

**JWG ATNP meeting  
Banff, Canada  
October 1995**

Presented by Inmarsat

## **DATA COMMUNICATION SERVICES**

### General

In the Inmarsat Aeronautical Mobile Services the provision of packet-mode data service capabilities is an option, but when provided the procedures are as described below.

The necessary elements of the data system are defined in accordance with OSI System Architecture using protocols defined for the responsibilities assigned to each layer. Each layer performs a subset of the functions required to communicate with another data system. The lower layers, i.e. the physical, data link and network layers, comprise the network-dependent portion of the ISO protocol architecture, and as such must be provided by the satellite communication system.

In the context of the terminology of the OSI architecture, these lower 3 layers form a sub-network - that is, the satellite sub-network.

### Data System Architecture

The satellite Sub-Network provides the OSI Network Service. Its overall function is to serve as a communication system providing reliable transfer of SNSDU between AES and GES, and thus performing:

- (a) physical link functions (Layer 1);
- (b) data link functions and protocols (Layer 2);
- (c) subnetwork functions and protocols (Layer 3).

Data services are carried in the forward direction on a P-channel and in the return direction on an R-channel or T-channel.

Figure 1 depicts the Reference Model for data communications.

### Link Layer Structure

The internal structure of the Link Layer comprises a Channel Interface sub-layer which

passes signal units (SUs) to and from the channel units, a Priority and Routing sub-layer which transmits SUs in priority order and reassociates SUs correctly on receipt, and a Link Service Data Unit (LSDU) Segmentation and Reassembly sub-layer which converts between lone SUs, sets of SUs and LSDUs.

In addition, when the Packet-mode Data service is supported, there is a Reliability sub-layer which ensures correct reception of sets of SUs which are transmitted under the Reliable Link Service (RLS) quality of service. When RLS is applied, the associated functions are provided between the Priority and Routing sub-layer and the LSDU Segmentation and Reassembly sub-layer.

The Link Management functions are defined to provide for:

- a) resource management - these are functions which control the transmission resources (i.e. channel and time-slot allocations) on the basis of predefined information or received data;
- b) channel unit control - these are functions which control the use of channel units, including synchronisation of T-Channel bursts with the time plan and enabling more than one priority and routing sub-layer to make use of a single multi-function channel unit, in a defined priority order.

The basic routing paths within this structure are illustrated in Figures 2A and 2B.

The functions required by the Priority and Routing sub-layer are defined by a "Transmit" process and "Message Assembler" processes.

The functions required by the Reliability sub-layer are defined by a "Queuing Unit" process and an "AcKnowledge" process.

Because the time of dispatch of any particular SU-set is rather uncertain in a Queuing Unit process (the reliability sub-layer), the associated Transmit process informs the Queuing Unit at the moment when either the last SU of the set or selected link layer signalling LSUs are dispatched. This allows accurate and thus, more efficient, use of timeouts in the LSDU transmission protocol.

### Satellite Sub-Network Layer Structure

A Higher Level Entity (HLE) or SNS user may connect

- a) directly to the satellite sub-network, or
- b) via an interface using an access protocol.

Within the layer 3 of the satellite sub-network, an SSND sub-layer is provided to enable access by HLEs through either direct connection to higher level entities or connection via a sub-network interworking functions.

The functions are described in terms of the SSND sub-layer peer to peer protocol and an abstract SubNetwork Service User interface. There is an SSND sub-layer in both the AES and the GES.

### Sub-Network Services

The SubNetwork Service (SNS) provides for transparent transfer of data between SubNetwork Service users. Each SNS user accesses the SNS by means of a Sub-Network Connection (SNC) end point identifier which has significance within the Sub-Network only. In particular, the SNS provides for the following:

- Independence of underlying satellite link transmission media;
- End-to-end transfer across the Satellite Sub-Network;
- Transparency of transferred information;
- Quality of service (QOS) selection;
- SNS-user-addressing;
- Transfer of globally significant Network Service Access Point (NSAP) addresses used for internetwork routing purposes.

The Satellite Sub-Network offers Connection-Oriented Services. It makes invisible to the HLEs the way in which supporting communications resources are utilized to achieve this transfer.

### Sub-Network Service features

The SubNetwork Service offers the following features to an SNS user:

- a) The means to establish a SubNetwork Connection (SNC) with another SNS user for the purpose of transferring SNS-user-data in the form of SubNetwork Service Data Units (SNSDUs).
- b) The establishment of an agreement between the two SNS users and both SSND sub-layer entities for Quality Of Service parameters associated with each SNC.
- c) The means of transferring SNSDUs in sequence on an SNC. The transfer of SNSDUs, which consist of an integer number of octets, is transparent and there are no constraints on the SNSDU content imposed by the SNS.
- d) The means of transferring separate expedited SNSDUs in sequence. Expedited SNSDUs are limited in length.
- e) The means by which the SNC can be returned to a defined state and the activities of the two SNS users synchronized.
- f) Optionally, the means for the SNS user to confirm the receipt of an SNSDU.
- g) The unconditional, and therefore possibly destructive, release of an SNC by either of the SNS users or by the SNS provider.

### Satellite SubNetwork Primitives

The subnetwork interfaces, to the upper layer or to an interworking sub-layer, are described by means of primitives and associated parameters.

Request and response primitives are translated by the SSND sub-layer into Sub-Network Protocol Data Units (SNPDUs) to be transmitted between peer SSND sub-layer entities. Received SNPDUs are translated by the SSND sub-layer into indication or confirm primitives. A Request primitive transported via an SNPDU is delivered to the receiving HLE

as an Indication primitive. The corresponding Response primitive is then transported via an SNPDU and delivered to the originating HLE as a Confirm primitive.

