1 **HFSNDPX/IW interface**

4.1.5.1.1 The ISO 8208 packets exchanged between the IW and the HFSNDPX shall be as defined in Table 4-36.

4.1.5.1.2 **Incoming call packet handling**

The IW shall forward the incoming call packet with the expedited data negotiation facility and “use of expedited data” parameter to the appropriate ISO 8208 DCE entity.

Note.— If the facility parameter is “no use of expedited data”, the IW forwards the incoming call packet with or without this facility.

4.1.5.1.3 **Call connected packet handling**

If the parameter of the expedited data negotiation facility is set to “use of expedited data” in the call connected packet, the IW shall forward this facility and its parameter with the packet to the appropriate ISO 8208 DCE entity. For each virtual call, the IW shall associate the HFSNDPX logical channel with the corresponding ISO 8208 DCE logical channel.

Note.— If the expedited data negotiation facility parameter is set to “no use of expedited data”, the IW forwards the call connected packet with or without this facility.

4.1.5.1.4 **Clear indication packet handling**

4.1.5.1.4.1 The IW shall disassociate the HFSNDPX logical channel with the corresponding ISO 8208 DCE logical channel and forward the packet to the ISO 8208 DCE entity.

4.1.5.1.5 **Data, interrupt, interrupt confirmation and reset indication packet handling**

4.1.5.1.5.1 Data, interrupt, interrupt confirmation and reset indication packets shall be forwarded to the appropriate ISO 8208 DCE entity based on the logical channel association established after the completion of a connection establishment

4.1.5.2 **ISO 8208 DCE/IW interface**

4.1.5.2.1 The ISO 8208 packets exchanged between the IW and the ISO 8208 DCE shall be as defined in Table 4-37.

4.1.5.2.2 **Call request packet handling**

If the call request packet does not contain the expedited data negotiation facility, the IW shall add this facility with its parameter set to “no use of expedited data” to the packet and shall forward it to the appropriate HFSNDPX entity; otherwise, the IW shall forward the call request packet with this facility and parameter. If the optional called DTE address is invalid, then the IW shall return a clear indication packet to the ISO 8208 DCE entity.

4.1.5.2.3 **Call accepted packet handling**

If the call accepted packet does not contain the expedited data negotiation facility, the IW shall add this facility with its parameter set to “no use of expedited data” to the packet and shall forward it to the appropriate HFSNDPX entity; otherwise, the IW shall forward the call accepted packet with this facility and parameter. For each virtual call, the IW shall associate the ISO 8208 DCE logical channel with the corresponding HFSNDPX logical channel.

4.1.5.2.4 **Clear request packet handling**

The IW shall disassociate the ISO 8208 DCE logical channel with the corresponding HFSNDPX logical channel and forward the packet to the HFSNDPX entity.

4.1.5.2.5 **Data, interrupt, interrupt confirmation and reset request packet handling**

Data, interrupt, interrupt confirmation and reset request packets shall be forwarded to the appropriate HFSNDPX entity based on the logical channel association established after the completion of a connection establishment.

4.1.5.3 **IW/CN interface**

The IW shall forward the connectivity notification event messages to the appropriate ISO 8208 DCE logical channel.

4.1.5.4 **ISO 8208 logical channel and HFSNDPX logical channel association**

Note.— ISO 8208 DCE logical channel identifier and the HFSNDPX logical channel number of an SNC need not be identical.

4.1.5.5 **Data transfer procedures**

4.1.5.5.1 **Flow control**

Flow control shall be applied between the HFSNDPX and the ISO 8208 DCE to prevent storage overflow.

4.1.5.6 **Cause and diagnostic code**

4.1.5.6.1 The IW shall replace the cause "local procedure error" in ISO 8208 packets received from the DCE, by the cause "remote procedure error" before forwarding them to the HFSNDPX. The IW shall replace the cause "local link error" in an HFNPDU received from the HFSNDPX by the cause "network congestion" before forwarding them to the DCE. All other causes shall be transferred without modification.

4.1.5.6.2 Diagnostic codes shall be transferred without modification.

4.1.6 **Management interface**

4.1.6.1 HFDL Aircraft Station Sub-system management interface

4.1.6.1.1 [The changes in log-on status conveyed from the HFDL Aircraft Station Sub-system management to the HFSNL shall be as defined in 4.9.2.1.1.]

4.1.6.1.2 [When the HFDL Aircraft Station Sub-system either logs-off or otherwise terminates communication with a HFDL Ground Station Sub-system, the HFDL Aircraft Station Sub-system HFSNL shall clear all connections with this HFDL Ground Station Sub-system.]

4.1.6.1.3 **Connectivity notification event**

4.1.6.1.3.1 The CN function shall be performed by the CN entity.

4.1.6.1.3.2 Log-on to a HFDL ground station sub-system

When the HFDL Aircraft Station Sub-system logs-on to a HFDL Ground Station Sub-system, the HFDL Aircraft Station Sub-system shall send a join event message to the attached ATN

router on the aircraft. This message shall include sufficient information for the attached ATN router to determine the address(es) of the DTE(s) attached to the HFDL Ground Station Sub-system.

Note.— The attached ATN router, on receiving the join event message, will have sufficient information to establish the SVCs.

4.1.6.1.3.3 **Log-off from a HFDL ground station sub-system**

[When the HFDL Aircraft Station Sub-system logs-off from a HFDL Ground Station Sub-system, the CN shall forward to the IW a leave event message indicating HFDL Aircraft Station Sub-system log-off from the HFDL Ground Station Sub-system.]

4.1.6.2 **HFDL ground station sub-system management interface**

4.1.6.2.1 The changes in log-on status conveyed from the HFDL Ground Station Sub-system management to the HFSNL shall be as defined in the SARPs.

4.1.6.2.2 When the HFDL Aircraft Station Sub-system logs-off from the HFDL Ground Station Sub-system, the HFSNL shall clear all connections associated with the HFDL Aircraft Station Sub-system, and shall release all resources associated with these SNCs. In addition, the HFDL Ground Station Sub-system shall provide to the attached ATN ground routers a leave event indication referencing the 24-bit ICAO aircraft identifier.

Table 4-15. HFNPDU type identifier encoding

Code	HFNPDU TYPE
Bits 654321	(refer to Figures 4-13 through 4-24 HFNPDU format)
0	CONNECTION REQUEST, NO CALLING NSAP ADD., NO CALLED NSAP ADD., NO FACILITY FIELD, NO RESTRICTION ON RESPONSE
1	CONNECTION REQUEST, NO CALLING NSAP ADD., NO CALLED NSAP ADD., WITH FACILITY FIELD, NO RESTRICTION ON RESPONSE
10	CONNECTION REQUEST, NO CALLING NSAP ADD., NO CALLED NSAP ADD., WITH FACILITY FIELD, NO RESTRICTION ON RESPONSE
11	CONNECTION REQUEST, NO CALLING NSAP ADD., NO CALLED NSAP ADD., WITH FACILITY FIELD, NO RESTRICTION ON RESPONSE
100	CONNECTION REQUEST, WITH CALLING NSAP ADD., NO CALLED NSAP ADD., NO FACILITY FIELD, NO RESTRICTION ON RESPONSE
101	CONNECTION REQUEST, WITH CALLING NSAP ADD., NO CALLED NSAP ADD., WITH FACILITY FIELD, NO RESTRICTION ON RESPONSE
110	CONNECTION REQUEST, WITH CALLING NSAP ADD., WITH CALLED NSAP ADD., NO FACILITY FIELD, NO RESTRICTION ON RESPONSE
111	CONNECTION REQUEST, WITH CALLING NSAP ADD., WITH CALLED NSAP ADD., WITH FACILITY FIELD, NO RESTRICTION ON RESPONSE
1000	CONNECTION CONFIRM, NO CALLED NSAP ADD., NO FACILITY FIELD
1001	CONNECTION CONFIRM, NO CALLED NSAP ADD., WITH FACILITY FIELD
1010	CONNECTION CONFIRM, WITH CALLED NSAP ADD., NO FACILITY FIELD
1011	CONNECTION CONFIRM, WITH CALLED NSAP ADD., WITH FACILITY FIELD
0011XX	SPARES
10000	CONNECTION RELEASED, NO CALLED NSAP ADD., NO FACILITY FIELD
10010	CONNECTION RELEASED, WITH CALLED NSAP ADD., NO FACILITY FIELD
0100X1	SPARES
0101XX	SPARES
11000	CONNECTION RELEASE COMPLETE
11010	SPARE
0111X0	SPARES
011XX1	SPARES
100000	CONNECTION REQUEST, NO CALLING NSAP ADD., NO FACILITY FIELD, WITH RESTRICTION ON RESPONSE
100001	CONNECTION REQUEST, NO CALLING NSAP ADD., WITH FACILITY FIELD, WITH RESTRICTION ON RESPONSE
100010	CONNECTION REQUEST, NO CALLING NSAP ADD., WITH FACILITY FIELD, WITH RESTRICTION ON RESPONSE
100011	CONNECTION REQUEST, NO CALLING NSAP ADD., WITH CALLED NSAP ADD., WITH FACILITY FIELD, WITH RESTRICTION ON RESPONSE

Code	HFNPDU TYPE
100100	CONNECTION REQUEST, WITH CALLING NSAP ADD., NO CALLED NSAP ADD., NO FACILITY FIELD, WITH RESTRICTION ON RESPONSE
100101	CONNECTION REQUEST, WITH CALLING NSAP ADD., NO CALLED NSAP ADD., WITH FACILITY FIELD, WITH RESTRICTION ON RESPONSE
100110	CONNECTION REQUEST, WITH CALLING NSAP ADD., WITH CALLED NSAP ADD., NO FACILITY FIELD, WITH RESTRICTION ON RESPONSE
100111	CONNECTION REQUEST, WITH CALLING NSAP ADD., WITH CALLED NSAP ADD., WITH FACILITY FIELD RESTRICTION ON RESPONSE
101XXX	SPARES
110000	DATA
110001	SPARE
110010	INTERRUPT
110011	RESET
110100	RESERVED
110101	SPARE
11011X	SPARES
111000	RESERVED
111001	FLOW CONTROL
111010	INTERRUPT CONFIRM
111011	RESET CONFIRM
11110X	SPARES
111110	SPARE
111111	RESERVED

Table 4-16. HFSNDPX generated cause field coding

Generating condition	Release/reset cause	
	Field Bits 8765	Coding Bits 4321
HFSNDPX originated release (local link error)	1001	11
HFSNDPX originated release (invalid facility request)	1000	11
HFSNDPX originated release (network congestion)	1000	101
HFSNDPX originated reset (local link error)	1000	101
HFSNDPX originated reset (network congestion)	1000	111

Table 4-17. Diagnostic code field codings (for those original noted by the HFSND sub-layer)

