Network Working Group
Request for Comments: 171
NIC 6793
Categories: D.4, D.5, and D.7
Updates: 114
Obsolete: None

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23 June 1971

THE DATA TRANSFER PROTOCOL

I. INTRODUCTION

A common protocol is desirable for data transfer in such diverse applications as remote job entry, file transfer, network mail system, graphics, remote program execution, and communication with block data terminals (such as printers, card, paper tape, and magnetic tape equipment, especially in context of terminal IMPs). Although it would be possible to include some or even all of the above applications in an all-inclusive file transfer protocol, a separation between data transfer and application functions would provide flexibility in implementation, and reduce complexity. Separating the data transfer function would also reduce proliferation of programs and protocols.

We have therefore defined a low-level data transfer protocol (DTP) to be used for transfer of data in file transfer, remote job entry, and other applications protocols. This paper concerns itself solely with the data transfer protocol. A companion paper (RFC 172) describes file transfer protocol.

II. DISCUSSION

The data transfer protocol (DTP) serves three basic functions. It provides for convenient separation of NCP messages into "logical" blocks (transactions, units, records, groups, and files), it allows for the separation of data and control information, and it includes some error control mechanisms.

Three modes of separating messages into transactions [1] are allowed by DTP. The first is an indefinite bit stream which terminates only when the connection is closed (i.e., the bit stream represents a single transaction for duration of connection). This mode would be useful in data transfer between hosts and terminal IMPs (TIPs).

The second mode utilizes a "transparent" block convention, similar to the ASCII DLE (Data Link Escape). In "transparent" mode, transactions (which may be arbitrarily long) end whenever the character sequence DLE ETX is encountered (DLE and ETX are 8-bit character codes). To prevent the possibility of a DLE ETX sequence occurring within data stream, any occurrence of DLE is replaced by DLE DLE on transmission. The extra DLE is stripped on reception. A departure from the ASCII convention is that "transparent" block does not begin with DLE STX, but with a transaction type byte. This mode will be useful in data transfer between terminal IMPs.

The third mode utilizes a count mechanism. Each transaction begins with a fixed-length descriptor field containing separate binary counts of information bits and filler bits. If a transaction has no filler bits, its filler count is zero. This mode will be useful in most host-to-host data transfer applications.

DTP allows for the above modes to be intermixed over the same connection (i.e., mode is not associated with connection, but only with transaction). The above transfer modes can represent transfer of either data or control information. The protocol allows for separating data or control information at a lower level, by providing different "type" codes (see SPECIFICATIONS) for data and control transactions. This provision may simplify some implementations.

The implementation of a workable [2] subset of the above modes is specifically permitted by DTP. To provide compatibility between hosts using different subsets of transfer modes, an initial "handshake" procedure is required by DTP. The handshake involves exchanging information on modes available for transmit and receive. This will enable host programs to agree on transfer modes acceptable for a connection.

The manner in which DTP is used would depend largely on the applications protocol. It is the applications protocol which defines the workable subset of transfer modes. For example, the file transfer protocol will not work just with the indefinite bit stream modes. At least, for control information one of the other two modes is required. Again, the use of information separator and abort functions provided in DTP (see SPECIFICATIONS) is defined by the applications protocol. For example, in a remote job entry protocol, aborts may be used to stop the execution of a job while they may not

cause any action in another applications protocol.

It should also be noted that DTP does not define a data transfer service. There is no standard server socket, or initial connection protocol defined for DTP. What DTP defines is a mechanism for data transfer which can be used to provide services for block data transfers, file transfers, remote job entry, network mail and numerous other applications.

There are to be no restrictions on the manner in which DTP is implemented at various sites. For example, DTP may be imbedded in an applications program such as for file transfer, or it may be a separate service program or subroutine used by several applications programs. Another implementation may employ macros or UUO's (user unimplemented operations on PDP-10's), to achieve the functions specified in DTP. It is also possible that in implementation, the separation between the DTP and applications protocols be only at a conceptual level.

III. SPECIFICATIONS

1. Byte Size for Network Connection

The standard byte size for network connections using DTP is 8-bit. However, other byte sizes specified by higher-level applications protocols or applications programs are also allowed by DTP. For the purpose of this document bytes are assumed to be 8-bits, unless otherwise stated.

2. Transactions

At DTP level, all information transmitted over connection is a sequence of transactions. DTP defines the rules for delimiting transactions. [3]

2A. Types

The first byte of each transaction shall define a transaction type, as shown below. (Note that code assignments do not conflict with assignments in TELNET protocol.) The transaction types may be referred by the hexadecimal code assigned to them. The transactions types are discussed in more detail in section 2B.