Thus in the basic protocol, an originating HLE sees a Confirm primitive in reply to its Request primitive, if a response is required. A HLE receiving an Indication primitive will reply with a Response primitive, if a response is required.

The translation between primitives and SNPDU's in the SSND sub-layer is not an instantaneous process. Flow control between the two connection end points is provided by queuing of service primitives. The SSND sub-layer removes and processes items in the queue only when capable of doing so. This conforms to the model of the connection-mode Network Layer Service as specified in OSI Network Service Definition (ISO/IEC 8348).

#### SubNetwork Protocol Data Unit (SNPDU)

The SubNetwork Protocol Data Unit (SNPDU) is a combination of the SubNetwork Protocol Control Information (SNPCI) and the SubNetwork Service Data Unit (SNSDU). It is the total information that is transferred between peer SSND sub-layer entities across the satellite sub-network.

The SNPCI supports the joint functions of the SSND peer entities within an AES and a GES communicating with each other. The meaning and definition of the various information elements contained in the SNPCIs are specified in section B.6 below.

All Sub-Network Protocol Data Units use the Reliable Link Service (RLS) and are passed in both directions at the Q precedence level determined from the priority QOS (priority of data on a connection) specified during the connection set up phase.

The general SNPDU format is given in Figure 3. The maximum length of an SNPDU is 506 octets.

Table \*\*\*13 shows the relationships between the primitives, SNPDU's and parameters/fields defined to support Connection-Oriented SubNetwork Services.

#### Logical Channel Number

Connections (*virtual calls*) within the satellite sub-network are identified by their Logical Channel Number (LCN), which is a number in the range from 1 through 255. Allocation of logical channel numbers is carried out in the SSND sub-layer during the connection set up phase. The logical channel identified by an LCN may be in the Ready state (no connection established or being established) or in one of the other states indicated in Figures 4A, 4B and 4C.

Call attempts from an HLE are identified by an SNC end point identifier (defined for example by an HLE logical channel number and a sub-network address). For a new ground-to-air connection set up, the GES SSND sub-layer allocates 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 set up, the AES SSND sub-layer allocates a logical channel number in the range 128 to 255, by choosing the highest numbered logical channel in the Ready state in that range.

Each SSND sub-layer maintains its own series of satellite logical channel numbers, for each AES and GES communicating with each other.

Each SSND sub-layer maintains the correspondence between the logical channel number (LCN) used by the satellite subnetwork and the SNC end point identifier of

the interfacing HLE while the channel is active.

Logical Channel Numbers are released by an SSND sub-layer after receipt of a CONNECTION RELEASE COMPLETE SNPDU (release originated from the local SSND) or transmission of a CONNECTION RELEASE COMPLETE SNPDU (release originated from the remote SSND).

### Satellite SubNetwork Dependent (SSND) sub-layer Protocol Description

The following section specifies the procedures for the establishment, use and release of Switched Virtual Circuits (SVCs) within the Satellite SubNetwork, and the interworking between the SNPDU and the primitives defined for providing Connection-Oriented SubNetwork Service to the Satellite SubNetwork Service user.

The state transition diagram of each logical channel in the SSND sub-layer entity, under normal operation, is shown in Figures 4A, 4B and 4C. The formats of the SubNetwork Protocol Data Units (SNPDUs) used by the SSND in performing its functions are shown in Figures 4/1 to 4/5. The formats of the various facility fields used in SNPDU during the connection set-up phase, are shown in figures 6/1 to 6/6. The format of the NSAP addresses carried in SNPDU during the connection set-up phase, are shown in figures 7/1 and 7/2. The SNPDU Type codes are summarised in Table 1.

### Connection Establishment Procedure

For the procedures to succeed, the AES involved in the connection establishment must have completed an initial log-on procedure, and not be engaged in either an handover or a log-off procedure.

The satellite Sub-Network never originates a connection setup.

The CONNECTION REQUEST/ CONNECTION CONFIRM SNPDU may contain SNS-User-Data (128 octets maximum) provided by the calling/ called HLE respectively.

### Procedure for originating SSND

When the satellite Sub-Network layer receives an SN-CONNECT request primitive from an SNS user, it processes the parameters and determines whether a connection can be established or not.

The SSND sub-layer allocates a logical channel which is in the Ready state, forwards the call request on to the peer SSND sub-layer by means of a CONNECTION REQUEST SNPDU and places the logical channel into the HLE \*\*\*Call Request

state. The logical channel is identified by its LCN.

Upon receipt of a CONNECTION CONFIRM SNPDU, the SSND sub-layer places the logical channel in the Data Transfer/Flow Control state (Flow control ready/no remote or local interrupt pending) and forwards an SN-CONNECT confirm primitive to the HLE.

The SSND sub-layer times out (see tN1, table 2) if it does not receive a response from the remote SSND sub-layer entity. It then initiates a connection release procedure.

#### Procedure for receiving SSND

When the SSND sub-layer receives a CONNECTION REQUEST SNPDU from its peer SSND sub-layer it places the logical channel selected by the originating SSND sub-layer entity, in the Incoming Call state. The SSND sub-layer constructs an SN-CONNECT indication primitive and transfers it to the HLE.

When the SSND receives an SN-CONNECT response primitive from the HLE, it forwards a CONNECTION CONFIRM SNPDU to its peer SSND sub-layer and places 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 SNPDU has been processed (receipt of a Fail/ Success LIDU).

If the receiving SSND cannot support the request (e.g. resources are not available, or an invalid parameter value is requested), it transmits a CONNECTION RELEASED SNPDU to the originating SSND sub-layer and places the logical channel in the Local Clear Request state.

#### Connection Release Procedure

A SubNetwork Connection (SNC) may be released at any time by any party. The SSND may release an SNC to indicate, for example, its inability to establish the requested SNC. An SNS user may release an SNC before having received a SN-CONNECT confirm primitive.