Generating condition	Diagnostic field coding (decimal)	Applicable HFNPDUs
HFNDP operation:		Released
Disconnection (temporary, e.g. handover)	1110 0001 (225)	Released
Disconnection (permanent, e.g. log off)	1110 0010 (226)	Released
Unable to establish call (temporary)	1110 0011 (227)	Released
Unable to establish call (permanent)	1110 0100 (228)	Released
Connection rejection-request quality of service not available (transient condition)	1110 0101 (229)	Released
Connection rejection-request quality of service not available (permanent condition)	1110 0110 (230)	Released
Protocol error (HFNPDU type invalid while in):		Released
Ready state	0001 0100 (20)	Released
IW call request state	0001 0101 (21)	
Incoming call state	0001 0110 (22)	Released
Data transfer state	0001 0111 (23)	Released
Remote clear request state	0001 1010 (26)	Released
Flow control state	0001 1011(27)	Reset
Remote reset request state	0001 1101 (29)	Reset
Protocol error (HFNPDU not allowed):		
Unidentifiable HFNPDU	0010 0001 (33)	Released, reset
Invalid LCN (see 4.7.3.3)	0010 0010 (34)	Released
HFNPDU too short	0010 0110 (38)	Released, reset
HFNPDU too long	0010 0111 (39)	Released, reset
HFNPDU type not compatible with facility	0010 1010 (42)	Released
Unauthorized interrupt confirm HFNPDU	0010 1011 (43)	Released, reset
Unauthorized interrupt HFNPDU	0010 1100 (44)	Reset
Invalid called DTE address	0100 0011 (67)	Released
Invalid calling DTE address	0100 0100 (68)	Released
Invalid facility length	0100 0101 (69)	Released
D-bit procedure not supported	1010 0110 (166)	Reset
Transmission error:		
No additional information	0000 0000 (0)	Released, reset
Invalid SNPDU number	0000 0001 (1)	Reset
Retransmission count surpassed	1001 0000 (144)	Released, reset
Timer expired:		
tN1 (for connection confirm HFNPDU)	0011 0001 (49)	Released
tN3 (for reset confirm HFNPDU)	0011 0011 (51)	Released
tN4 (for interrupt confirm HFNPDU)	0011 1001 (57)	Reset
tN7 (for flow control (suspend) supervision)	0011 1011 (59)	Reset

Table 4-18. HFSNDPX time supervision

Timer design	Start event	Normally terminated by	Action when timer expires
tN1	Transmission of connection request HFNPDU	Reception of connection confirm or connection released HFNPDU	The HFSNDPX shall initiate a release of the connection
tN3	Transmission of reset HFNPDU	Reception of reset confirm or reset HFNPDU	The HFSNDPX shall initiate a release of the connection
tN4	Transmission of reset HFNPDU	Reception or interrupt confirm HFNPDU	HFSNDPX shall initiate a reset of connection
tN6	Transmission of connection released HFNPDU	Reception of connection release complete or connection released HFNPDU	Return logical channel to ready state
tN7	Transmission of flow control (suspend) HFNPDU	Transmission of flow control (resume) HFNPDU	HFSNDPX shall initiate a reset of connection

Notes.—

1. The timers tN2, tN5 and tN8 are reserved.

2. Timers are started when the HFSNDPX receives success status in the transmission status indication LIDU from the link layer, unless the response HFNPDU from the remote HFSNDPX has been received prior to the status indication.

Table 4-19. HFSNDPX supervision of tranmission errors — receiving a ”fail” LPDU

HFNPDU type reported through fail	HFSNDPX action
CONNECTION REQUEST	Send clear indication packet to IW and return the logical channel to the ready state
CONNECTION CONFIRM, CONNECTION RELEASE COMPLETE, INTERRUPT CONFIRM	No action
RESET CONFIRM	Retry once. If retry fails then return logical channel to the data transfer state
CONNECTION RELEASED	Retry once. If retry fails then return logical channel to the data transfer state
DATA, INTERRUPT	HFSNDPX initiates a reset of the connection (reset cause = “network congestion”)
FLOW CONTROL	HFSNDPX initiates a reset of the connection (reset cause = “network congestion”)
RESET	Retry once. If retry fails then initiate a release of the connection (release cause = “network congestion”)

Note.— For HFNPDU which are confirmed by the remote HFSND sub-layer entity, processing of the corresponding fail LPDU only applies if it is received prior to the reception of the expected response from the other end.

Table 4-20. HFSNDPX timers

Timer	Value (seconds)
tN1	[180]
tN3	[120]
tN4	[120]
tN6	[120]
tN7	[60]

Table 4-21. HFSNDPX actions — any state

HFNPDU received from remote HFSNDPX	Any state
Any HFNPDU with an invalid HFNPDU type	Discard
Any HFNPDU less than 2 octets in length	Discard

Note.— The HFNPDU type is invalid if it is identified as "spare" or "reserved" in Table 4-15.

Table 4-22. HFSNDPX actions — connection establishments states

HFSNDPX received from remote HFSNDPX	Ready state	Call setup states (Notes 1, 3) IW call request	Incoming call
Action: Error send CONNECTION RELEASED D = 0010 1010 (extend clear to IW)	Action: Normal (forward to IW)	Not applicable	Action: Error send CONNECTION RELEASED D = 0010 0110 (extend clear to IW)
CONNECTION CONFIRM	Action Error * send CONNECTION RELEASED D = 0001 0100	Action: Normal (forward to IW) or Action: Error (Note 2), send CONNECTION RELEASED (extend clear to IW) D = 0010 1010	Action: Error send CONNECTION RELEASED D = 0010 0110 (extend clear to IW)
CONNECTION RELEASED	Action: Normal (do not forward)	Action: Normal (forward to IW)	Action: Normal (forward to IW)
CONNECTION RELEASE COMPLETE	Action: Error * send CONNECTION RELEASED D = 0001 0100	Action: Error send CONNECTION RELEASED D = 0010 1010 (extend clear to IW)	Action: Error send CONNECTION RELEASED D = 0010 0110 (extend clear to IW)
DATA,INTERRUUPT, INTERRUPT CONFIRM, RESET, RESET CONFIRM, FLOW CONTROL	Action: Error * send CONNECTION RELEASED D = 0001 0100	Action: Error send CONNECTION RELEASED D = 0010 1010 (extend clear to IW)	Action: Error send CONNECTION RELEASED D = 0010 0110 (extend clear to IW)

* HFSNDPX internal connection release request (i.e. IW not informed)

Notes.—

1. *In case where the HFNPDU is not acceptable to the state of the logical channel (i.e., Action = Error), the clearing cause field is equal to 147, i.e. HFSND local link error.*
2. *The error may occur of fast select with restriction on response has been requested.*
3. *If the HFNPDU is acceptable to the state of the logical channel (i.e. action = normal) but contains a format error or is otherwise unacceptable then the HFSND initiates a connection release (diagnostic codes that may apply include 34,38,39,67,68,69,225-230).*

Table 4-23. HFSNDPX actions — data transfer and connection release states

Action	Data transfer and call clearing states		
HFNPDU received from remote HFSNDPX	Ready state	Call setup states (Notes 1, 3) IW call request	Incoming call
CONNECTION REQUEST	Action: Error send CONNECTION RELEASED D = 0010 0111 (see Note 1)(extend clear to IW)	Action: Discard	Action: Error send CONNECTION RELEASED D = 0001 1010
CONNECTION CONFIRM	Action: Error send CONNECTION RELEASED D = 0001 0111 (see Note 1)(extend clear to IW)	Action: Discard	Action: Error send CONNECTION RELEASED D = 0001 1010
CONNECTION RELEASE COMPLETE	Action: Error send CONNECTION RELEASED D = 0010 0111 (extend clear to IW) (see Note 1)	Action: Normal	Action: Error send CONNECTION RELEASED D = 0001 1010
CONNECTION RELEASED	Action: Normal (forward to IW)	Action: Normal (do not forward to IW)	Action: Discard
DATA,INTERRUUPT, INTERRUPT CONFIRM, RESET, RESET CONFIRM, FLOW CONTROL	See Table 4-24	Action: Discard	Action: Error send CONNECTION RELEASED D = 0001 1010

* Internal clear (at connection establishment) or clear requested by the IW

Notes.—

1. The clearing cause field is equal to 147, i.e. HFSND local link error.

2. If the HFNPDU is acceptable to the state of the logical channel (i.e. Action = Normal) but contains a format error, then the HFSND initiates a connection release procedure (diagnostic codes that may apply include 38,39).

Table 4-24. HFSNDPX actions - data transfer states

Action	Data transfer states			
HFNPDU received from remote HFSNDPX	Flow Control		Local Reset Request	Remote Reset Request
RESET	Action: Normal		Action: Normal (Do Not Forward)	Action: Discard
CONNECTION CONFIRM	Action: Error send RESET HFNPDU D = 0001 1011(extend reset to IW)		Action: Normal (Do Not Forward)	Action: Error send RESET HFNPDU D = 0001 1101
INTERRUPT	No remote interrupt pending: Action: Normal	*Remote interrupt ongoing:* Action: Error send RESET HFNPDU D = 0010 1100 (extend reset to IW)	Action: Discard	Action: Error send RESET HFNPDU D = 0001 1101
INTERRUPT CONFIRM	No local interrupt pending: Action: Error send RESET HFNPDU D = 0010 1100 (extend reset to IW)	*Local interrupt ongoing:* Action Normal	Action: Discard	Action: Error send RESET HFNPDU D = 0001 1101
DATA with valid HFSNDPX No.	Action: Normal (if flow control ready) or Action: Discard (if flow control not ready)		Action: Discard	Action: Error send RESET HFNPDU D = 0001 1101
DATA with valid HFSNDPX No. (unrecoverable)	Action: Error send RESET HFNPDU D = 0000 0001 (extend reset to IW) or Action: Discard (if flow control not ready)		Action: Discard	Action: Error send RESET HFNPDU D = 0001 1101
FLOW CONTROL (suspend) with valid HFSNDPX No. or flow control (resume)	Action: Normal		Action: Discard	Action: Error send RESET HFNPDU D = 0001 1101
FLOW CONTROL (suspend) with valid HFSNDPX No.	Action: Error send RESET HFNPDU D = 0000 0001 (extend reset to IW)		Action: Discard	Action: Error send RESET HFNPDU D = 0001 1101

Notes.—

1. In cases where the HFNPDU is not acceptable to the state of the logical channel (i.e. Action = Error), the resetting cause field is equal to 133, i.e. HFND local link error,

2. If the HFNPDU is acceptable to the state of the logical channel (i.e. Action = Normal) but contains a format error, then the HFND initiates a connection release procedure (diagnostic codes that may apply include 1, 38,39).

