

COMMERCIAL IP SECURITY OPTION (CIPSO 2.2)

[1.](#) Status

This Internet Draft provides the high level specification for a Commercial IP Security Option (CIPSO). This draft reflects the version as approved by the CIPSO IETF Working Group. Distribution of this memo is unlimited.

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[2.](#) Background

Currently the Internet Protocol includes two security options. One of these options is the DoD Basic Security Option (BSO) (Type 130) which allows IP datagrams to be labeled with security classifications. This option provides sixteen security classifications and a variable number of handling restrictions. To handle additional security information, such as security categories or compartments, another security option (Type 133) exists and is referred to as the DoD Extended Security Option (ESO). The values for the fixed fields within these two options are administered by the Defense Information Systems Agency (DISA).

Computer vendors are now building commercial operating systems with mandatory access controls and multi-level security. These systems are no longer built specifically for a particular group in the defense or intelligence communities. They are generally available commercial systems for use in a variety of government and civil sector environments.

The small number of ESO format codes can not support all the possible applications of a commercial security option. The BSO and ESO were

designed to only support the United States DoD. CIPSO has been designed to support multiple security policies. This Internet Draft provides the format and procedures required to support a Mandatory Access Control security policy. Support for additional security policies shall be defined in future RFCs.

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3. CIPSO Format

Option type: 134 (Class 0, Number 6, Copy on Fragmentation)
Option length: Variable

This option permits security related information to be passed between systems within a single Domain of Interpretation (DOI). A DOI is a collection of systems which agree on the meaning of particular values in the security option. An authority that has been assigned a DOI identifier will define a mapping between appropriate CIPSO field values and their human readable equivalent. This authority will distribute that mapping to hosts within the authority's domain. These mappings may be sensitive, therefore a DOI authority is not required to make these mappings available to anyone other than the systems that are included in the DOI.

This option MUST be copied on fragmentation. This option appears at most once in a datagram. All multi-octet fields in the option are defined to be transmitted in network byte order. The format of this option is as follows:

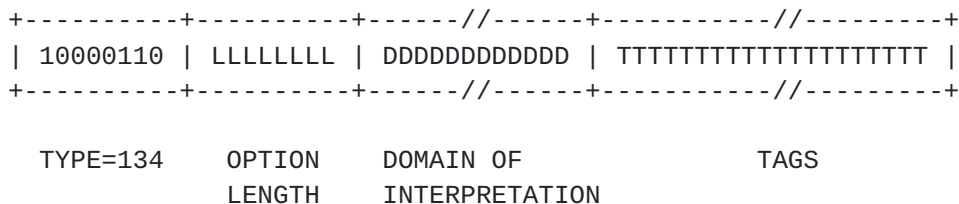


Figure 1. CIPSO Format

3.1 Type

This field is 1 octet in length. Its value is 134.

3.2 Length

This field is 1 octet in length. It is the total length of the option including the type and length fields. With the current IP header length restriction of 40 octets the value of this field MUST not exceed 40.

3.3 Domain of Interpretation Identifier

This field is an unsigned 32 bit integer. The value 0 is reserved and MUST not appear as the DOI identifier in any CIPSO option. Implementations

should assume that the DOI identifier field is not aligned on any particular byte boundary.

To conserve space in the protocol, security levels and categories are represented by numbers rather than their ASCII equivalent. This requires a mapping table within CIPSO hosts to map these numbers to their corresponding ASCII representations. Non-related groups of systems may

have their own unique mappings. For example, one group of systems may use the number 5 to represent Unclassified while another group may use the number 1 to represent that same security level. The DOI identifier is used to identify which mapping was used for the values within the option.

3.4 Tag Types

A common format for passing security related information is necessary for interoperability. CIPSO uses sets of "tags" to contain the security information relevant to the data in the IP packet. Each tag begins with a tag type identifier followed by the length of the tag and ends with the actual security information to be passed. All multi-octet fields in a tag are defined to be transmitted in network byte order. Like the DOI identifier field in the CIPSO header, implementations should assume that all tags, as well as fields within a tag, are not aligned on any particular octet boundary. The tag types defined in this document contain alignment bytes to assist alignment of some information, however alignment can not be guaranteed if CIPSO is not the first IP option.

CIPSO tag types 0 through 127 are reserved for defining standard tag formats. Their definitions will be published in RFCs. Tag types whose identifiers are greater than 127 are defined by the DOI authority and may only be meaningful in certain Domains of Interpretation. For these tag types, implementations will require the DOI identifier as well as the tag number to determine the security policy and the format associated with the tag. Use of tag types above 127 are restricted to closed networks where interoperability with other networks will not be an issue. Implementations that support a tag type greater than 127 MUST support at least one DOI that requires only tag types 1 to 127.