The CONNECTION RELEASED SNPDU may contain SNS-User-Data (128 octets maximum) provided by the HLE.

#### Procedure for originating SSND

available upon request (a.u.r.)

#### Procedure for receiving SSND

a.u.r.

#### SSND initiated release

If either SSND entity needs to disconnect an SNC, it places the logical channel in the Local Clear Request state, signals an SN-DISCONNECT indication primitive to its SNS user and transmits \* a CONNECTION RELEASED SNPDU to the remote SSND. It expects to receive a response from the remote SSND (a CONNECTION RELEASE COMPLETE SNPDU or CONNECTION RELEASED SNPDU), and returns the logical channel to the Ready state when either the expected response is received or it times out (see tN6, table 2).

\* The AES SSND waits until all DATA/ INTERRUPT SNPDUs in transmission and pertaining to that connection have been processed (receipt of Fail/ Success LIDUs) before transmitting the CONNECTION RELEASED SNPDU.

### Data Transfer and Expedited Data Transfer Procedures

For the procedures to succeed, the logical channel must have completed connection establishment, and not be engaged in a release or reset procedure.

The data/ expedited data transfer procedure applies independently to each logical channel which is in the Data Transfer/Flow Control state. In addition, the expedited data transfer procedure also applies when data flow is suspended on the logical channel.

#### Data transfer Procedure

SNS-user-data is forwarded transparently and in the same order between users of the Sub-Network Connection via the satellite sub-network.

Upon receipt of an SN-DATA request primitive, the SSND generates a sequence of one or more DATA SNPDU's. The number of DATA SNPDU's needed in the sequence depends on the amount of SNS-User-Data, considering that the maximum User Data Field length of a DATA SNPDU is equal to 503 octets.

Each DATA SNPDU, except the last one, will have the exact maximum User Data Field length and its M-bit set to 1. The User Data Field of the last SNPDU which belongs to the sequence may have less than the maximum length and its M-bit set to 0. Such a sequence is called an "M-bit sequence (MBS)."

User data from one SN-DATA primitive may not be concatenated by the sub-network with user data from another SN-DATA primitive.

The originating SSND sub-layer entity assigns an SNPDU number to each individual DATA SNPDU, independently from the SNPDU number assigned in the other direction of data transmission. SNPDU numbers are consecutive over a given connection. The sequence numbering of DATA SNPDU's is performed modulo 256 and the SNPDU numbers cycle through the entire range from 0 through 255. The first DATA SNPDU to be transmitted over the satellite link, when the logical channel has just entered the Flow Control state, has an SNPDU number equal to 0.

The originating SSND sub-layer entity has access to a data buffer with a size according to the following table. Each time a DATA SNPDU is forwarded to the link layer, timer tN2 is restarted and a copy of the DATA SNPDU is placed in the buffer. If there is not sufficient room in the buffer then the oldest SNPDU(s) in the buffer is (are) deleted to make space. When timer tN2 expires, all SNPDU's in the buffer corresponding to that virtual connection are deleted. The purpose of this arrangement is to enable the peer SSND entities to maintain synchronism if flow control is invoked.

Transmit channel bit rate	AES requirement (requirement is the minimum of the two values)		GES requirement (requirement is the minimum of the two values)	
	per VC	Total	per VC	Total
600	2K	15K	1K	17K
1200	3K	20K	1K	17K
2400	4K	25K	1K	17K
4800	N/A	N/A	1K	17K

10500	4K	25K	1K	17K
-------	----	-----	----	-----

When an SSND entity receives a DATA SNPDU sequence, it constructs an SN-DATA indication primitive and forwards it to the HLE. If a DATA SNPDU is received with M-bit set to 1 but containing less than the maximum user data, the SSND sub-layer entity initiates reset of the logical channel.

Error detection/recovery in a DATA SNPDU sequence, is described in Section \*\*\*5.1.2.

### Receipt Confirmation Procedure

Provision of receipt confirmation service is optional. If the service is not provided, the SSND sub-layer entity will set the D-bit to zero in all SNPDU, otherwise the procedures shall be in accordance with the remaining of this section (including sub-sections).

If the originating HLE requires confirmation of delivery of the SN-DATA primitive, this is indicated in the confirmation request parameter of the primitive. The D-bit of the last DATA SNPDU of an M-bit sequence is mapped to/from the Confirmation Request parameter of the SN-DATA request and SN-DATA indication primitives. It is set to 1, when an end-to-end acknowledgment is requested. The D-bit of any other DATA SNPDU is set to 0.

Whenever an SN-DATA primitive is transferred across the satellite sub-network with the D bit = 1 in the final SNPDU of the corresponding sequence of SNPDU, the entities involved in the transfer must note that an acknowledgement is expected. Such acknowledgements will be issued in the same order that the corresponding SN-DATA indications were issued.

### Flow Control Procedure

Flow control is provided within the SSND sub-layer to recover from events at the receiving end which may cause buffer overflow at the receiving SSND sub-layer.

When the receiving SSND sub-layer senses that such a condition is occurring, it places the logical channel in the data transfer/Flow Control- flow control not ready state and generates a FLOW CONTROL SNPDU with its control field set to Suspend and the SNPDU number set to the SNPDU number of the last received (and accepted) DATA SNPDU, and sends it to the peer SSND sub-layer. If there are any missing DATA SNPDU in the GES SSND, the SNPDU number in the FLOW CONTROL SNPDU with its control field set to suspend is set to the SNPDU number of the SNPDU received and accepted before the missing SNPDU. The SSND sub-layer entity discards all the SNPDU received after the SNPDU number in the FLOW



CONTROL SNPDU and clears timer tN8. When subsequently, the receiving SSND sub-layer is able to resume the data transfer, it generates a further FLOW CONTROL SNPDU with its control field set to Resume and returns the logical channel to the data transfer/Flow Control-flow control ready state. However, if the SSND sub-layer is not able to resume the data transfer before the associated timer expires (see tN7, Table 2), it initiates a reset of the logical channel.