Table 4-25. Summary of link interface data units and parameters

Direction	LIDU name	Parameters
From the subnetwork layer to the link layer	Data	HGS ID (in HAS) ID (in HGS) RLS Q number LSDU
From the link layer to the subnetwork layer	Data	HGS ID (in HAS) ID (in HGS) RLS RLS Success/Fail First two octets of LSDU

Table 4-26. Subnetwork connection priority mapping

Action	Priority/Q number mapping		
Categories of Messages	SNC priority in CALL REQUEST/CALL ACCEPTED packet	Q Number	SNC priority in INCOMING CALL/CALL CONNECTED packet
Unspecified	255	0	None
Reserved	254-15	Invalid/reject call	Not applicable
Distress communications, urgent communications, network/system management	14	14	14
Reserved	13	Invalid/reject call	Not applicable
Reserved	12	Invalid/reject call	Not applicable
Communications relating to direction finding, flight safety messages	11	11	11
Reserved	10	Invalid/reject call	Not applicable
Reserved	9	Invalid/reject call	Not applicable
Meteorological communications	8	8	8
Flight regularity communications	7	7	7
Aeronautical information services messages	6	6	6
Aeronautical administrative messages, network/systems administration	5	5	5
Reserved	4	Invalid/reject call	Not applicable
Urgent priority administrative and UN Charter communications	3	3	3
High priority administrative and State/Government communications	2	2	2
Normal priority/administrative	1	1	1
Normal priority/administrative	0	0	None

Note.— SNC priority value 225 (unspecified) in call request/call accepted packet should be mapped to Q number = 0, and none in incoming call/call connected packet.

Table 4-27. DCE actions at restart, call setup, and call clearing states

DCE state	State definition	Action when entering state
r1	PACKET LAYER READY	All VCs are returned to the p1 state (see p1 state READY explanation) and all PVCs are returned to d1, (flow control ready) state.
r2	DTE RESTART REQUEST	The DCE returns each VC to the p1 state (see p1 state explanation) and issues a restart confirmation packet to the DTE.
r3	DCE RESTART INDICATION	The DCE returns each VC to the p1 state (see p1 state explanation) and issues a restart indication packet to the DTE.
p1	READY	Release all resources assigned to VC channel.
p2	DTE CALL REQUEST	Determine if sufficient resources exist to support request; if so, allocate resources and forward ISO 8208 call request packet to IW; if not, enter DCE clear indication to DTE state (p7). Determination of resources and allocation is as defined in ISO 8208.
p3	DCE INCOMING ALL	Determine if sufficient resources exist to support request; if so, allocate resources and forward ISO 8208 incoming call packet to DTE; if not, send a clear request packet to the IW. Determination of resources and allocation is as defined in ISO 8208.
p4	DATA TRANSFER	No action
p5	CALL COLLISION	Send a clear request to the IW, corresponding to the incoming call packet (the DTE in its call collision state ignores the incoming call), and proceed with the DTE call request packet.
p6	DTE CLEAR REQUEST	Release all resources assigned to VC channel. Send an ISO 8208 clear confirmation packet to the DTE, a clear request packet to the IW, and enter p1 state.
p7	DCE CLEAR INDICATION TO DTE	Forward ISO 8208 clear indication packet to DTE.

Note.— State nomenclature in this table may differ from that used ISO 8208

Table 4-28. Actions at reset, interrupt, and flow control states

DCE state	State definition	Action when entering state
d1	FLOW CONTROL READY	No action.
d2	RESET REQUEST BY DTE	Remove data packets transmitted to DTE from window; discard any data packets that represent partially transmitted M-bit sequences and discard interrupt and interrupt confirmation packets awaiting transfer to the DTE; reset all window counters to zero. Send reset confirmation packet to DTE. Return channel to d1 state.
d3	RESET INDICATION BY DCE TO DTE	Remove data packets transmits to DTE from window; discard any data packets that represent partially transmitted M-bit sequences and discard interrupt and interrupt confirmation packets awaiting transfer to the DTE; reset all window counters to zero. Send reset indication packet to DTE.
i1	DTE INTERRUPT READY	No action
i2	DTE INTERRUPT SENT	Forward interrupt packet received from DTE to IW.
j1	DTE INTERRUPT READY	No action.
j2	DTE INTERRUPT SENT	Forward interrupt packet received from IW to DTE.
f1	DTE INTERRUPT READY	No action.
f2	DTE RECEIVE NOT READY	No action.
g1	DTE RECEIVE READY	No action.
g2	DTE RECEIVE NOT READY	No action.

Note.— State nomenclature in this table may differ from that used in ISO 8208.

Table 4-29. DCE state table - any state

Received from DTE	**DCE special cases** **Any state**
Any packet less than 2 octets in length	A = DIAG D = 38
Any packet with an invalid general format identifier	A = DIAG D = 40
Any packet with unassigned logical channel identifier	A = DIAG D = 36
Any packet with a valid general format identifier and an assigned logical channel identifier (includes a logical channel identifier of 0)	See Table 4-30

Table 4-30. DTE effect on DCE restart states

	DCE restart states (see Notes 6 and 7)		
Packet received from DTE	Packet layer READY (see Note 1) r1	DTE RESTART REQUEST see Note 4) r2	DCE RESTART INDICATION see Note 5) r3
Packets having a packet type identifier shorter than 1 ocet with assigned logical channel identifier <> 0	see Table 4-31	A = ERROR S = r3 D = 38 (see Note 3)	A = DISCARD
Packet supported by DCE other than restart with a logical channeel identifier of 0	A = DIAG D = 36	A = DIAG D = 36	A = DIAG D = 36
Packet with a packet type identifier which is undefined or not supported by DCE and with assigned logical channel identifier<> 0	see Table 4-31	A = ERROR S = r3 D = 33 (see Note 3)	A = DISCARD
Restart request, or restart confirmation packet with a logical channel identifier <> 0	see Table 4-31	A = ERROR S = r3 D = 41 (see Note 3)	A = DISCARD
Restart request	A = NORMAL (see Note 1) S = r2	A = DISCARD	A = NORMAL (4.2) S = p1 or d1 (see Note 2)
Restart confirmation	A = ERROR S = r3 D = 17 (see Note 8)	A = ERROR S = r3 D = 18 (see Note 3)	A = NORMAL (4.4) S = p1 or d1 (see Note 2)
Restart request or restart confirmation packet with format error	A = DIAG D = 38, 39, 81 or 82	A = DISCARD	A = ERROR D = 38, 39, 81 or 82
Call setup, call clearing, data, interrupt, flow control, or reset packet	see Table 4-31	A = ERROR S = r3 D = 18	A = DISCARD
Packets having a packet type identifier shorter than 1 byte and a logical channel identifier equal to 0	A = DIAG D = 38	A = ERROR S = r3 D = 38	A = DISCARD
Packet with a packet type identifier which is undefined or not supported by DCE and a logical channel identifier equal to 0	A = DIAG D = 33	A = ERROR S = r3 D = 33 (see Note 4)	A = DISCARD

Notes.—

1. *Receipt of a restart request packet causes the DCE to issue clear request packet to the IW for each VC with the DCE entity.*
2. *The VC channels are returned to state p1, the PVC channels are returned to state d1.*
3. *No action is taken by the DCE.*
4. *The restart request packet is not forwarded to the IW.*
5. *The DCE upon entering the r3 state checks for the completion of r2 processing and issues an ISO 8208 restart indication packet to the DTE, when the r3 state is entered via the r2 state. If the r3 state is not entered via r2 state, the DCE performs all of the actions normally performed when entering r2 and issues an ISO 8208 restart indication packet to the DTE, and send a clear request packet to the IW for each VC associated with the DCE entity.*
6. *Table entries are defined as follows: A = action to be taken, S = state to be entered, D = diagnostic code to be used in packets generated as a result of this action, and discard indicates that the received packet is to be from the buffers.*
7. *The number in the parentheses below an "A = normal" table entry is the paragraph number in ISO 8208, second edition. The DCE shall take the same action as the one taken by the DTE, acting as a DCE, to perform nominal processing on the received packet. If no paragraph number is referenced, the normal processing is defined in the table entry.*
8. *The error procedure consists of entering the r3 state and sending a restart indication packet to the DTE.*

Table 4-31. DTE effect on DCE call setup and clearing states

Packet received from DTE	DCE call setup and clearing states (see Notes 5 and 6)						
	READY p1	DTE CALL REQUEST p2	DCE INCOMING CALL p3	DATA TRANSFER p4	CALL COLLISION P5 (See Notes 1 and 4)	DTE CLEAR REQUEST P6	DCE CLEAR INDICATION TO DTE P7
Packet having a packet type identifier shorter than 1 octet	A = ERROR S = p7 D = 38	A = ERROR S = p7 D = 38 See Note 2	A = ERROR S = p7 D = 38 See Note 2	See Table 4-32	A = ERROR S = p7 D = 38 See Note 2	A = ERROR S = p7 D = 38 See Note 2	A = DISCARD
packet having a packet type identifier which is undefined or not supported by DCE	A = ERROR S = p7 D = 33	A = ERROR S = p7 D = 33 See Note 2	A = ERROR S = p7 D = 33 See Note 2	See Table 4-32	A = ERROR S = p7 D = 33 See Note 2	A = ERROR S = p7 D = 33 See Note 2	A = DISCARD
RESTART REQUEST, or RESTART Confirmation packet with logical channel identifier not = 0	A = ERROR S = p7 D = 41	A = ERROR S = p7 D = 41 See Note 2	A = ERROR S = p7 D = 41 See Note 2	See Table 4-32	A = ERROR S = p7 D = 41 See Note 2	A = ERROR S = p7 D = 41See Note 2	A = DISCARD
CALL REQUEST	A = ERROR (5.2.2) S = p2 (forward)	A = ERROR S = p7 D = 21 See Note 2	A = ERROR (5.2.5) S = p5	A = ERROR S = p7 D = 23 See Note 2	A = ERROR S = p7 D = 24 See Note 2	A = ERROR S = p7 D = 25 See Note 2	A = DISCARD
CALL ACCEPTED	A = ERROR S = p7 D = 20	A = ERROR S = p7 D = 21 See Note 2	A = NORMAL (5.2.4) S = p4(Frd)/ A = ERROR S = p7 D = 42; See Note 2 and 3	A = ERROR S = p7 D = 23 See Note 2	A = ERROR S = p7 D = 24 See Note 2 and 4	A = ERROR S = p7 D = 25 See Note 2	A = DISCARD
CLEAR REQUEST	A = NORMAL (4.5.5.2) S = p6	A = NORMAL (4.5.5.2) S = p6 (forward)	A = NORMAL (4.5.5.2) S = p6 (forward)	A = NORMAL (4.5.5.2) S = p6 (forward)	A = NORMAL (4.5.5.2) S = p6 (forward)	A = DISCARD	A = NORMAL (4.5.5.4) S = p1 (do not forward)
CLEAR CONFIRMATION	A = ERROR S = p7 D = 20	A = ERROR S = p7 D = 21 See Note 2	A = ERROR S = p7 D = 22 See Note 2	A = ERROR S = p7 D = 23 See Note 2	A = ERROR S = p7 D = 24 See Note 2	A = ERROR S = p7 D = 25 See Note 2	A = NORMAL (5.5.4) S = p1 (do not forward)
Data, interrupt, flow control or reset packets	A = ERROR S = p7 D = 20	A = ERROR S = p7 D = 21 See Note 2	A = ERROR S = p7 D = 22 See Note 2	See Table 4-32	A = ERROR S = p7 D = 24 See Note 2	A = ERROR S = p7 D = 25 See Note 2	A = DISCARD