Code		Transaction Type
Hex	Octal	
B0	260	Indefinite bit stream -- data.
B1	261	Transparent (DLE) block--data.
B2	262	Descriptor and counts--data.
B3	263	Modes available (handshake).
B4	264	Information separators (endcode).
B5	265	Error codes.
B6	266	Abort.
B7	267	No operation (NoOp).
B8	270	Indefinite bit stream--control.
B9	271	Transparent (DLE) block--control.
BA	272	Descriptor and counts--control.
BB	273	(unassigned but reserved for data transfer)
BC	274	" " "
BD	275	" " "
BE	276	" " "
BF	277	" " "

2B. Syntax and Semantics

2B.1 Type B0 and B8 (indefinite bitstream modes) transactions terminate only when the NCP connection is "closed". There is no other escape convention defined in DTP at this level. It should be noted, that closing connection in bitstream mode represents an implicit file separator (see section 2B.5).

2B.2 Type B1 and B0 (transparent block modes) transactions terminate when the byte sequence DLE ETX is encountered. The sender shall replace any occurrence of DLE in data stream by the sequence DLE DLE. The receiver shall strip the extra DLE. The transaction is assumed to by byte-oriented. The code for DLE is Hex ’90’ or Octal ’220’ (this is different from the ASCII DLE which is Hex ’10’ or Octal ’020). ETX is Hex ’03’ or Octal ’03’ (the same as ASCII ETX) [4].

2B.3 Type B2 and BA (descriptor and counts modes) transactions have three fields, a 9-byte (72-bits) descriptor field [5] and variable length (including zero) info and filler fields, as shown below. The total length of a transaction is (72+info+filler) bits.

```
|<B2 or BA><Info count><NUL><Seq #><NUL><filler count>|<info><filler> |

|  3-bits    24-bits 8-bits 16-bits 8-bits  8-bits    |Variable length|

|<----- 72-bit descriptor field ---------------------->|info and filler|
```

Info count is a binary count of number of bits in info field, not including descriptor or filler bits. Number of info bits is limited to (2**24 - 1), as there are 24 bits in info count field.

Sequence # is a sequential count in round-robin manner of B2 and BA type transaction. The inclusion of sequence numbers would help in debugging and error control, as sequence numbers may be used to check for missing transactions, and aid in locating errors. Hosts not wishing to implement this mechanism should have all 1's in the field. The count shall start from zero and continue sequentially to all 1's, after which it is reset to all zeros. The permitted sequence numbers are one greater than the previous, and all 1's.

Filler count is a binary count of bits used as fillers (i.e., not information) after the end of meaningful data. Number of filler bits is limited to 255, as there are 8 bits in filler count field.

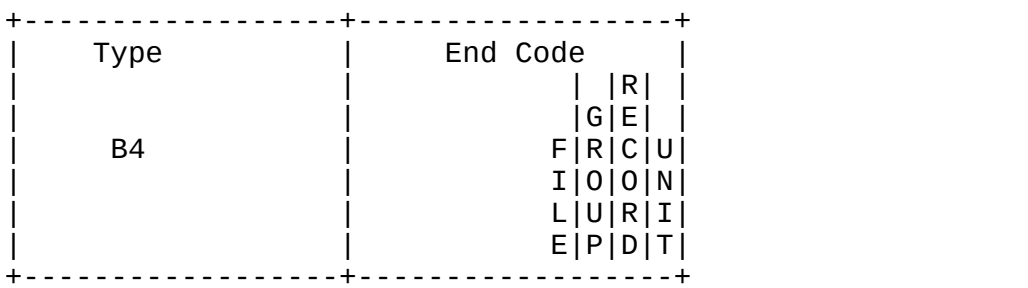
The NUL bytes contain all 0's.

2B.4 Type B3 (modes available) transactions have a fixed length of 3 bytes, as shown below. First byte defines transaction type as B3, second byte defines modes available for send, and third byte defines modes available for receive.

Type	I send								I receive							
B3	0	0	BA	B2	B9	B1	B8	B0	0	0	BA	B2	B9	B1	B8	B0

The modes are indicated by bit-coding, as shown above. The particular bit or bits, if set to logical "1", indicate that mode to be available. The 2 most significant bits should be set to logical "0". The use of type B3 transactions is discussed in section 3B.