When the SSND sub-layer entity receives a FLOW CONTROL SNPDU with its control field set to Suspend, it stops transmitting new DATA SNPDUs on the indicated logical channel, deletes from its data buffer all DATA SNPDUs which have been sent over that connection up to and including the one whose SNPDU number is equal to the SNPDU number of the FLOW CONTROL SNPDU and stops tN2. If the SNPDU number in the FLOW CONTROL (SUSPEND) SNPDU is other than that of the last SNPDU transmitted by the sub-layer and the SNPDU which was transmitted immediately after the SNPDU identified in the FLOW CONTROL (SUSPEND) SNPDU is not in its data buffer, the SSND sub-layer entity initiates reset of the logical channel.

When the SSND sub-layer entity receives a FLOW CONTROL SNPDU with its control field set to Resume, it is able to restart transmitting DATA SNPDUs on the indicated logical channel, starting from the ones remaining in the data buffer, if any. The first (re)transmitted DATA SNPDU will have its SNPDU number equal to the SNPDU number of the previously received FLOW CONTROL SNPDU (Suspend) plus one modulo 256, unless a reset procedure has been invoked.

Immediately after a connection set-up or a reset operation, the SSND sub-layer sets the SNPDU number of the last transmitted and last received SNPDUs to be 255. This allows the assertion of flow control to take place before any data SNPDUs have been received and accepted by the SSND sub-layer.

#### Expedited Data Transfer Procedure

The expedited data transfer allows an SSND sub-layer to transmit SNS-User-Data contained in an SN-EXPEDITED DATA request primitive to a peer SSND sub-layer bypassing any flow control that may have been applied by network layer entities.

Expedited data is forwarded transparently and in the same order between users of the Sub-Network Connection via the satellite sub-network.

Only one INTERRUPT SNPDU at a time, with a maximum user data length of 32 octets, is permitted in each direction of a virtual connection over the satellite link.

#### Reset Procedure

The reset procedure applies to each logical channel and can apply only in the Data transfer phase.

The reset procedure is used to resynchronise an SNC and/or to report the detection of

unrecoverable loss of data.

During a reset procedure, the following actions relative to the logical channel are taken:

- 1: The DATA SNPDUs in the data buffer are flushed and tN2 (see Table 2) is stopped;
- 2: The DATA SNPDUs which have not been passed to the link layer are flushed from the queue of DATA SNPDUs awaiting transmission;
- 3: The SNPDUs that have been received prior to receiving/transmitting a RESET SNPDU but which do not constitute an entire sequence are flushed from the reassembly area, any outstanding association (if any) for delivery confirmation is cleared, and both tN5 and tN8 are stopped;
- 4: The expected (DATA) SNPDU number is reset to 0 and subsequently transmitted DATA SNPDUs are numbered starting from 0; and
- 5: Any outstanding INTERRUPT SNPDU to or from the remote SSND remains unconfirmed, tN4 is stopped.

When the reset procedure has been initiated by the SNS-user (SN-RESET request), the SSND sub-layer indicates when it is ready to receive subsequent data by sending an SN-RESET confirm primitive to the SNS-user. This may or may not be related to the completion of the reset procedure. Any data or expedited data received from the SNS-user following the SN-RESET confirm primitive is transmitted when the reset procedure is complete.

When the SSND sub-layer has sent an SN-RESET indication primitive to the SNS-user, the user replies with an SN-RESET response primitive when it is ready to receive and transmit further data. Any data or expedited data received by the SSND sub-layer following the SN-RESET response primitive is transmitted when the reset procedure has completed.

#### Error Procedure

Errors which can be detected by the Satellite SubNetwork Layer, may be the result of the following events:

- Log on renewal/Log-off;
- link congestion;
- transmission error; or
- peer SSND sub-layer protocol error.

Error handling depends on the current logical channel states. When an error is

detected, the SSND sub-layer can either reset or clear the relevant connection.

Errors are notified to the SNS user by means of originator and reason parameters within the relevant primitive. They are notified to the remote SSND by using the corresponding fields of the SNPDU, i.e. reset or clearing cause and diagnostic code. There is a one-to-one mapping between originator and reset/clearing cause, and between reason and diagnostic code.

The following procedure shall be used by the SSND sub-layer when generating cause codes:

- all protocol errors detected by the SSND sub-layer shall result in a clear or a reset with a cause code of SSND local link error;
- a cause code of network congestion will be used if a connection is cleared due to lack of resources, if a reset is generated by the SSND due to flow-control problems, or if a connection is reset or cleared due to a transmission error (time out or Fail LIDU reception);
- a cause code of invalid facility request is used if a requested SSND facility is not provided by the SSND implementation in the connection establishment phase; and
- no other cause codes are generated by the SSND.

Table 3.1 gives the coding of the cause field which may be generated by the SSND and passed to the remote SSND sub-layer.

Table 3.2 gives the coding of the corresponding Diagnostic Code field.

### Error Handling

#### Log-On Renewal/AES Log-Off

The AES management function provides the SSND sub-layer entity with AES log-on information by mean of AES management interface data units, Figures D1b and 33C refer.