Notes.—

1. *On entering the p5 state, the DCE sends a clear request packet to the IW, corresponding to the incoming call (the DTE in its call collision state ignores the incoming call), and proceeds with the DTE call request.*
2. *The error procedure consists of performing the actions specified when entering the p7 state (including sending a clear indication packet to the DTE) and additionally sending a clear request to the IW.*
3. *The use of fast select facility with restriction on response prohibits the DTE from sending a call accepted packet.*
4. *The DTE in the event of a call collision must discard the call request packet received from the DCE.*
5. *Table entries are defined as follows: A = action taken, S = the state to be entered, d= diagnostic code to be used in packet generated as a result of this action, discard indicates that the received packet is to be cleaned from the buffers.*
6. *The number in parentheses below an "A = normal" table entry is the paragraph number in ISO 8208, second edition. The DCE shall take the same action as those taken by the DTE to perform normal processing on the received packet. If no paragraph is referenced, the normal processing is defined in the table entry.*
7. *If the packet is acceptable to the state of the logical channel (i.e. action = normal) but contains a format error or is otherwise unacceptable, then the DCE shall initiate a connection release procedure (diagnostic codes that may apply include 34, 38, 39, 65, 66, 69, 73, 77, 82). If such an error is detected in state p1 or state p7, the DCE does not send a clear request packet to the IW.*

Table 4-32. DTE effect on DCE reset states

	DCE Restart States (see Notes 2 and 3)		
Packet received from DTE	FLOW CONTROL READY d1	RESET REQUEST by DTE d2	RESET INDICATION BY DCE to DTE d3
Packet with a packet type identifier shorter than 1 octet	A = ERROR S = d3 D = 38 (see Note 1)	A = ERROR S = r3 D = 38 (see Note 3)	A = DISCARD
Packet with a packet type identifier which is undifined or not supported by DCE	A = ERROR S = d3 D = 33 (see Note 1)	A = ERROR S = d3 D = 33 (see Note 1)	A = DISCARD
RESTART REQUEST, or RESTART CONFIRMATION packet with logical channel identifier<> 0	A = ERROR S = r3 D = 41 (see Note 1)	A = ERROR S = d3 D = 41 (see Note 1)	A = DISCARD
RESET REQUEST	A = NORMAL (8.2) D = d2 (forward)	A = DISCARD	A = NORMAL (8.3) D = d1 (do not forward)
RESET CONFIRMATION	A = ERROR S = d3 D = 27 (see Note 1)	A = ERROR S = d3 D = 28 (see Note 1)	A = NORMAL (8.4) D = d1 (do not forward)
INTERRUPT packet	see Tabke 4-33	A = ERROR S = d3 D = 28 (see Note 1)	A = DISCARD
INTERRUPT CONFIRMATION packet	see Table 4-33	A = ERROR S = d3 D = 28 (see Note 1)	A = ERROR
DATA or flow control packet	see Table 4-34	A = ERROR S = d3 D = 28 (see Note 1)	A = DISCARD

Notes.—

1. *The error procedure consists of performing the specified actions when entering the d3 state (which includes forwarding a reset indication packet to the DTE) and sending a areset request packet to the IW.*
2. *Table entries are defined as follows: A = action to be taken S = the state to be entered, D = the diagnostic code to be used in packets generated as a result of this action, and discard indicates that the received packet os to be cleared from the AES buffers.*
3. *The number in paretheses below an "A = normal" table entry is the paragraph number in ISO 8208, second edition. The DCE shall be taken the same actions as those taken by the DTE to perform normal processing on the received packet. I fno paragraph is referenced, the normal processing is defined in the table entry.*
4. *If the packet is acceptable to the state of the logical channle (i.e. action = normal) but contains a format error, then the DCE shall initate a connection reset procedure (diagnostic cosed that may apply include 38, 39, 81, 82).*

Table 4-33. DTE effect on DCE interrupt transfer states

	DTE/DCE INTERRUPT TRANSFER STATES (see Notes 2 and 3)	
Packet received from DTE	DTE INTERRUPT READY i1	DTE INTERRUPT SENT i2
INTERRUPT (see Note 1)	A = NORMAL (6.8.2) S = i2 (forward)	A = ERROR S = d3 S = 44 (see Note 4)
	DTE/DCE INTERRUPT TRANSFER STATES (see Notes 2 and 3)	
Packet received from DTE	DCE INTERRUPT READY j1	DCE INTERRUPT SENT j2
INTERRUPT CONFIRMATION (see Note 1)	A = ERROR S = d3 D = 43 (see Note 4)	A = NORMAL (6.8.3) S = j1 (forward)

Notes.—

1. *If packet is acceptable to the state of the logical channel (i.e. action = normal) but contains a format error, then the error procedure applies (see Note 4).*
2. *Table entries are defined as follows: A = action to be taken, S = the state to be entered, and D = the diagnostic code to be used in packets generated as a result of this action.*
3. *The number in parentheses below an "A = normal" table entry is the paragraph number in ISO 8208, second edition. The DCE shall take the same action as those taken by the DTE to perform normal processing on the received packet. If no paragraph is referenced, the normal processing is defined in the table entry.*
4. *The error procedure consists of performing the specified actions when entering the d3 state (which includes forwarding a reset indication packet to the DTE) and sending a reset request packet to the IW.*

Table 4-34. DTE effect on DCE flow control transfer states

Packet received from DTE	DCE Flow Control Transfer States (See Note 2)	
	DCE RECEIVE READY f1	DEC RECEIVE NOT READY f2
DATA packet with invalid PR	A = ERROR S = d3 D = 2 (See Note 4)	A = ERROR S = d3 D = 2 (See Note 4)
DATA packet with valid PR but invalid PS or user data field with improper format	A = ERROR S = d3 D = (See Note 5) (See Note 4)	A = DISCARD (process PR data)
DATA packet with valid PR with M-bit set to 1 when the user data field is partially full, or the D-bit set to 1 (when not supported)	A = ERROR S = d3 D = 165 or 166 (See Note 4)	A = DISCARD (process PR data)
DATA packet with valid PR, PS and user dat field with proper format	A = NORMAL (forward)	A = DISCARD (process PR data) (See Note 7)
	DCE Flow Control Transfer States (See Note 2 and 3)	
Packet received from DTE	DCE RECEIVE READY g1	DEC RECEIVE NOT READY g2
RR, or RNR packet with an invalid PR	A = ERROR S = d3 D = 2 (See Note 4)	A = ERROR S = d3 D = 2 (See Note 4)
RR packet with a valid PR (See Note 6)	A = NORMAL (4.7.1.5)	A = NORMAL (4.7.1.5) S = g1
RNR packet with a valid PR (See Note 6)	A = NORMAL (4.7.1.6) S = g2	A = NORMAL (4.7.1.6)

Notes.—

1. *The RR and RNR procedures are a local DTE/DCE matter and the corresponding packets are not forwarded to the IW.*
2. *Table entries are defined as follows: A = action taken, S = the state to be entered, D = the diagnostic code to be used in packets generated as a result of this action, and discard indicates that the received packets is to be cleared from the buffers.*
3. *The number in parentheses below an "A = normal" table entry is the paragraph number in ISO 8208, second edition. The DCE shall take the same action as those taken by the DTE to perform normal processing on the received packet. If no paragraph is referenced, the normal processing is defined in the table entry.*
4. *The error procedures consists of performing the specified actions when entering the d3 state (which includes forwarding a reset indication packet to the DTE) and sending a reset request packet to the IW.*
5. *The diagnostic codes are a follows: D = 1 for invalid PS: D = 39 for a user data field greater than 128 octets: D = 82 for a user data field not octet aligned.*
6. *For RR, RNR, or REJECT packets, the presence of one or more octets beyond the third octet is considered an error. Although a valid P(R) may be accepted to update the status of outstanding data packets, the DCE shall invike the error procedure as defined in Note 4 (with D = 39).*
7. *If possible, the DCE should process thses packets normally. On the other hand, the DCE may define an internal mechanism to indicate that valid data packets have been discarded during a receive-not-ready condition. In this case, when the receive-not-ready condition clears, the DCE should reset the logical channel, forward both a reset indication packet to the DTE (D = 0, no addtional information) and a reset request packet to the IW.*

Table 4-35. DCE timer

Timer design	Default time-limit value	Start event	Normally terminated by	Action when timer expires
tN10	[60 s]	DCE issues a RESTART INDICATION packet	Reception of RESTART CONFIRMATION or RESTART REQUEST packet	DCE enters the r1 state and may issue a DIAGNOSTIC packet (D = 52)
tN11	[180 s]	DCE issues an INCOMING CALL packet	Reception of CALL ACCEPTED or CLEAR REQUEST or CALL REQUEST packet	DCE enters the p7 state signaling a CLEAR INDICATION packet (D = 49) (see Note)
tN12	[60 s]	DCE issues a RESET INDICATION packet	Receipt of RESET CONFIRMATION or RESET REQUEST packet	DCE enters the p7 state signaling a CLEAR INDICATION packet (D = 49) (see Note)
tN13	[60 s]	DCE issues a CLEAR INDICATION packet	Reception of a CLEAR CONFIRMATION or CLEAR REQUEST packet	DCE enters the p1 state and may issue a DIAGNOSTIC packet (D = 50)

Note.— The clear is extended to the IW, i.e. the DCE shall issue a clear request packet to the IW.