Tag type 0 is reserved. Tag types 1, 2, and 5 are defined in this Internet Draft. Types 3 and 4 are reserved for work in progress. The standard format for all current and future CIPSO tags is shown below:

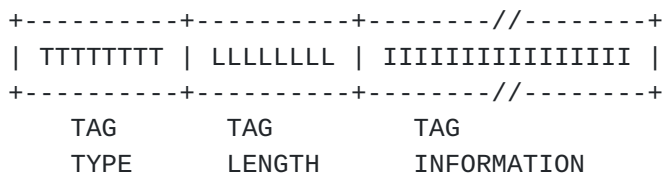


Figure 2: Standard Tag Format

In the three tag types described in this document, the length and count restrictions are based on the current IP limitation of 40 octets for all IP options. If the IP header is later expanded, then the length and count restrictions specified in this document may increase to use the full area provided for IP options.

3.4.1 Tag Type Classes

Tag classes consist of tag types that have common processing requirements and support the same security policy. The three tags defined in this Internet Draft belong to the Mandatory Access Control (MAC) Sensitivity

class and support the MAC Sensitivity security policy.

3.4.2 Tag Type 1

This is referred to as the "bit-mapped" tag type. Tag type 1 is included in the MAC Sensitivity tag type class. The format of this tag type is as follows:

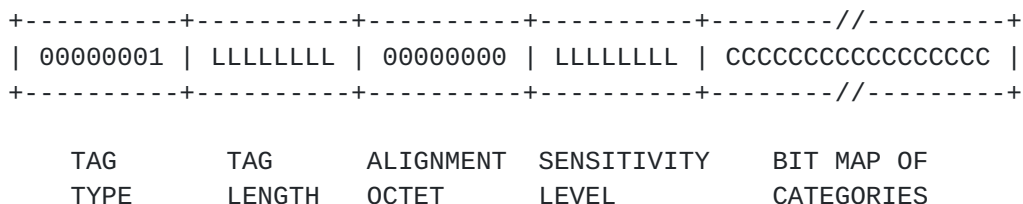


Figure 3. Tag Type 1 Format

3.4.2.1 Tag Type

This field is 1 octet in length and has a value of 1.

3.4.2.2 Tag Length

This field is 1 octet in length. It is the total length of the tag type including the type and length fields. With the current IP header length restriction of 40 bytes the value within this field is between 4 and 34.

3.4.2.3 Alignment Octet

This field is 1 octet in length and always has the value of 0. Its purpose is to align the category bitmap field on an even octet boundary. This will speed many implementations including router implementations.

3.4.2.4 Sensitivity Level

This field is 1 octet in length. Its value is from 0 to 255. The values are ordered with 0 being the minimum value and 255 representing the maximum value.

3.4.2.5 Bit Map of Categories

The length of this field is variable and ranges from 0 to 30 octets. This provides representation of categories 0 to 239. The ordering of the bits

is left to right or MSB to LSB. For example category 0 is represented by the most significant bit of the first byte and category 15 is represented by the least significant bit of the second byte. Figure 4 graphically shows this ordering. Bit N is binary 1 if category N is part of the label for the datagram, and bit N is binary 0 if category N is not part of the label. Except for the optimized tag 1 format described in the next section,

minimal encoding SHOULD be used resulting in no trailing zero octets in the category bitmap.

	octet 0	octet 1	octet 2	octet 3	octet 4	octet 5		
	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	. . .	
bit	01234567	89111111	11112222	22222233	33333333	44444444		
number		012345	67890123	45678901	23456789	01234567		

Figure 4. Ordering of Bits in Tag 1 Bit Map

3.4.2.6 Optimized Tag 1 Format

Routers work most efficiently when processing fixed length fields. To support these routers there is an optimized form of tag type 1. The format does not change. The only change is to the category bitmap which is set to a constant length of 10 octets. Trailing octets required to fill out the 10 octets are zero filled. Ten octets, allowing for 80 categories, was chosen because it makes the total length of the CIPSO option 20 octets. If CIPSO is the only option then the option will be full word aligned and additional filler octets will not be required.