When the AES renews its log-on to the same GES, the SSND sub-layer places each logical channel from 'data transfer - flow control ready' state to 'data transfer - flow control not ready' state. The SSND should not pass an SNPDU (original or retransmission) to its interfacing link layer until the SSND has received information regarding the completion of AES log-on to the GES. After the SSND has received information regarding the completion of AES log-on to the GES, it transmits a FLOW CONTROL (suspend) SNPDU, followed by a FLOW CONTROL (resume) SNPDU. For logical channels in states other than data transfer, the SSND sub-layer considers each outstanding status LIDU from its interfacing link layer as a failure LIDU and then acts according to Table 2.2. For logical channels in data transfer state, the SSND sub-layer considers each outstanding LIDU, except those associated

with a DATA or a FLOW CONTROL (SUSPEND) SNPDU, as a failure LIDU and then acts according to Table 2.2. However, the SNPDU to be transmitted or retransmitted as a result of action in Table 2.2 is not forwarded to the link layer until the SSND sub-layer receives information regarding AES log-on from the sub-network management function.

When the AES changes over logged-on GES, the aircraft SSND sub-layer releases each Sub-Network Connection with the old GES, by sending an SN-DISCONNECT indication on each of them and releases all the resources associated with these SNCs. It is the responsibility of the HLE(s) to set up any connections again.

When the AES logs off the aircraft SSND sub-layer clears all connections with the HLE(s) and releases all resources allocated to all SNCs.

When the GES is notified that the AES is no longer logged on to it, the GES SSND sub-layer releases all the Sub-Network Connections associated with the AES by sending an SN-DISCONNECT indication for each to the HLE(s) which had connections with that AES. It is the responsibility of the HLE(s) to set up any connections again.

The logical channels released by these procedures are returned to the Ready state.

#### Transmission error

A transmission error at the SubNetwork layer, occurs when an SNPDU is delayed or lost.

Loss of SNPDU's may occur when the maximum number of retransmission attempts by the link layer is exceeded. The originating SSND is then informed of the error (fail LIDU).

DATA SNPDU's may be received out of sequence by the ground SSND, due to differences in the time taken in transmission. This will be detected by means of the SNPDU number.

#### Protocol Error

Two types of protocol error may occur at the SSND. These are:

1. Syntactical error which occurs when a received SNPDU does not conform to the format specifications over the Satellite SubNetwork.
2. Logical error which occurs when the AES or Ground SSND receives from the peer entity an SNPDU that is not an acceptable input to the current state of the logical channel.

Tables 4.1 to 4.4 summarize the actions the SSND follows upon detection of a syntactical or logical error.

#### SNPDU/Primitive construction rules

##### SNPDU general construction rules

The maximum SNPDU length is that which can fit into the data field of one ISU, followed by 63 SSUs, i.e. 506 bytes.

When a SubNetwork Connection set-up is requested, the satellite Sub-Network layer will process the parameter field of the SN-CONNECT primitives to either provide the required SubNetwork QOSs which are imposed by the SNS user (such as Q priority), or to contribute to the establishment of an agreement between the two SNS users and itself for the optional QOS associated with the SubNetwork Connection.

- While processing the QOS parameters field, the satellite Sub-Network layer will delete both the ones which correspond to default values and the Q priority requirement. It will memorise the latter for inclusion in LIDUs over a same connection.
- Field activation flags are used to determine whether an optional field is present or not, in given SNPDU.

#### DTE Addresses

##### DTE Address Format and Characteristics

Appendix 7 of the Inmarsat aeronautical System Definition Manual- Module 1, defines the DTE addressing plan.

The 'DTE addresses length' field consists of field-length indicators for the calling-and called-DTE address. Bits 8,7,6 and 5 indicate the length of the calling-DTE address in semi-octets. Bits 4,3,2 and 1 indicate the length of the called-DTE address in semi-octets. Each address-length indicator is binary-coded, where bit 5 or 1 is the low-order bit of the indicator. The maximum length of a complete DTE address is 15 semi-octets.

Each digit of a DTE address is coded in a semi-octet in binary-coded decimal, where bit 5 or 1 is the low-order bit of the digit. Starting from the high-order digit, the address is coded in successive octets, with two digits per octet. In each octets, the higher-order digit is coded in bits 8, 7, 6 and 5.

The combined length of the Called and Calling DTE address fields in the SNPDU must consist of an integer number of octets. Therefore if, after compression, the Called or Calling DTE address, but not both, consists of an odd number of semi-octets the four least significant bits of the last octet (bits 1 to 4) of the Calling DTE address are zero-filled in order to maintain octet alignment.

##### DTE Address Processing

The SSND sub-layer transfers the DTE addresses between the primitive and the corresponding SNPDU. Routing performed within the aeronautical subnetwork is based, exclusively, on the analysis of the DTE addresses.

The DTE address and DTE addresses length fields are always present in the CONNECTION REQUEST SNPDU, but never transmitted in the CONNECTION CONFIRM/CONNECTION RELEASED SNPDU across the satellite link. DTE addresses are regenerated as required, by the receiving SSND sub-layer entity.

#### DTE Address Compression and Expansion

The SSND functions process the calling/called DTE address prefix field, which indicates the format of the DTE address. Fields within the DTE address, which are also contained in the signal unit (LPDU) header are not transmitted, in order to conserve transmission capacity.

The only type of address which undergoes compression/expansion is the AES DTE address. All other types of address are directly mapped between the SN-primitive and the SNPDU. Address compression/expansion function, when appropriate, is always performed before mapping the DTE address fields between SN-primitives and corresponding SPPDUs.

The only portion of the AES DTE address that is transmitted within the SPPDUs is the D digit, when present. Therefore, the length of the compressed AES DTE address is either 0 or 1 semi-octet.

The originating SSND sub-layer entity obtains the link layer AES ID by either calculating the binary equivalent of the Inmarsat Mobile Number, or by implicit knowledge of the AES ID. The receiving SSND sub-layer entity reconstructs the complete DTE address, using the AES ID of the associated Link Interface Control Information.