Table 4-36. HFNDPX/IW interface

Packets received from HFNDPX	Action
INCOMING CALL	See 4.7.5.1.2
CALL CONNECTED	See 4.7.5.1.3
CALL INDICATION	See 4.7.5.1.4
DATA	See 4.7.5.1.5
INTERRUPT	See 4.7.5.1.5
INTERRUPT CONFIRMATION	See 4.7.5.1.5
RESET INDICATION	See 4.7.5.1.5

Packets sent to HFNDPX
CALL REQUEST
CALL ACCEPTED
CLEAR REQUEST
DATA
INTERRUPT
INTERRUPT CONFIRMATION
RESET REQUEST

Table 4-37. ISO 8208 DCE/IW interface

Packets received from ISO 8208 DCE	Action
CALL REQUEST	See 4.7.5.2.2
CALL ACCEPTED	See 4.7.5.2.3
CLEAR REQUEST	See 4.7.5.2.4
DATA	See 4.7.5.2.5
INTERRUPT	See 4.7.5.2.5
INTERRUPT CONFIRMATION	See 4.7.5.2.5
RESET REQUEST	See 4.7.5.2.5

Packets sent to ISO DCE
INCOMING CALL
CALL CONNECTED
CLEAR INDICATION
DATA
INTERRUPT
INTERRUPT CONFIRMATION
RESET INDICATION
RESTART INDICATION