3.4.3 Tag Type 2

This is referred to as the "enumerated" tag type. It is used to describe large but sparsely populated sets of categories. Tag type 2 is in the MAC Sensitivity tag type class. The format of this tag type is as follows:

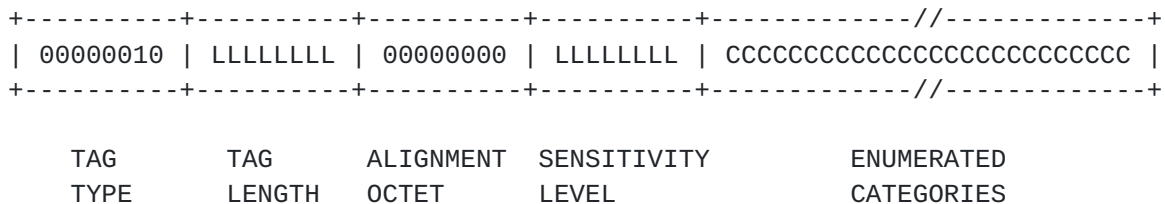


Figure 5. Tag Type 2 Format

3.4.3.1 Tag Type

This field is one octet in length and has a value of 2.

3.4.3.2 Tag Length

This field is 1 octet in length. It is the total length of the tag type including the type and length fields. With the current IP header length

restriction of 40 bytes the value within this field is between 4 and 34.

3.4.3.3 Alignment Octet

This field is 1 octet in length and always has the value of 0. Its purpose is to align the category field on an even octet boundary. This will

speed many implementations including router implementations.

3.4.3.4 Sensitivity Level

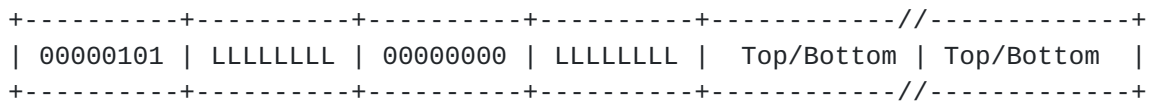
This field is 1 octet in length. Its value is from 0 to 255. The values are ordered with 0 being the minimum value and 255 representing the maximum value.

3.4.3.5 Enumerated Categories

In this tag, categories are represented by their actual value rather than by their position within a bit field. The length of each category is 2 octets. Up to 15 categories may be represented by this tag. Valid values for categories are 0 to 65534. Category 65535 is not a valid category value. The categories MUST be listed in ascending order within the tag.

3.4.4 Tag Type 5

This is referred to as the "range" tag type. It is used to represent labels where all categories in a range, or set of ranges, are included in the sensitivity label. Tag type 5 is in the MAC Sensitivity tag type class. The format of this tag type is as follows:



TAG TYPE	TAG LENGTH	ALIGNMENT OCTET	SENSITIVITY LEVEL	CATEGORY RANGES
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Figure 6. Tag Type 5 Format

3.4.4.1 Tag Type

This field is one octet in length and has a value of 5.

3.4.4.2 Tag Length

This field is 1 octet in length. It is the total length of the tag type including the type and length fields. With the current IP header length restriction of 40 bytes the value within this field is between 4 and 34.

3.4.4.3 Alignment Octet

This field is 1 octet in length and always has the value of 0. Its purpose is to align the category range field on an even octet boundary. This will speed many implementations including router implementations.

3.4.4.4 Sensitivity Level

This field is 1 octet in length. Its value is from 0 to 255. The values are ordered with 0 being the minimum value and 255 representing the maximum value.

3.4.4.5 Category Ranges

A category range is a 4 octet field comprised of the 2 octet index of the highest numbered category followed by the 2 octet index of the lowest numbered category. These range endpoints are inclusive within the range of categories. All categories within a range are included in the sensitivity label. This tag may contain a maximum of 7 category pairs. The bottom category endpoint for the last pair in the tag MAY be omitted and SHOULD be assumed to be 0. The ranges MUST be non-overlapping and be listed in descending order. Valid values for categories are 0 to 65534. Category **65535** is not a valid category value.

3.4.5 Minimum Requirements

A CIPSO implementation MUST be capable of generating at least tag type 1 in the non-optimized form. In addition, a CIPSO implementation MUST be able to receive any valid tag type 1 even those using the optimized tag type 1 format.

4. Configuration Parameters

The configuration parameters defined below are required for all CIPSO hosts, gateways, and routers that support multiple sensitivity labels. A CIPSO host is defined to be the origination or destination system for an IP datagram. A CIPSO gateway provides IP routing services between two or more IP networks and may be required to perform label translations between networks. A CIPSO gateway may be an enhanced CIPSO host or it may just provide gateway services with no end system CIPSO capabilities. A CIPSO router is a dedicated IP router that routes IP datagrams between two or more IP networks.