#### NSAP Addresses

##### NSAP Address Format and Characteristics

Within the SNPDU, the NSAP address consists of:

- a) An address coding/length octet:
  - bits 6 to 1 indicate the number of semi-octets (up to a maximum of 40) of the remainder of the NSAP address field. This field is binary coded, bit 1 is the low-order bit.
  - bits 8 and 7 specify the coding rule in use, they are encoded as shown in figure 7/1,2.
- b) The fields of the NSAP address format. Each digit of an NSAP address is coded in a semi-octet in binary-coded decimal, where bit 5 or 1 is the low-order bit of the digit. Starting from the high-order digit of the address, the address is coded in successive octets, with two digits per octet. In each octets, the higher-order digit is coded in bits 8,7,6, and 5. This field in the SNPDU must consist of an integer number of octets. Therefore if the NSAP address consists of an odd number of semi-octets the four least significant bits of the last octet (bits 1 to 4) are zero-filled in order to maintain octet alignment.

#### NSAP Address Processing

The SSND sub-layer entity transparently transfers the Calling/Called NSAP addresses, if present, between the primitive and the corresponding SNPDU.

If the responding NSAP address (where explicitly supplied) in either the SN-CONNECT response primitive or the SN-DISCONNECT request primitive, is equal to the called NSAP address of the corresponding SN-CONNECT indication primitive, then it is not transmitted via the CONNECTION CONFIRM/CONNECTION RELEASED SNPDU across the satellite link.

#### SNS-User-Data

The SNS-User-Data is transferred unmodified to/from the primitive. The maximum user data length is equal to 503 octets, in a DATA SNPDU.

#### Receipt Confirmation Selection

If the SSND sub-layer entity does not support the receipt confirmation selection, i.e. use of the D-bit, then the SSND sets the D-bit of CONNECTION REQUEST or CONNECTION CONFIRM SNPDU to indicate that the D-bit procedure is not used, i.e. bit 7 of the first octet is set to zero. Otherwise,

- In a CONNECTION REQUEST SNPDU, the D-bit is set to 1 to indicate that the user may require end-to-end acknowledgment of some Data Primitives. In such SNPDU, the Delivery confirmation bit (D) is mapped to/from the receipt confirmation selection parameter of the SN-CONNECT primitive.
- In a DATA SNPDU, the D-bit of the last SNPDU of an M-Bit sequence (Section B.1.b refers) is mapped to/from the confirmation request parameter.

#### Priority

The Priority applies on a per SubNetwork Connection basis and is negotiated by both SNS users.

The range of specified values for the priority of data on a connection is 0 (lowest priority) to 14 (highest priority). The value 255 indicates "unspecified". All other values are reserved, whereas the Q precedence values for data communication within the satellite subnetwork are limited to 0-3, 5-8, 11, 14. Conversion between values for the priority of data on a connection and Q precedence values is defined in Table 17.

If the priority is not requested by the HLE, a default Q precedence value (Q=0) is used for sending all SNPDU's over the connection.

The priority field is not encoded within the facility field of an SNPDU.

The Q precedence value to be used for sending a CONNECTION REQUEST SNPDU is determined from the target (SN-CONNECT request primitive) value for the priority of data on a connection and is passed to the link layer within the corresponding LICI.

The Q precedence value to be used for sending a CONNECTION RELEASED SNPDU, before the connection has been successfully set up, is determined from either the target (SN-CONNECT request primitive) or the LICI accompanying the CONNECTION REQUEST SNPDU which is passed by the link layer. This value is also used to encode the available value for the priority of data on a connection within the SN-CONNECT indication primitive, unless its value is set to 0.

The Q precedence value to be used for sending a CONNECTION CONFIRM SNPDU is determined from the selected (SN-CONNECT response) value for the priority of data on a connection and is passed by the remote link layer to the originating SSND sub-layer entity within the LICI accompanying the CONNECTION CONFIRM SNPDU. This value is used to encode the selected value for the priority of data on a connection within the SN-CONNECT confirm primitive unless the value is zero and no priority had been

previously requested and is then used for sending all SNPDUs once a connection has been established. If an SNPDU is subsequently received with a priority in the accompanying LICI which is different to that agreed at connection set-up, the receiving SSND sub-layer entity shall release the connection with a cause code of Connection rejection - requested quality of service is not available (permanent condition).

If a requested priority value (target or selected) is invalid, i.e. the corresponding Q precedence level is not allowed for data communication, the SSND sub-layer entity rejects the call set-up. The diagnostic code/reason parameter in the CONNECTION RELEASED SNPDU (if sent)/SN-DISCONNECT indication primitive is set to "connection rejection-requested quality of service (QOS) not available/permanent condition".

#### Throughput Class Negotiation

The throughput negotiation applies on a per SubNetwork Connection basis, independently in each direction, and is negotiated by both SNS users and the SNS provider.

#### Throughput

The throughput subparameter is defined as one of the values (unspecified, 75, 150, 300, 600, 1200, 2400, 4800, 9600, 19200, 48000 and 64000 bps). The satellite subnetwork supports a subset consisting of all values up to a maximum determined by the bit rate of the data channels.

The network call setup primitives use the following subparameters for each direction of data transfer. In the SN-CONNECT request there are the TARGET and LQA (Lowest Quality Acceptable) values. In the SN-CONNECT indication there are the AVAILABLE and LQA values. The SN-CONNECT response and confirm provide for the SELECTED value.

The CONNECTION REQUEST SNPDU provides a throughput class negotiation (TCN) and minimum throughput class negotiation (MTCN) facility field for each direction of transfer. The CONNECTION CONFIRM SNPDU provides a TCN facility field for each direction of data transfer. Figures 6/3 and 4 indicate the format of these facility fields.

The GES, in determining whether there is sufficient capacity for a connection, takes account of the throughput requirements already accepted (as indicated in the SELECTED values of connections in progress). Consideration is given both to current calls to each aircraft and to sets of aircraft sharing channels/groups of channels, when determining whether there is enough capacity remaining to provide the requested minimum throughput.