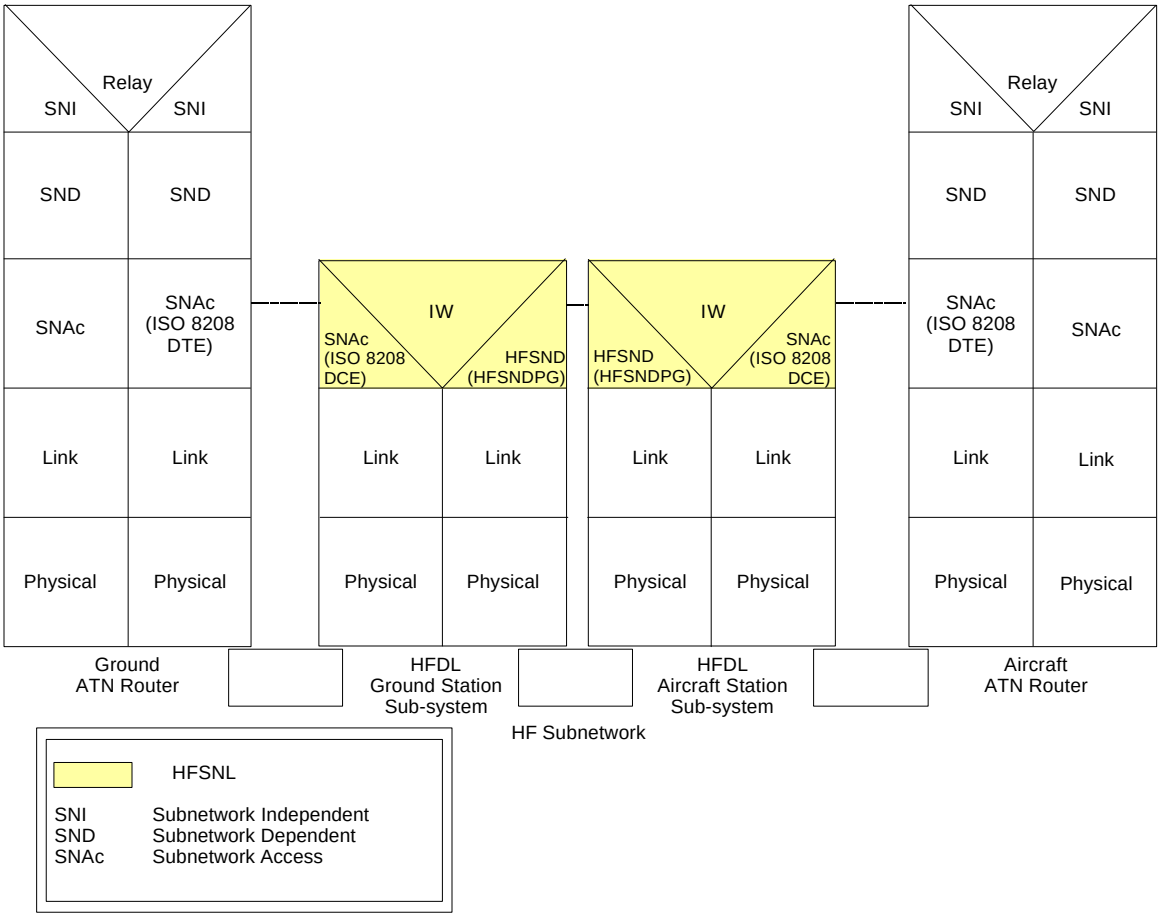


Figure 4-11. HFSNL function and the ATN subnetwork

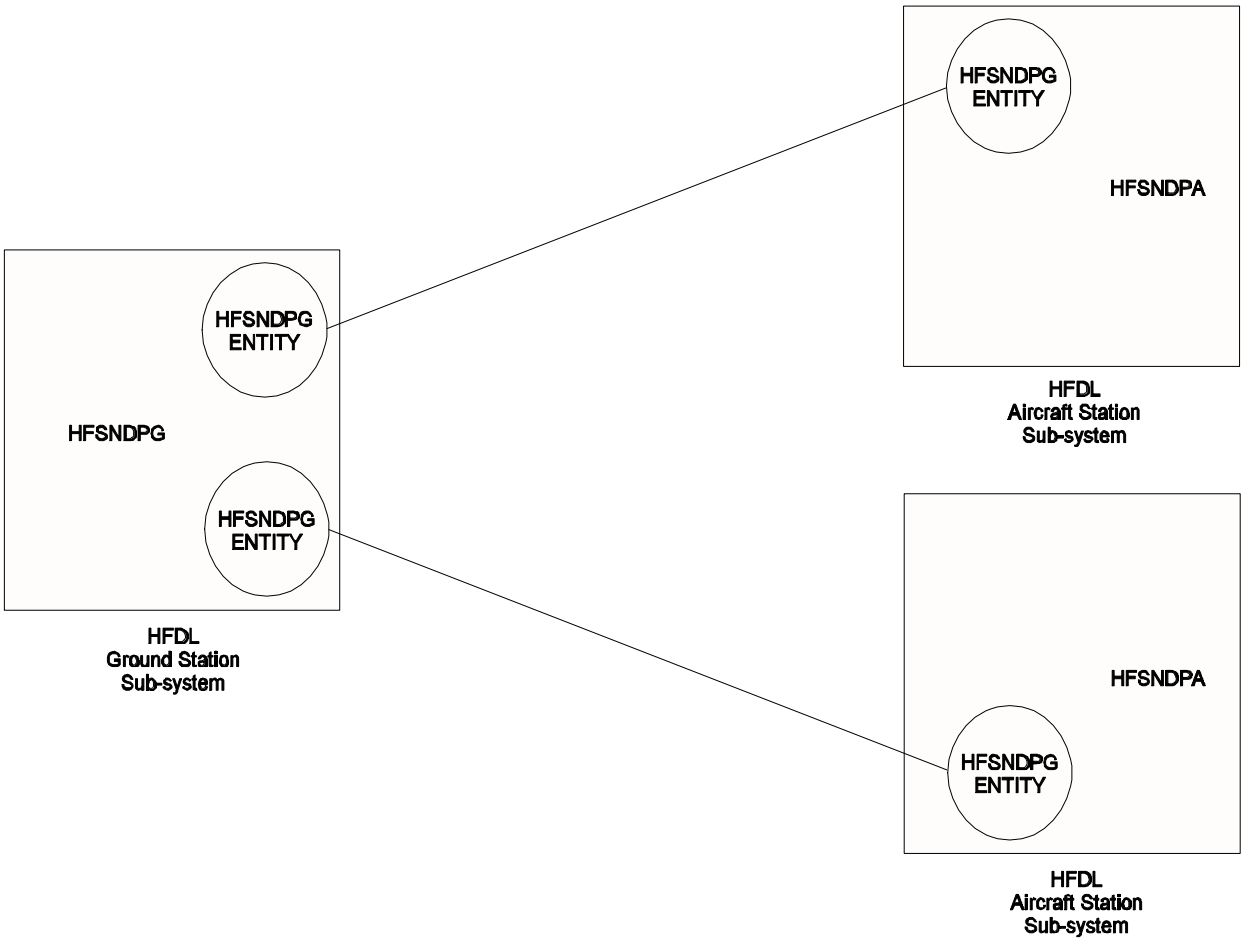


Figure 4-12. HFSNDPX entities

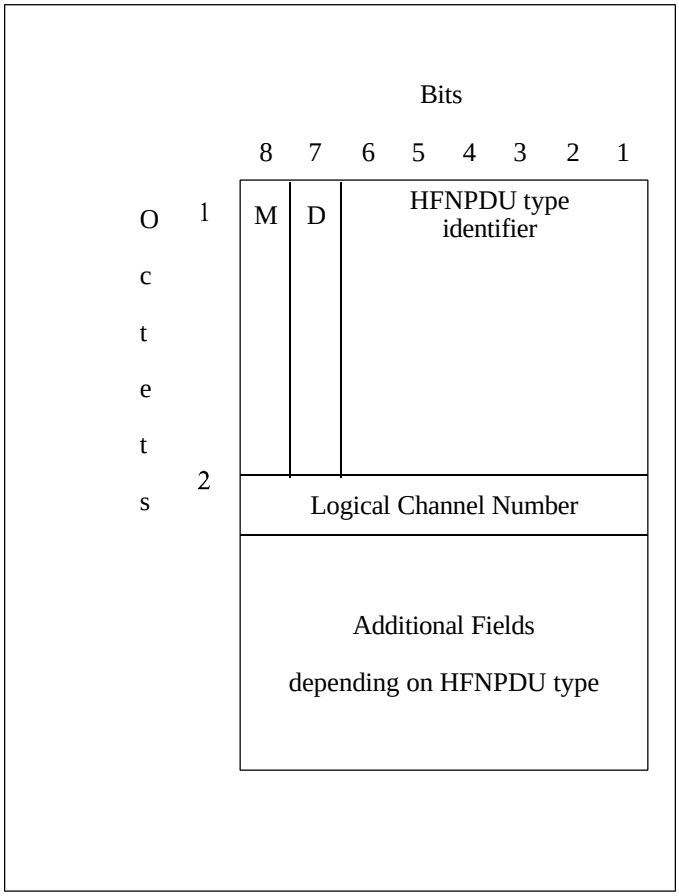


Figure 4-13. General format of a HFNPDU

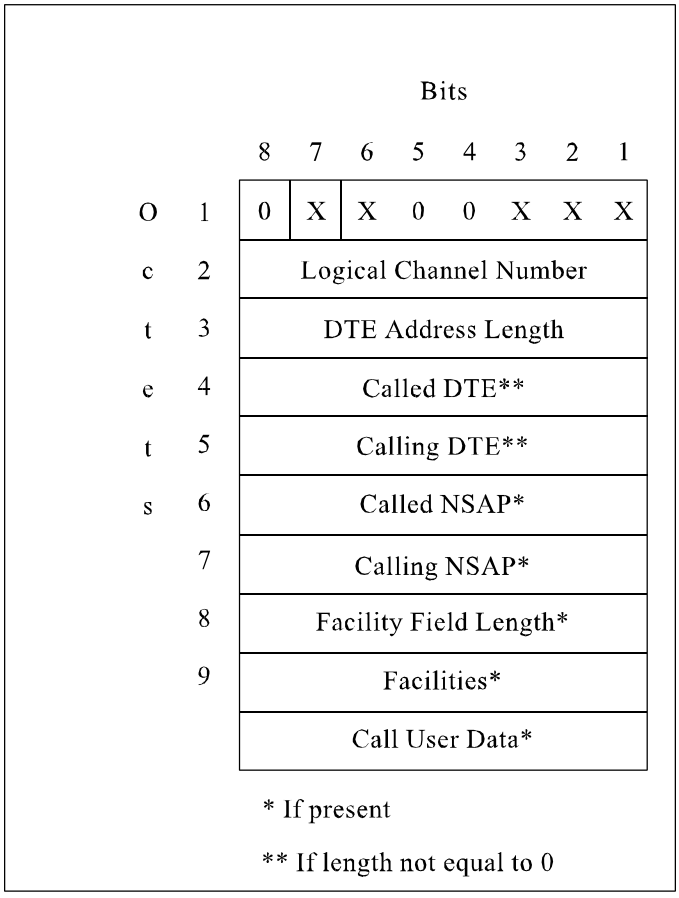


Figure 4-14. Connection request HFNPDU format

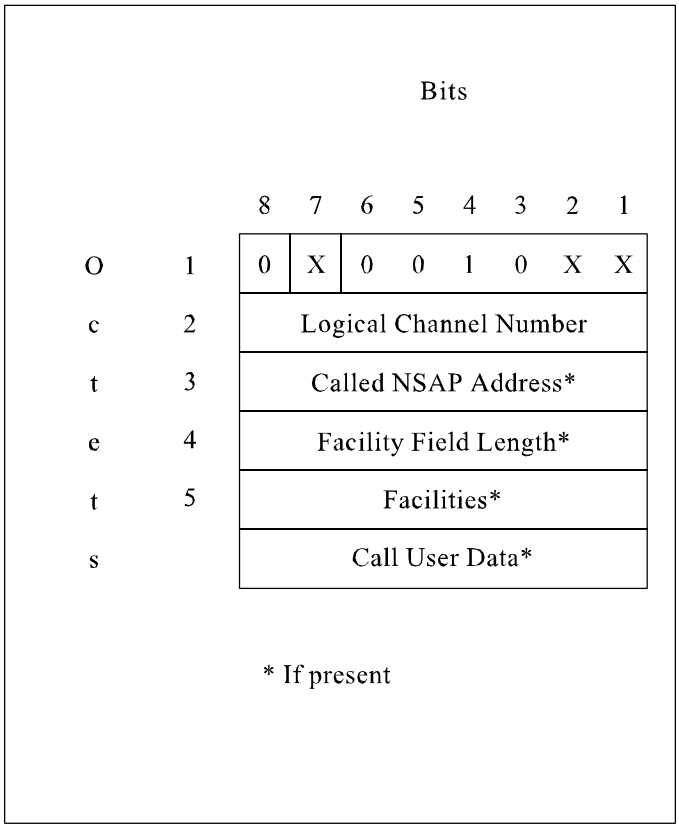


Figure 4-15. Connection confirm HFNPDU format

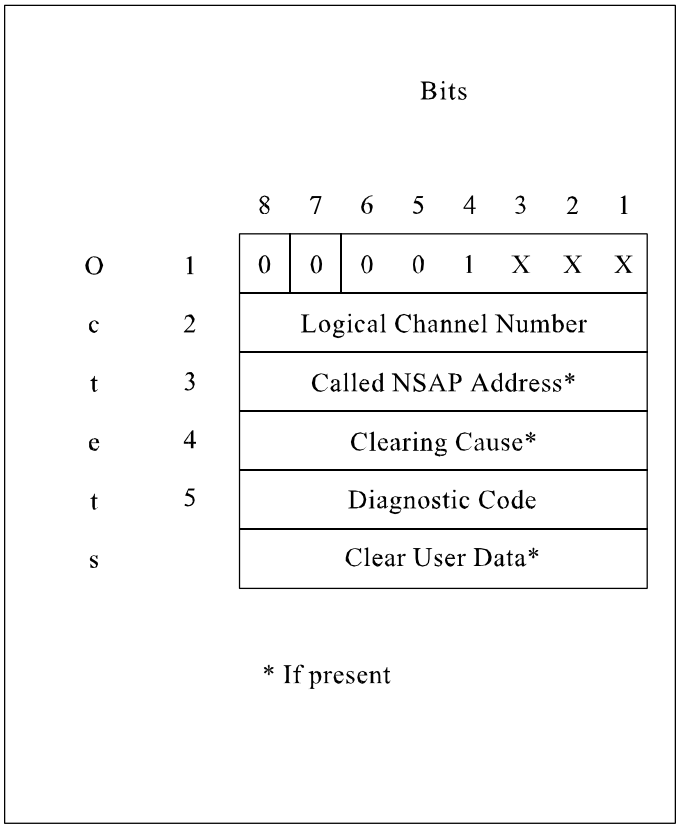


Figure 4-16. Connection released HFNPDU format

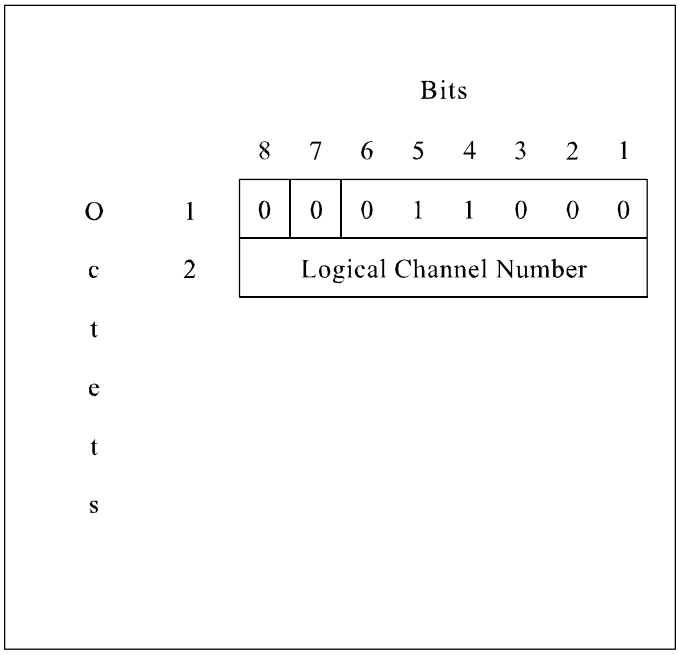


Figure 4-17. Connection release complete HFNPDU format

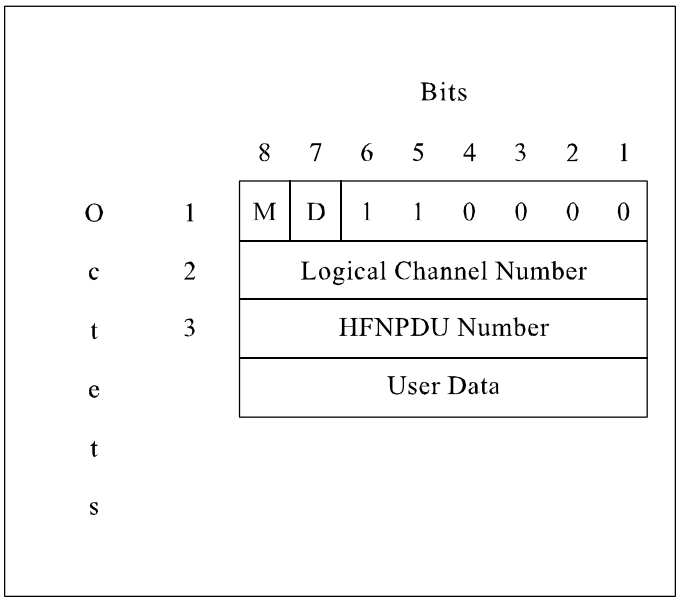


Figure 4-18. Data HFNPDU format

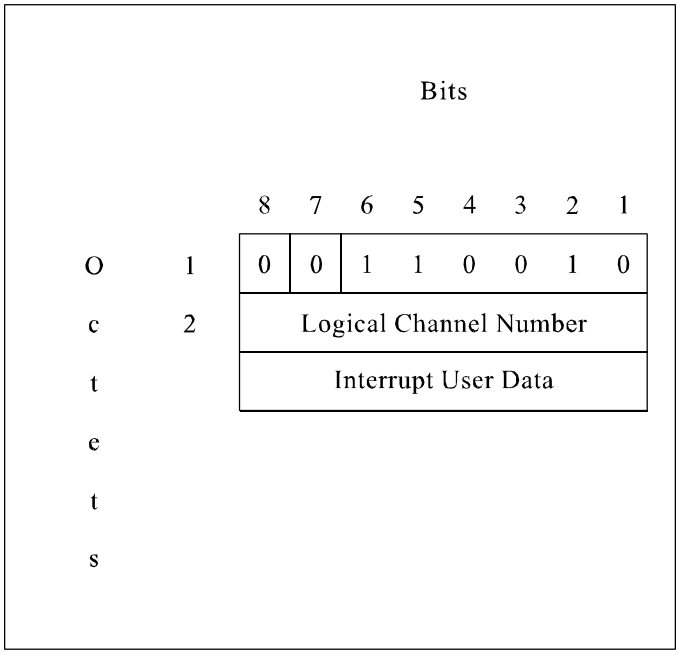


Figure 4-19. Interrupt data HFNPDU format

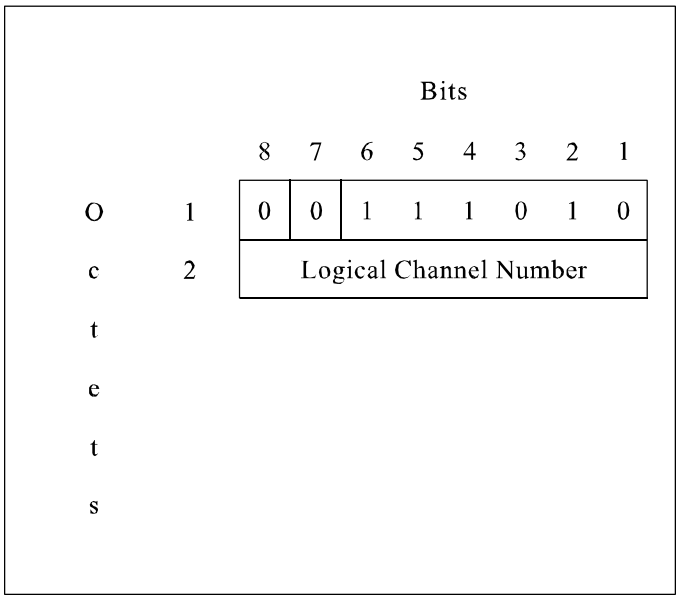


Figure 4-20. Interrupt confirm HFNPDU format

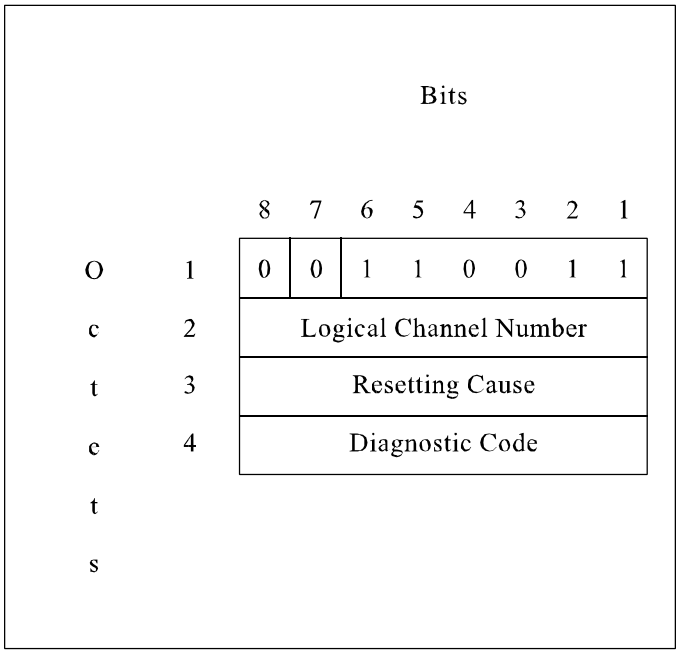


Figure 4-21. Reset HFNPDU format

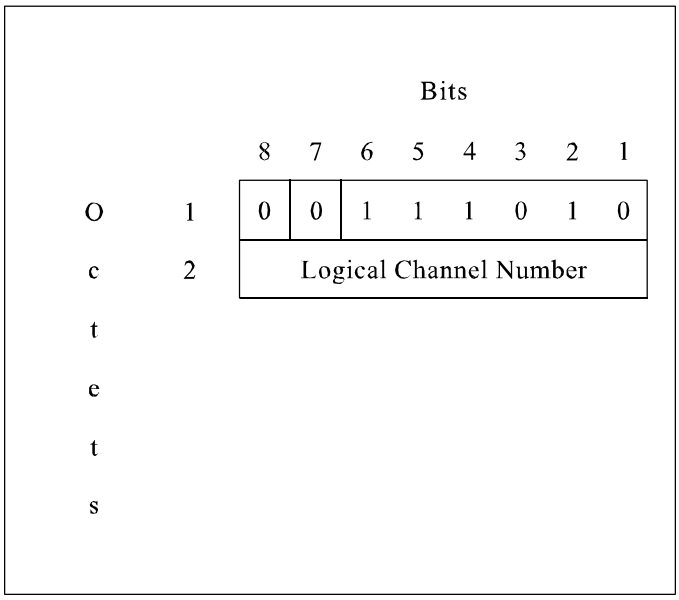