An implementation of CIPSO on a host MUST have the capability to reject a datagram for reasons that the information contained can not be adequately protected by the receiving host or if acceptance may result in violation of the host or network security policy. In addition, a CIPSO gateway or router MUST be able to reject datagrams going to networks that can not provide adequate protection or may violate the network's security policy. To provide this capability the following minimal set of configuration parameters are required for CIPSO implementations:

HOST_LABEL_MAX - This parameter contains the maximum sensitivity label that a CIPSO host is authorized to handle. All datagrams that have a label greater than this maximum MUST be rejected by the CIPSO host. This parameter does not apply to CIPSO gateways or routers. This parameter need not be defined explicitly as it can be implicitly derived from the PORT_LABEL_MAX parameters for the associated interfaces.

HOST_LABEL_MIN - This parameter contains the minimum sensitivity label that a CIPSO host is authorized to handle. All datagrams that have a label less than this minimum MUST be rejected by the CIPSO host. This parameter does not apply to CIPSO gateways or routers. This parameter need not be defined explicitly as it can be implicitly derived from the PORT_LABEL_MIN parameters for the associated interfaces.

PORT_LABEL_MAX - This parameter contains the maximum sensitivity label for all datagrams that may exit a particular network interface port. All outgoing datagrams that have a label greater than this maximum MUST be rejected by the CIPSO system. The label within this parameter MUST be less than or equal to the label within the HOST_LABEL_MAX parameter. This parameter does not apply to CIPSO hosts that support only one network port.

PORT_LABEL_MIN - This parameter contains the minimum sensitivity label for all datagrams that may exit a particular network interface port. All outgoing datagrams that have a label less than this minimum MUST be rejected by the CIPSO system. The label within this parameter MUST be greater than or equal to the label within the HOST_LABEL_MIN parameter. This parameter does not apply to CIPSO hosts that support only one network port.

PORT_DOI - This parameter is used to assign a DOI identifier value to a particular network interface port. All CIPSO labels within datagrams going out this port MUST use the specified DOI identifier. All CIPSO hosts and gateways MUST support either this parameter, the NET_DOI parameter, or the HOST_DOI parameter.

NET_DOI - This parameter is used to assign a DOI identifier value to a particular IP network address. All CIPSO labels within datagrams destined for the particular IP network MUST use the specified DOI identifier. All CIPSO hosts and gateways MUST support either this parameter, the PORT_DOI parameter, or the HOST_DOI parameter.

HOST_DOI - This parameter is used to assign a DOI identifier value to a particular IP host address. All CIPSO labels within datagrams destined for the particular IP host will use the specified DOI identifier. All CIPSO hosts and gateways MUST support either this parameter, the PORT_DOI parameter, or the NET_DOI parameter.

This list represents the minimal set of configuration parameters required to be compliant. Implementors are encouraged to add to this list to provide enhanced functionality and control. For example, many security policies may require both incoming and outgoing datagrams be checked against the port and host label ranges.

4.1 Port Range Parameters

The labels represented by the PORT_LABEL_MAX and PORT_LABEL_MIN parameters MAY be in CIPSO or local format. Some CIPSO systems, such as routers, may want to have the range parameters expressed in CIPSO format so that incoming labels do not have to be converted to a local format before being compared against the range. If multiple DOIs are supported by one of these CIPSO

systems then multiple port range parameters would be needed, one set for each DOI supported on a particular port.

The port range will usually represent the total set of labels that may exist on the logical network accessed through the corresponding network interface. It may, however, represent a subset of these labels that are allowed to enter the CIPSO system.

4.2 Single Label CIPSO Hosts

CIPSO implementations that support only one label are not required to support the parameters described above. These limited implementations are only required to support a NET_LABEL parameter. This parameter contains the CIPSO label that may be inserted in datagrams that exit the host. In addition, the host MUST reject any incoming datagram that has a label which is not equivalent to the NET_LABEL parameter.

5. Handling Procedures

This section describes the processing requirements for incoming and outgoing IP datagrams. Just providing the correct CIPSO label format is not enough. Assumptions will be made by one system on how a receiving system will handle the CIPSO label. Wrong assumptions may lead to non-interoperability or even a security incident. The requirements described below represent the minimal set needed for interoperability and that provide users some level of confidence. Many other requirements could be added to increase user confidence, however at the risk of restricting creativity and limiting vendor participation.

5.1 Input Procedures

All datagrams received through a network port MUST have a security label associated with them, either contained in the datagram or assigned to the receiving port. Without this label the host, gateway, or router will not have the information it needs to make security decisions. This security label will be obtained from the CIPSO if the option is present in the datagram. See [section 4.1.2](#) for handling procedures for unlabeled datagrams. This label will be compared against the PORT (if appropriate) and HOST configuration parameters defined in [section 3](#).