The settings described below are applied to the throughput values in each direction of transfer.

#### AES Actions

##### (a) Calls Originated at the AES

For a call originated at the AES, the TARGET and LQA throughput values in the SN-CONNECT request primitive are mapped transparently to the TCN and MTCN values in the CONNECTION REQUEST SNPDU. If the TARGET or LQA throughput values are not present in the primitive, then the facility fields are not included in the SNPDU.



The throughput value returned in the TCN value in the CONNECTION CONFIRM SNPDU is mapped transparently to the SELECTED throughput value in the SN-CONNECT confirm primitive.

(b) Calls originated on the Ground

For calls originated on the ground, the TCN and MTCN values in the CONNECTION REQUEST SNPDU are mapped transparently by the AES into the AVAILABLE and LQA throughput values in the SN-CONNECT indication primitive. The SELECTED throughput value returned in the SN-CONNECT response primitive is mapped transparently to the TCN value in the CONNECTION CONFIRM SNPDU.

GES Actions

(a) Calls originated at the AES

For calls originated at the AES, the GES calculates the available throughput capacity remaining to and from the aircraft and sets the AVAILABLE and LQA throughput values in the SN-CONNECT indication primitive as follows:

If the TCN value in the CONNECTION REQUEST SNPDU is less than the calculated available throughput value, the AVAILABLE value in the primitive is set equal to the TCN value; otherwise the AVAILABLE value in the primitive is set equal to the calculated value.

If the MTCN value is greater than either a preset value or is greater than the calculated available throughput value then the connection request is rejected; otherwise the LQA value in the primitive is set equal to the MTCN value.

The selected throughput value in the SN-CONNECT response primitive is transferred to the TCN value in the CONNECTION CONFIRM SNPDU.

(b) Calls Originated on the Ground

For calls originated on the ground, the GES calculates the available throughput capacity and sets the TCN and MTCN values in the CONNECTION REQUEST SNPDU as follows:

If the TARGET value in the primitive is less than the calculated available value, then the TARGET value is transferred to the TCN value in the CONNECTION REQUEST SNPDU; otherwise the calculated value is transferred to the TCN value.

If the LQA throughput value in the primitive is greater than a preset throughput value or is greater than the calculated available value, then the connection attempt is rejected; otherwise the LQA throughput value is transferred to the MTCN value in the CONNECTION REQUEST SNPDU.

The SELECTED throughput value in the SN-CONNECT confirm primitive is transferred from the TCN value in the CONNECTION CONFIRM SNPDU.

### Transit Delay

The transit delay negotiation applies to both directions of transfer.

The Transit Delay Selection and Indication (TDSAI) and End to End Transit Delay negotiation facilities are mapped to/from the Transit Delay QOS parameter of SN-CONNECT primitives. Each subparameter value can range from 1 up to 65,534 milliseconds in 1 millisecond steps or can have the value 'unspecified'.

For air originated connection set-up, the Sub-Network TARGET transit delay subparameter is transferred transparently to the GES by means of the TDSAI facility. At the GES, a default value corresponding to a mean value for the transit delay of a DATA SNPDU of 131 octets across the satellite subnetwork is transferred to the HLE as the Sub-Network AVAILABLE subparameter in the SN-CONNECT indication primitive. That value is also transferred back to the AES by means of the TDSAI facility of the CONNECTION CONFIRM SNPDU and delivered to the originating HLE in the SN-CONNECT confirm primitive.

For ground originated connection set-up, a default value corresponding to a mean value for the transit delay of a DATA SNPDU of 131 octets across the satellite subnetwork is transferred to the AES by means of the TDSAI facility which is then transparently forwarded to the HLE as the Sub-Network AVAILABLE sub-parameter in the SN-CONNECT indication primitive. That value is not transferred back in the CONNECTION CONFIRM SNPDU, but the GES passed it back to the originating HLE in the SN-CONNECT confirm primitive.

End-to-End Transit Delay QOS parameter of SN-CONNECT primitives are transferred transparently across the satellite subnetwork in the End-to-End Transit Delay Negotiation facility.

### Expedited Data Negotiation

The Expedited Data Negotiation facility is mapped to/from the Expedited Data Selection parameter of SN-CONNECT primitives. The satellite Sub-Network layer supports this service, and does not transfer the parameter unless the value of this parameter is set to "no use of expedited data" (Figure 6/5 refers).

The remote SSND will regenerate the parameter with the default condition, i.e. "use of expedited data", if the Expedited Data Negotiation facility field is not present in the CONNECTION REQUEST or CONNECTION CONFIRM SNPDU. Otherwise the Expedited Data Selection parameter of the SN-CONNECT primitives is mapped directly from the Expedited Data Negotiation facility of the corresponding SNPDU.

### Fast Select Control

The Fast Select Control parameter of the SN-CONNECT primitive is used to impose controls on the transfer of user data during connection establishment and release and on whether or not the connection may enter the data-transfer state. It should be noted

that this parameter is only provided in order to allow interworking with X.25 networks and is not a standard parameter in the OSI Network Service interface. It is only present when requested by an SNS-user interworking with such a network and requiring these specific services for a particular connection.

This parameter may have two possible values:

- fast select with restriction on response; or
- no fast select.

In the absence of the Fast Select Control parameter (the default case) the CONNECTION REQUEST, CONNECTION CONFIRM and CONNECTION RELEASED SNPDUs associated with this connection may contain a maximum of 128 octets of user-data and there is no restriction on the connection entering a data-transfer phase.

A parameter value of "fast select with restriction on response" indicates that the only response allowed to the CONNECTION REQUEST SNPDU is a CONNECTION RELEASED SNPDU (i.e. no data transfer phase) and that both these SNPDUs may contain a maximum of 128 octets of user-data. A parameter value of "no fast select" indicates that the CONNECTION REQUEST SNPDU may contain a maximum of 16 octets of data, that the CONNECTION CONFIRM and CONNECTION RELEASED SNPDUs must not contain user-data and that there is no restriction on the connection entering a normal data-transfer phase.