Figure 4-22. Reset confirm HFNPDU format

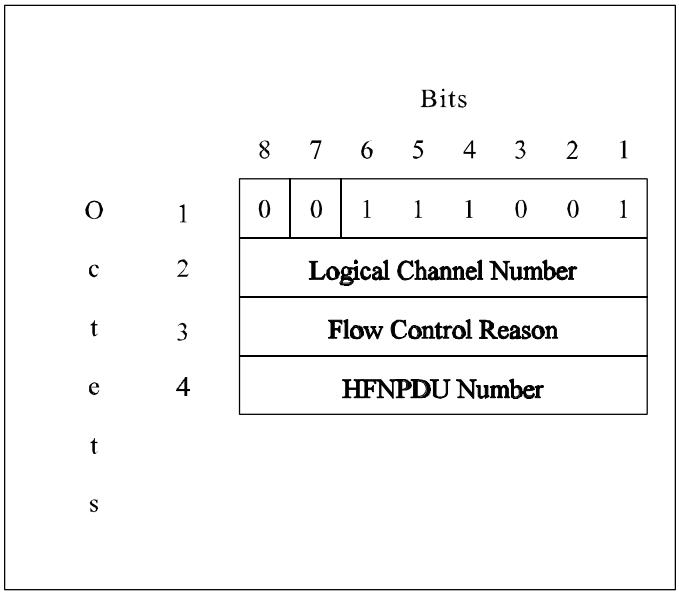


Figure 4-23. Flow control (suspend) HFNPDU format

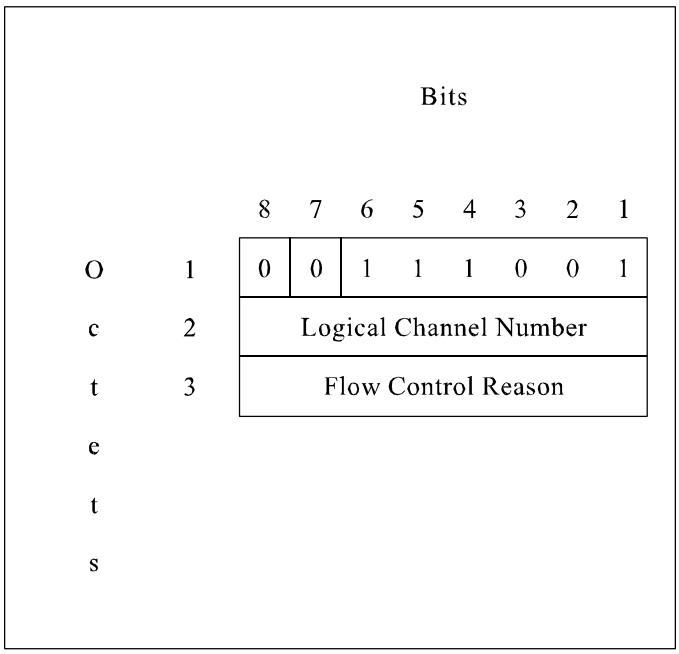
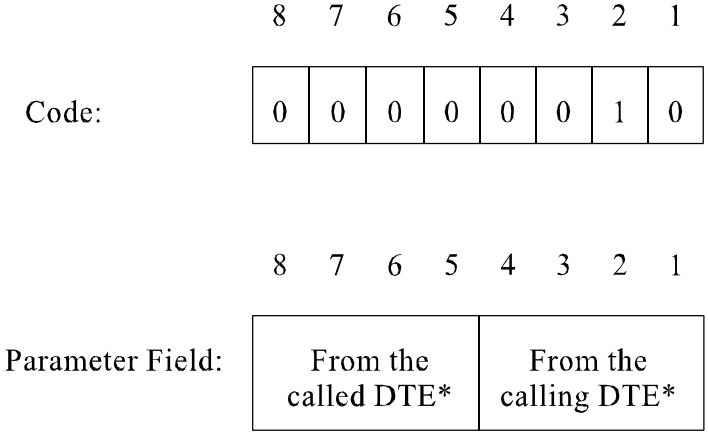


Figure 4-24. Flow control (resume) HFNPDU format



* The four bits indicating each throughput class are binary coded and correspond to throughput classes as indicated on the right.

Bits: 8765 or Bits: 4321	Throughput class (bits/s) as defined in ISO-8208
0000	Reserved
0001	Reserved
0010	Reserved
0011	75
0100	150
0101	300
0110	600
0111	1200
1000	2400
1001	4800
1010	9600
1011	19200
1100	48000
1101	64000
1110	Reserved
1111	Reserved

Figure 4-25. Throughput class negotiation (TCN) facility field

Figure 4-26. Figure to be developed

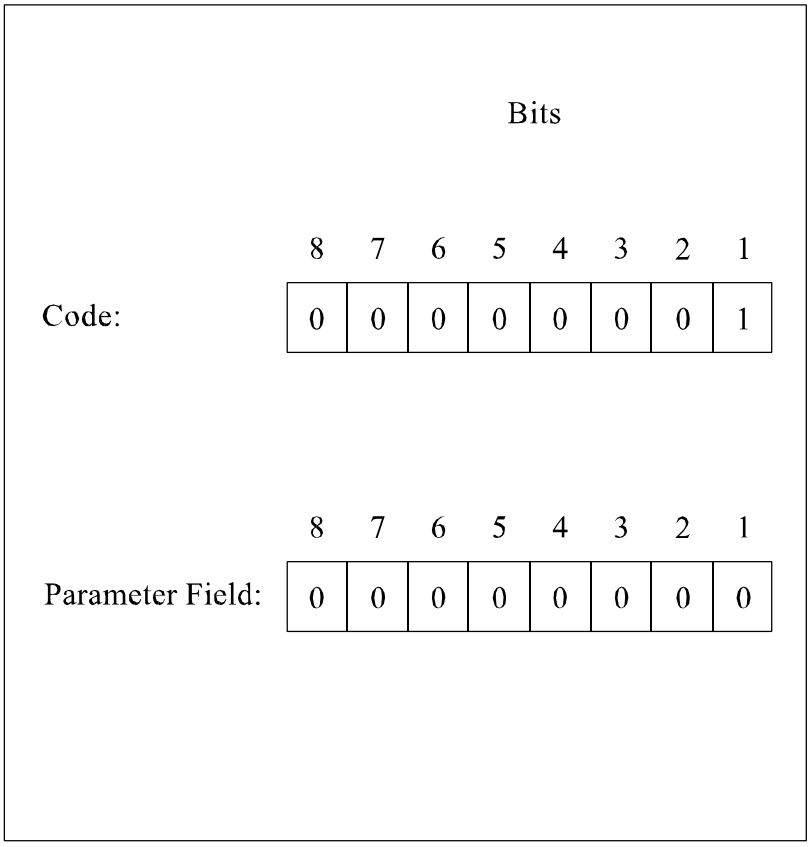


Figure 4-27. Fast select (use not permitted)

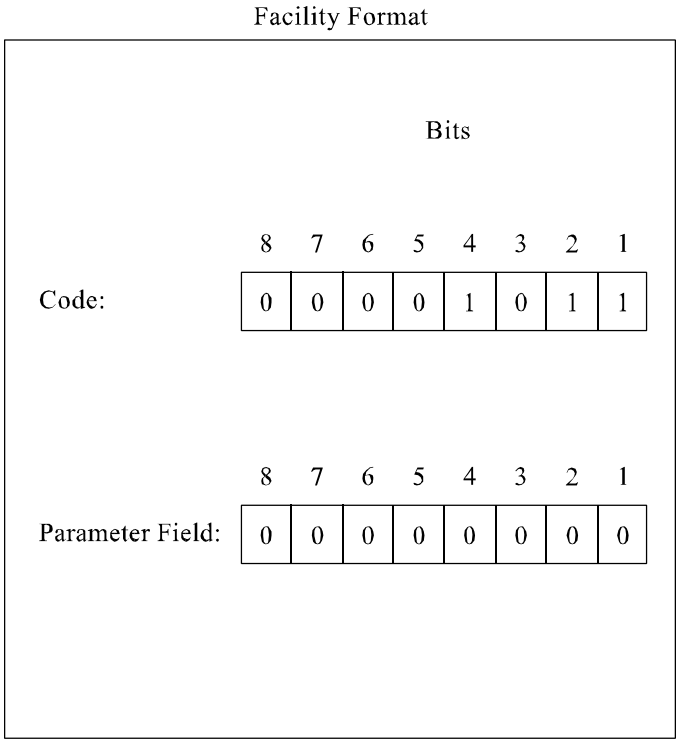


Figure 4-28. Expedited data negotiation ("no use of expedited data") facility format