If any field within the CIPSO option, such as the DOI identifier, is not recognized the IP datagram is discarded and an ICMP "parameter problem" (type 12) is generated and returned. The ICMP code field is set to "bad parameter" (code 0) and the pointer is set to the start of the CIPSO field

that is unrecognized.

If the contents of the CIPSO are valid but the security label is outside of the configured host or port label range, the datagram is discarded and an ICMP "destination unreachable" (type 3) is generated and returned. The code field of the ICMP is set to "communication with destination network administratively prohibited" (code 9) or to

"communication with destination host administratively prohibited" (code 10). The value of the code field used is dependent upon whether the originator of the ICMP message is acting as a CIPSO host or a CIPSO gateway. The recipient of the ICMP message MUST be able to handle either value. The same procedure is performed if a CIPSO can not be added to an IP packet because it is too large to fit in the IP options area.

If the error is triggered by receipt of an ICMP message, the message is discarded and no response is permitted (consistent with general ICMP processing rules).

5.1.1 Unrecognized tag types

The default condition for any CIPSO implementation is that an unrecognized tag type MUST be treated as a "parameter problem" and handled as described in [section 4.1](#). A CIPSO implementation MAY allow the system administrator to identify tag types that may safely be ignored. This capability is an allowable enhancement, not a requirement.

5.1.2 Unlabeled Packets

A network port may be configured to not require a CIPSO label for all incoming datagrams. For this configuration a CIPSO label must be assigned to that network port and associated with all unlabeled IP datagrams. This capability might be used for single level networks or networks that have CIPSO and non-CIPSO hosts and the non-CIPSO hosts all operate at the same label.

If a CIPSO option is required and none is found, the datagram is discarded and an ICMP "parameter problem" (type 12) is generated and returned to the originator of the datagram. The code field of the ICMP is set to "option missing" (code 1) and the ICMP pointer is set to 134 (the value of the option type for the missing CIPSO option).

5.2 Output Procedures

A CIPSO option MUST appear only once in a datagram. Only one tag type from the MAC Sensitivity class MAY be included in a CIPSO option. Given the current set of defined tag types, this means that CIPSO labels at first will contain only one tag.

All datagrams leaving a CIPSO system MUST meet the following condition:

$$\text{PORT_LABEL_MIN} \leq \text{CIPSO label} \leq \text{PORT_LABEL_MAX}$$

If this condition is not satisfied the datagram MUST be discarded.
If the CIPSO system only supports one port, the HOST_LABEL_MIN and the
HOST_LABEL_MAX parameters MAY be substituted for the PORT parameters in
the above condition.

The DOI identifier to be used for all outgoing datagrams is configured by

the administrator. If port level DOI identifier assignment is used, then the PORT_DOI configuration parameter MUST contain the DOI identifier to use. If network level DOI assignment is used, then the NET_DOI parameter MUST contain the DOI identifier to use. And if host level DOI assignment is employed, then the HOST_DOI parameter MUST contain the DOI identifier to use. A CIPSO implementation need only support one level of DOI assignment.

5.3 DOI Processing Requirements

A CIPSO implementation MUST support at least one DOI and SHOULD support multiple DOIs. System and network administrators are cautioned to ensure that at least one DOI is common within an IP network to allow for broadcasting of IP datagrams.

CIPSO gateways MUST be capable of translating a CIPSO option from one DOI to another when forwarding datagrams between networks. For efficiency purposes this capability is only a desired feature for CIPSO routers.

5.4 Label of ICMP Messages

The CIPSO label to be used on all outgoing ICMP messages MUST be equivalent to the label of the datagram that caused the ICMP message. If the ICMP was generated due to a problem associated with the original CIPSO label then the following responses are allowed:

- a. Use the CIPSO label of the original IP datagram
- b. Drop the original datagram with no return message generated

In most cases these options will have the same effect. If you can not interpret the label or if it is outside the label range of your host or interface then an ICMP message with the same label will probably not be able to exit the system.

6. Assignment of DOI Identifier Numbers

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Requests for assignment of a DOI identifier number should be addressed to the Internet Assigned Numbers Authority (IANA).

7. Acknowledgements

Much of the material in this RFC is based on (and copied from) work done by Gary Winiger of Sun Microsystems and published as Commercial

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8. Author's Address

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9. References

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[RFC 1108](#), "U.S. Department of Defense Security Options for the Internet Protocol", Stephen Kent, IAB, 1 March, 1991.

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