This parameter does not map directly onto a parameter field in the CONNECTION REQUEST SNPDU. Both bit 6 of the SNPDU type field and the fast select facility field are used to convey the information associated with this parameter. If the parameter is absent, bit 6 of the SNPDU field is set to zero and the fast select facility field is not encoded in the SNPDU. If the parameter is present and has a value of "fast select with restriction on response", bit 6 is set to one and the fast select facility field is not encoded. If the parameter is present with a value of "no fast select", bit 6 is set to zero and the fast select facility field is encoded with a parameter value of 0 (use not permitted).

The receiving SSND sub-layer will regenerate the Fast Select Control parameter in the SN-CONNECT indication primitive according to these rules.

#### Data Qualifier

This parameter is used in an SN-DATA request primitive to indicate that the associated data is qualified in some way, e.g. control data rather than user data. If present, bit 3 in the SNPDU type field is set to one in the associated SNPDU DATA sequence. This bit position is referred to as the Qualifier or 'Q' bit. The receiving SSND regenerates this parameter in the SN-DATA indication primitive if the Q-bit is

set to one in the received SNPDU data sequence. If the Q-bit is cleared, no parameter is present.

If an invalid DATA packet sequence is received, i.e. with different Q-bit values, the receiving SSND sub-layer should reset the connection with a diagnostic value of inconsistent Q-bit settings.

It should be noted that this parameter is only provided in order to allow interworking with X.25 networks and is not a standard parameter in the OSI Network Service interface. It is only present when requested by an SNS user interworking with such a network and requiring this specific service for a particular SN-DATA request. The support of this parameter is optional.

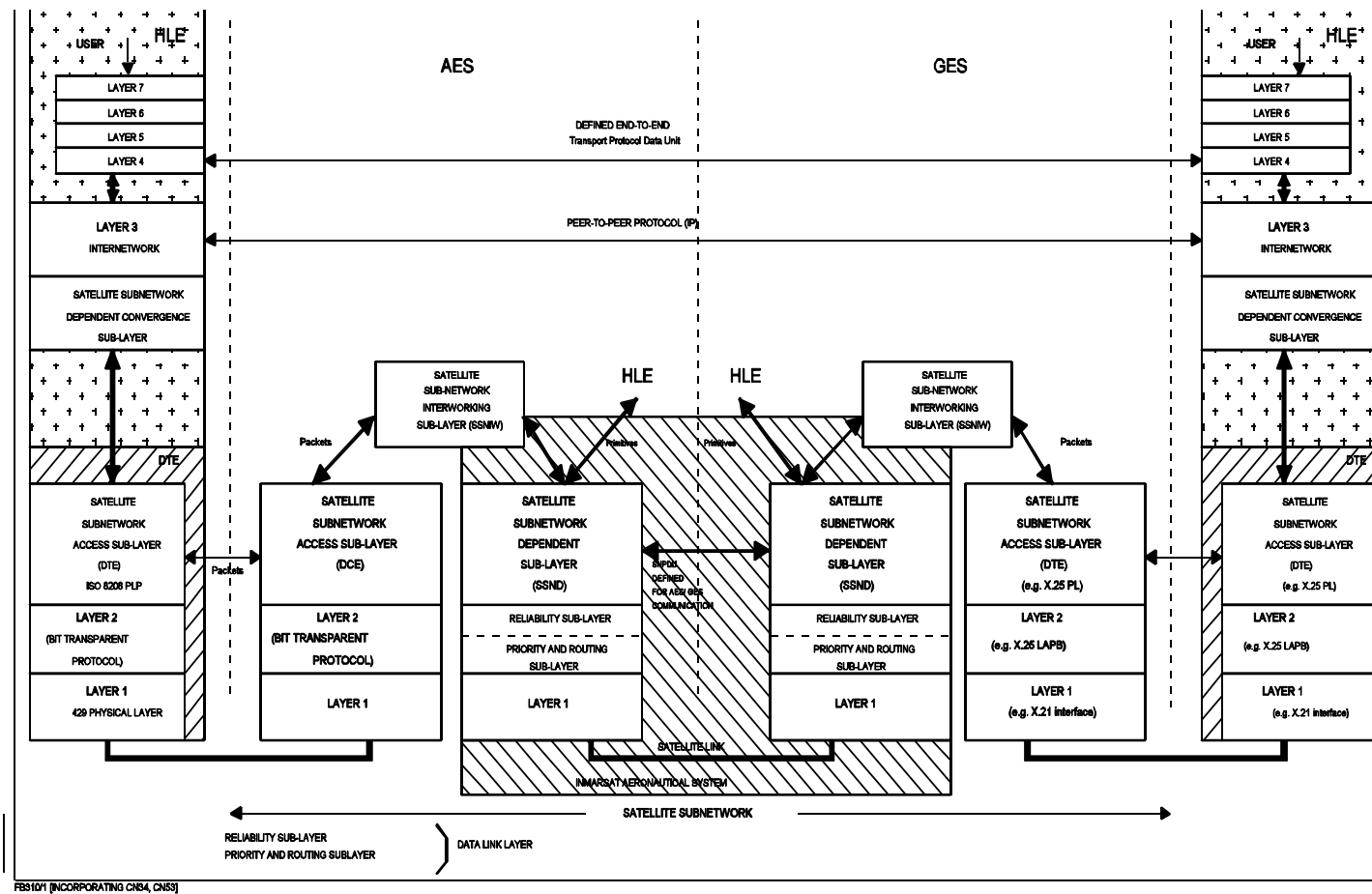


Figure 1 Aviation Reference Model