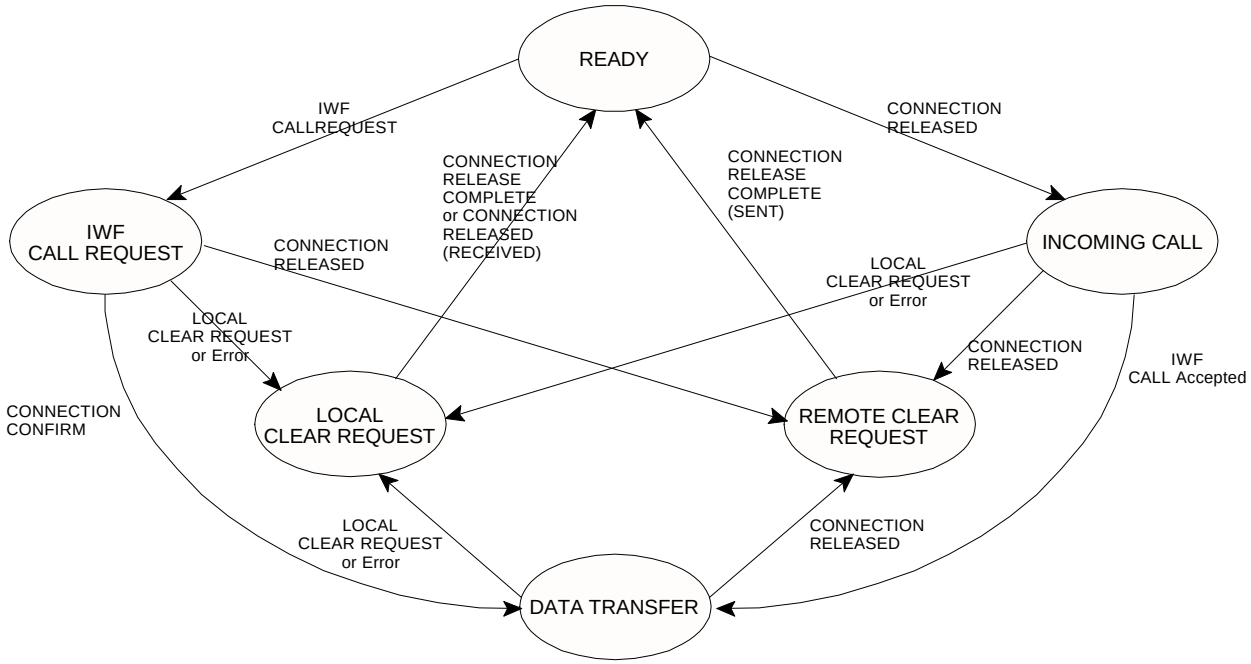


Figure 4-29. Connection establishment and release state diagram

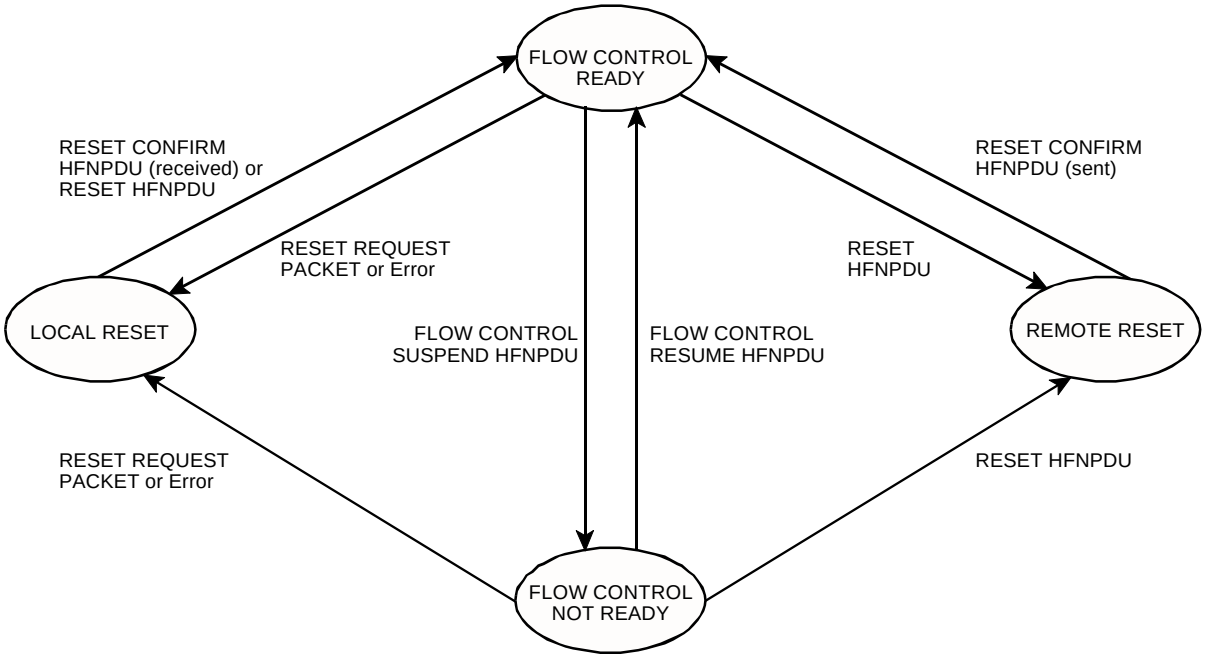


Figure 4-30. Reset and flow control state diagrams within the data transfer state

State Label/State Name:	**B0**	contention slot selection backoff inactive	
Entry Actions:	-		
Transition Events		**Transition Actions**	**Next States**
contention slot clash detected		initialize slot retry count, n = 1	**B1**
State Label/State Name:	**B1**	process present SPDU slot assignment codes	
Entry Actions:	select uniform random variable, m; where 0 £ m £ (3n-1)		
Transition Events		**Transition Actions**	**Next States**
Reserved slot assigned this aircraft		*schedule reserved slot time*	**B0**
(no reserved slot for this a/c) & (m > 0)		m = m – 1	**B2**
(no slots available) & (m = 0)		-	**B2**
(contention slot available and no reserved slots for this a/c) & (m = 0)		preselect random contention slot from those available	**B3**
State Label/State Name:	**B2**	await next SPDU and process assignment codes	
Entry Actions:	Process the assignment codes from the SPDU		
Transition Events		**Transition Actions**	**Next States**
consecutive SPDUs not received		indicate frequency search required	**B0**
reserved slot assigned this aircraft		*schedule reserved slot time*	**B0**
(no reserved slot for this a/c) & (m > 0)		m = m – 1	**B2**
(no slots available) & (m = 0)		-	**B2**
(contention slot available and no reserved slots for this a/c) & (m = 0)		preselect random contention slot from those available	**B3**
State Label/State Name:	**B3**	await active slot	
Entry Actions:	schedule preselected contention slot time		
Transition Events		**Transition Actions**	**Next States**
slot time active		-	**B4**
State Label/State Name:	**B4**	transmit MPDU	
Entry Actions:	Provide the MPDU to the modem for transmit		
Transition Events		**Transition Actions**	**Next States**
MPDU transmit indication received		-	**B5**
State Label/State Name:	**B5**	await acknowledgement codes	
Entry Actions:	check acknowledgement codes in appropriate SPDU(s)		
Transition Events		**Transition Actions**	**Next States**
consecutive SPDUs not received		indicate frequency search required	**B0**
all LPDUs ACK		-	**B0**
partial LPDUs ACK		indicate retransmission required	**B0**
(no LPDUs ACK) & (n = 2)		indicate frequency search required	**B0**
(no LPDUs ACK) & (n < 2)		n = n + 1	**B1**

Figure A.1 HFDL contention slot selection

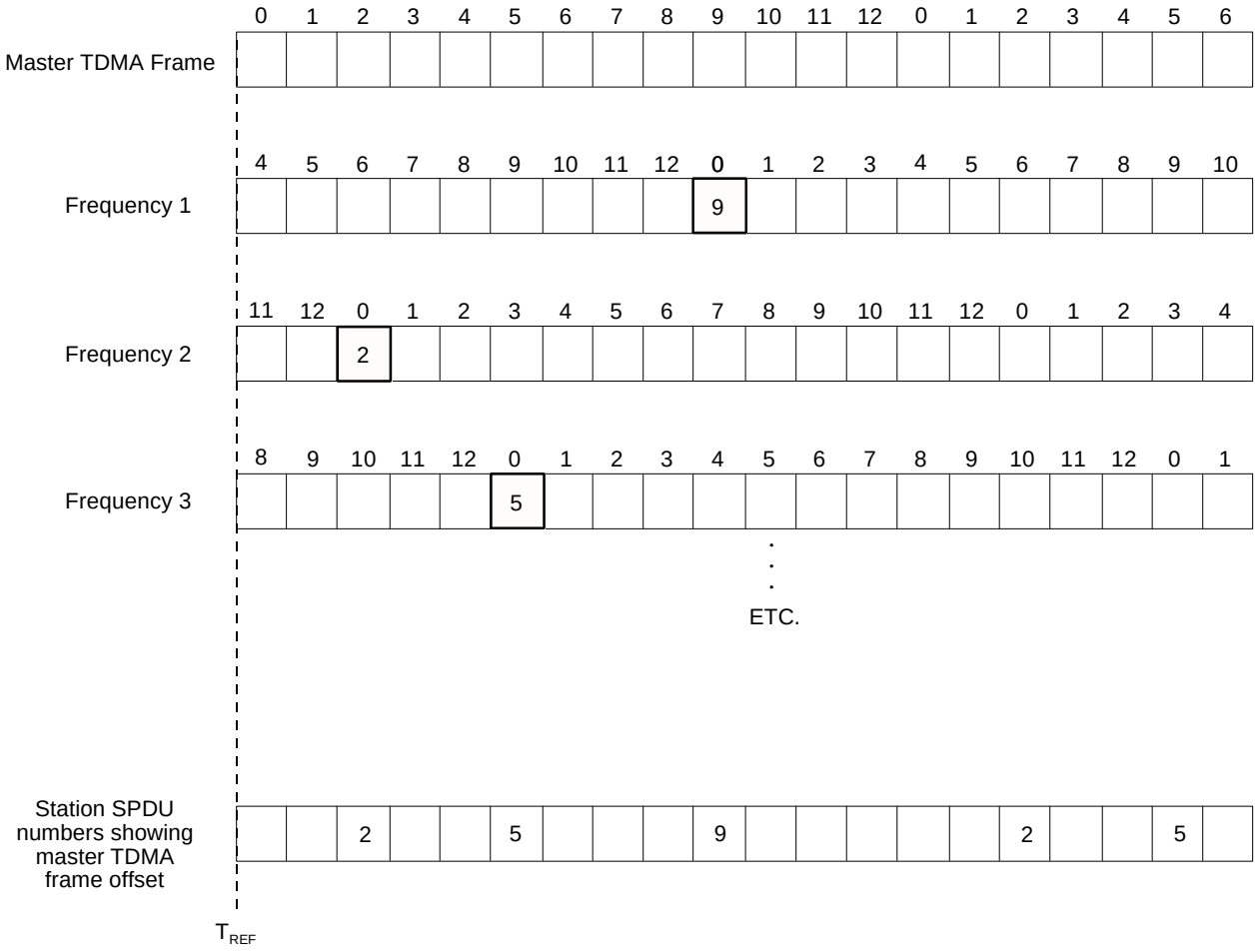


Figure A-2. Intra-station synchronization

— — — — — — — —