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THE DATA TRANSFER PROTOCOL

This paper is a revision of RFC 171, NIC 6793. The changes to RFC 171 are given below. The protocol is then restated for your convenience.

CHANGES TO RFC 171

1) The sequence number field is changed to 16 bits in the error (Type B5) transactions, thus resolving the ambiguity in the previous specification. In addition, the information separators (Type B4) transactions shall also contain a 16-bit sequence number field.

2) The modes available (Type B3) transactions shall define only the modes available for receive, instead of both receive and send. In simplex connections modes available transactions should not be sent as they are meaningless. In full-duplex connections, the modes available transactions are still required.

3) The code assignments for "End Code" in information separators and for "function" in abort transactions have been changed to reflect a numerical order rather than "bit-coding".

4) Minor editorial changes.

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 may provide flexibility in implementation, and reduce complexity. Separating the data transfer function from the specific applications functions may also reduce proliferation of programs and protocols.

We have therefore defined a data transfer protocol (DTP) which should be used for transfer of data in file transfer, remote job entry, and other applications protocols. This paper concerns itself only with the data transfer protocol. A companion paper (RFC 265) describes the 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.

Transfer Modes

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) convention. 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 would 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 (i.e., not information) bits. If a transaction has no filler bits, its filler count is zero. This mode would be useful in most host-to-host data transfer applications.

DTP allows for transfer modes to be intermixed over the same connection (i.e., the transfer mode is not associated with connection, but only with transaction). The transfer modes can represent transfer of either data or control information. The protocol allows for separating data and 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 subset of transfer modes is specifically permitted by DTP. To provide compatibility between hosts using different subsets of transfer modes, an initial "handshake" procedure may be used. The handshake involves exchanging information on modes available for receive. This will enable host programs to agree on transfer modes acceptable for a connection.

Using DTP

The manner in which DTP is used would depend largely on the applications protocol. It is the applications protocol which defines the use of transfer modes and the use of information separator and abort functions provided in DTP (see SPECIFICATIONS). 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 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 (unimplemented user 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 bits. However, other byte sizes specified by applications protocols 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 a connection is a sequence of transactions. DTP defines the rules for delimiting transactions.

2A. Types

The first 8-bit 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 will be referred to by the hexadecimal code assigned to them. (The transaction 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.
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 through BF	273 through 277	Unassigned but reserved for DTP.

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 the closing of a connection in bitstream mode is an implicit file separator (see Section 2B.5).

2B.2 Type B1 and B9 (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 be 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'). [2] ETX is Hex '03' or Octal '03' (the same as ASCII ETX).

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

```
|<B2 or BA>|<Info count>| <NUL> <Sequence #>| <NUL> |<filler count>|
|<-8-bit-> |<--24-bit-->|<8-bit><--16-bit-->|<8-bit>|<---8-bit---->|
|<--------------------72-bit descriptor field--------------------->|
```

Info count is a binary count of the number of bits in the info field, not including descriptor or filler bits. The 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, BA, and B4 type transactions. The inclusion of sequence numbers will 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, all 1's, and zero for the first transaction only.

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 must contain all 0's.

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

```
+-----------------+--------------------+
|Type             |      I receive     |
|        B3       |                    |
|                 |0|0|BA|B2|B9|B1|B8|B0|
+-----------------+--------------------+
```

The modes are indicated by bit-coding, as shown above. The particular bits, if set to logical "1", indicate that the corresponding modes are handled by the sender's receive side. The two most significant bits should be set to logical "0". Mode available transactions have no significance in a simplex connection. The use of type B3 transactions is discussed in section 3B.

2B.5 Type B4 (information separator) transactions have a fixed length of four bytes, as shown below. First byte defines the transaction type B4, second byte defines the separator, and third and fourth bytes contain a 16-bit sequence number.

```
+------------+------------+------------------------+
|Type        |  End Code  |      Sequence Number   |
|     B4     |            |            |           |
|            |            |            |           |
+------------+------------+------------+-----------+
```

The following separator codes are assigned:

Code Hex	Octal	Meaning
01	001	Unit separator
02	002	Record separator
03	003	Group separator
04	004	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 four bytes, as shown below. First byte defines the transaction type B5, second byte indicates an error code, and third and fourth bytes may indicate the sequence number of a transaction in which an error occurred.

```
+------------+------------+------------------------+
|Type        |  End Code  |      Sequence Number   |
|     B5     |            |            |           |
|            |            |            |           |
+------------+------------+------------+-----------+
```

The following error codes are assigned:

Error Code		Meaning
Hex	Octal	
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 DLF sequence (other than DLE DLE or DLE FTX).
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 two bytes, as shown below. First byte defines the transaction type B6, and second byte defines the abort function.

```
+------------+------------+
|Type        |  Function  |
|     B6     |            |
|            |            |
+------------+------------+
```

The following abort codes are assigned:

Abort Code		Meaning
Hex	Octal	
00	000	Abort preceding transaction
01	001	Abort preceding unit
02	002	Abort preceding record
03	003	Abort preceding group
04	004	Abort preceding file

DTP does not require the receiver of an abort to take specific action, therefore a sender should not make any assumptions thereof. 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 (8-bit) long, and indicate no operation. These may be useful as fillers when the 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. [3]

3B. The first transaction after a full-duplex connection is made will be type B3 (modes available) indicating the transfer modes available for receive. The modes available (Type B3) transaction is not applicable in simplex connections. It is the sender's responsibility to choose a mode acceptable to the receiver. [4] If an acceptable mode is not available or if mode chosen is not acceptable, the connection may be closed.

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

Endnotes

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

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

[3] It is, however, recommended that the standard Initial Connection Protocol as specified in RFC 165 or any subsequent standard document be adopted where feasible.

[4] It is suggested that when available, the sender should choose 'descriptor and count' mode (Type B2 or BA). The 'indefinite bitstream' mode (Type B0 or B8) should be chosen only when the other two modes are not available.