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PROTOCOL OPTIONS

Introduction

This memo collectes the definition of the various options used in the Internet protocols, in particular the options from Internet Protocol (IP) [1] and Transmission Control Protocol (TCP) [2].

Internet Protocol Options

The option field is variable in length. The format is an option-type octet, an option-length octet, and the actual option-data octets. There are two special case options which have only the option-type octet.

The option-length octet, which follows, includes the option-type octet and the option-length octet in the octet count of the option length.

The option-type octet can be viewed as having 3 fields:

    1 bit   reserved, must be zero
    2 bits   option class,
    5 bits   option number.

The option classes are:

    0 = control
    1 = internet error
    2 = experimental debugging and measurement
    3 = reserved for future use

The following internet options are defined:

| CLASS	NUMBER	LENGTH	DESCRIPTION
0	0	-	End of Option list. This option occupies only 1 octet; it has no length octet.
0	1	-	No Operation. This option occupies only 1 octet; it has no length octet.
0	2	4	S/P/T. Used to carry Security, Precedence, and user group (TCC) information compatible with AUTODIN II requirements.
0	3	var.	Source Routing. Used to route the internet packet based on information supplied by the source.
0	4	var.	BCR Open.
0	5	var.	BCR Close.
0	6	var.	BCR other.
0	7	var.	Return Route. Used to record the route taken by an internet packet.
0	8	2	Stream ID. Used to carry the stream identifier.
1	1	var.	General Error Report. Used to report errors in internet packet processing.
2	4	4	Internet Timestamp. Used to carry timestamping information.
2	5	4	Satellite Timestamp. Used as above for special satellite network testing.

Specific Option Definitions

End of Option List

```
+--------+
|00000000|
+--------+
  Type=0
```

This option indicates the end of the option list. This might not coincide with the end of the internet header according to the internet header length. This is used at the end of all options, not the end of each option, and need only be used if the end of the options would not otherwise coincide with the end of the internet header.
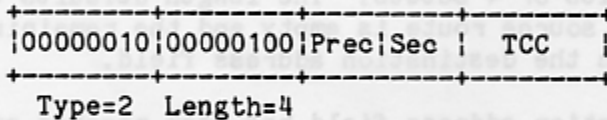
No Operation

```
+--------+
|00000001|
+--------+
   Type=1
```
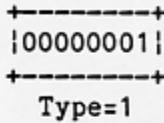
This option may be used between options, for example, to align the
beginning of a subsequent option on a 32 bit boundary.

S/P/T

This option provides a way for AUTODIN II hosts to send security,
precedence, and TCC (closed user groups) parameters through networks
whose transport leader does not contain fields for this information.
The format for this option is as follows:

```
+--------+--------+--------+--------+
|00000010|00000100|Prec|Sec |  TCC   |
+--------+--------+--------+--------+
   Type=2  Length=4
```

Precedence: 4 bits

   Specifies one of 16 levels of precedence
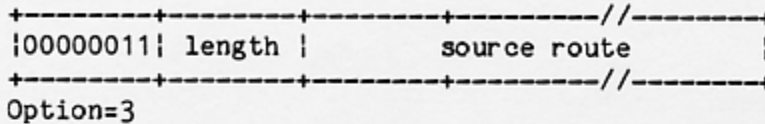
Security: 4 bits

   Specifies one of 16 levels of security

Transmission Control Code: 8 bits

   Provides a means to compartmentalize traffic and define controlled
   communities of interest among subscribers.

   This option might be used between hosts on the AUTODIN II network
   and other networks, such as the EDN at DCEC.

Source Route

```
+--------+--------+--------+--------//--------+
|00000011| length |      source route        |
+--------+--------+--------+--------//--------+
```
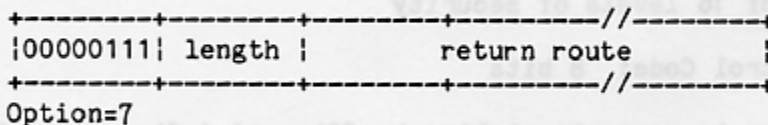Option=3

The source route option provides a means for the source of an internet datagram to supply routing information to be used by the gateways in forwarding the datagram to the destination.

The option begins with the option type code. The second octet is the option length which includes the option type code and the length octet, as well as length-2 octets of source route data.

A source route is composed of a series of internet addresses. Each internet address is 32 bits or 4 octets. The length defaults to two, which indicates the source route is empty and the remaining routing is to be based on the destination address field.

If the address in destination address field has been reached and this option's length is not two, the next address in the source route replaces the address in the destination address field, and is deleted from the source route and this option's length is reduced by four. (The Internet Header Length Field must be changed also.)

Return Route

```
+--------+--------+--------+--------//--------+
|00000111| length |      return route        |
+--------+--------+--------+--------//--------+
```
Option=7

The return route option provides a means to record the route of an internet datagram.

The option begins with the option type code. The second octet is the option length which includes the option type code and the length octet, as well as length-2 octets of return route data.

A return route is composed of a series of internet addresses. The length defaults to two, which indicates the return route is empty.

When an internet module routes a datagram it checks to see if the return route option is present. If it is, it inserts its own internet address as known in the environment into which this

datagram is being forwarded into the return route at the front of
the address string and increments the length by four.