2B.5 Type B4 (information separator) transactions have fixed length of 2 bytes, as shown below. First byte defines transaction type as B4, and second byte defines the separator.

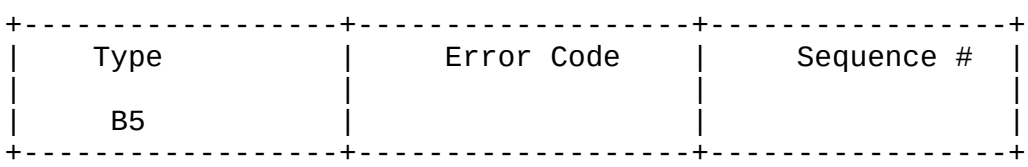


The following separator codes are assigned:

Code		Meaning
Hex	Octal	
01	001	Unit separator
03	003	Record separator
07	007	Group separator
0F	017	File separator

Files, groups, records, and units may be data blocks that a user defines to be so. The only restriction is that of the hierarchical relationship File>Groups>Records>Units (where '>' means 'contains'). Thus a file separator marks not only the end of file, but also the end of group, record, and unit. These separators may provide a convenient "logical" separation of data at the data transfer level. Their use is governed by the applications protocol.

2B.6 Type B5 (error codes) transactions have a fixed length of 3 bytes, as shown below. First byte defines transaction type as B5, second byte indicates an error code, and third byte may indicate the sequence number on which error occurred.



The following error codes are assigned:

Error Code Hex	Error Code Octal	Meaning
00	000	Undefined error
01	001	Out of sync. (type code other than B0 through BF).
02	002	Broken sequence (the sequence # field contains the first expected but not received sequence number).
03	003	Illegal DLE sequence (other than DLE DLE or DLE ETX).
B0 through BF	260 through 277	The transaction type (indicated by by error code) is not implemented.

The error code transaction is defined only for the purpose of error control. DTP does not require the receiver of an error code to take any recovery action. The receiver may discard the error code transaction. In addition, DTP does not require that sequence numbers be remembered or transmitted.

2B.7 Type B6 (abort) transactions have a fixed length of 2 bytes, as shown below. First byte defines transaction type as B6, and second byte defines the abort function.

Type	Function							
					R			
				G	E			
		F	R	C	U			
		I	O	O	N			
		L	U	R	I			
		E	P	D	T			

The following abort codes are assigned:

Abort Code Hex	Abort Code Octal	Meaning
00	000	Abort preceding transaction
01	001	Abort preceding unit
02	002	Abort preceding record
07	007	Abort preceding group
0F	017	Abort preceding file

DTP does not require the receiver of an abort to take specific action, therefore sender should not necessarily make any assumptions. The manner in which abort is handled is to be specified by higher-level applications protocols.

2B.8 Type B7 (NoOp) transactions are one byte long, and indicate no operation. These may be useful as fillers when byte size used for network connections is other than 8-bits.

3. Initial Connection, Handshake and Error Recovery

3A. DTP does not specify the mechanism used in establishing connections. It is up to the applications protocol (e.g., file transfer protocol) to choose the mechanism which suits its requirements. [6]

3B. The first transaction after connection is made will be type B3 (modes available). In a full-duplex connection, both server and user will communicate type B3 transactions, indicating modes available for send and receive. In a simplex connection only sender will communicate a type B3 transaction. It is the sender's responsibility to choose a mode acceptable to the receiver. If an acceptable mode is not available or if mode chosen is not acceptable, the connection may be closed. [7]

3C. No error recovery mechanisms are specified by DTP. The applications protocol may implement error recovery and further error control mechanisms.

END NOTES

[1] The term transaction is used here to mean a block of data defined by the transfer mode.

[2] What constitutes a workable subset is entirely governed by the high-level application protocol.

[3] Transactions suppress the notion of host-IMP messages, and may have a logical interpretation similar to that of flags (and data) defined by Mealy in RFC 91.

[4] This assignment is made to be consistent with the TELNET philosophy of maintaining the integrity of the 128 Network ASCII characters.

[5] A 72-b9t descriptor field provides a convenient separation of information bits, as 72 is the least common multiple of 8 and 36, the commonly encountered byte sizes on ARPA network host computers.

[6] It is, however, recommended that the standard initial connection protocol be adopted where feasible.

[7] It is recommended that when more than one mode is available, the sender should choose 'descriptor and count' mode (Type B2 or BA). The 'bitstream' mode (type B0 or B8) should be chosen only when the other two modes cannot be used.

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