BCR Options

BCR OPEN

```
+--------+--------+------
|00000100| length | data
+--------+--------+------
```

Type=4

BCR CLOSE

```
+--------+--------+------
|00000101| length | data
+--------+--------+------
```

Type=5

BCR OTHER

```
+--------+--------+------
|00000110| length | data
+--------+--------+------
```

Type=6

These options are used with the BCR.

Stream Identifier

```
+--------+--------+----------+--------+
|00001000|00000010|    Stream ID    |
+--------+--------+----------+--------+
```

Type=8 Length=2

This option provides a way for the 16-bit SATNET stream identifier
to be carried through networks that do not support the stream
concept.

General Error Report

```
+--------+--------+--------+--------+--------//--------+
|00100001| length |err code|   id   |                 |
+--------+--------+--------+--------+--------//--------+
```
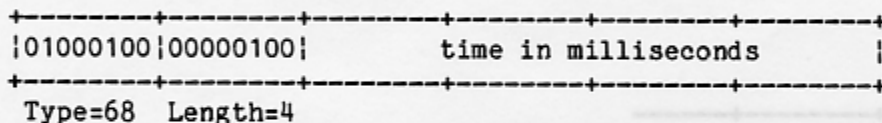
Type=33

The general error report is used to report an error detected in processing an internet packet to the originator of that packet. The "err code" indicates the type of error detected and the "id" is copied from the identification field of the packet in error, additional octets of error information may be present depending on the err code.

ERR CODE:

   0 - Undetermined Error, used when no information is available about the type of error or the error does not fit any defined class. Following the id should be as much of the datagram as fits in the option space.
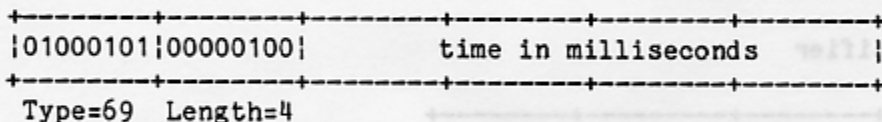
   No err codes have been defined for specific classes as yet.

Internet Timestamp

```
+--------+--------+--------+--------+--------+--------+
|01000100|00000100|         time in milliseconds      |
+--------+--------+--------+--------+--------+--------+
 Type=68  Length=4
```

The data of the timestamp is a 32 bit time measured in milliseconds.

Satellite Timestamp

```
+--------+--------+--------+--------+--------+--------+
|01000101|00000100|         time in milliseconds      |
+--------+--------+--------+--------+--------+--------+
 Type=69  Length=4
```

The data of the timestamp is a 32 bit time measured in milliseconds.

The options are just that, optional. That is, the presence or absence of an option is the choice of the sender, but each internet module must understand how to process every option.

Transmission Control Protocol Options

Options may occupy space at the end of the TCP header and are a multiple
of 8 bits in length. All options are included in the checksum. An
option may begin on any octet boundary. All options have the same basic
format:

  Option kind: 8 bits

  Option length: 8 bits

     Length in octets (including the two octets of length and kind
     information)

There are two special cases for options.

     The first is the End-of-Options option. Only one octet is
     associated with this option, the kind octet itself.

     The second is the No-Operation option and is also one octet long.

  Note that the list of options may be shorter than the data offset
  field might imply. The content of the header beyond the End-of-Option
  option should be header padding (i.e., zero).

Currently defined options include (kind indicated in octal):

Kind	Length	Meaning
0	-	End of option list.
1	-	No-Operation.
100	-	Reserved.
105	4	Buffer Size.

Specific Option Definitions

End of Option List

```
+--------+
|00000000|
+--------+
 Kind=0
```
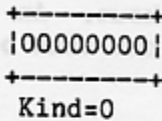
This option code indicates the end of the option list. This might
not coincide with the end of the TCP header according to the Data
Offset field. This is used at the end of all options, not the end
of each option, and need only be used if the end of the options
would not otherwise coincide with the end of the TCP header.

No-Operation

```
+--------+
|00000001|
+--------+
 Kind=1
```
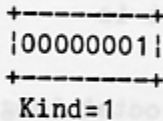
This option code may be used between options, for example, to align
the beginning of a subsequent option on a word boundary. There is
no guarantee that senders will use this option, so receivers must be
prepared to process options even if they do not begin on a word
boundary.

Buffer Size

```
+--------+--------+--------+--------+
|01000101|00000100|    buffer size |
+--------+--------+--------+--------+
 Kind=105 Length=4
```
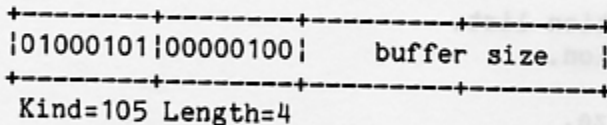
Buffer Size Option Data: 16 bits

If this option is present, then it communicates the receive buffer
size at the TCP which sends this segment. This field should only
be sent in segments with the SYN control bit set. If this option
is not used, the default buffer size of one octet is assumed.

References
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[1]   Postel, J., "Internetwork Protocol," IEN 111, USC/Information
        Sciences Institute, August 1979.

[2]   Postel, J., "Transmission Control Protocol," IEN 112,
        USC/Information Sciences Institute, August 1979.