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Experimental Values in IPv4, IPv6, ICMPv4, ICMPv6, UDP, and TCP Headers

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Abstract

When experimenting with or extending protocols, it is often necessary to use some sort of protocol number or constant in order to actually test or experiment with the new function, even when testing in a closed environment. This document reserves some ranges of numbers for experimentation purposes in specific protocols where the need to support experimentation has been identified, and it describes the numbers that have already been reserved by other documents.

1. Introduction

[RFC3692] recommends assigning option numbers for experiments and testing. This document documents several such assignments for the number spaces whose IANA considerations are documented in [RFC2780]. This document generally follows the form of [RFC2780].

When using these values, carefully consider the advice in Sections 1 and 1.1 of [RFC3692]. It is not appropriate to simply select one of these values and hard code it into a system.

Note: while [RFC3692] says that it may not be necessary to allocate values for UDP and TCP ports, Sections 6 and 7.1 explicitly reserve ports for this purpose to avoid any possible conflict.

2. Fields in the IPv4 Header

The IPv4 header [RFC0791] contains the following fields that carry values assigned by the IANA: Version, Type of Service, Protocol, Source Address, Destination Address, and Option Type.

2.1. IP Version Field in the IPv4 Header

The Version field in IPv4 packets is always 4.

2.2. IPv4 Type of Service Field

[RFC2474] defines Pool 2 (all code points xxxx11, where 'x' refers to either '0' or '1') as Experimental/Local Use, so no additional code points should be needed. The Explicit Congestion Notification (ECN) field [RFC3168] has no free code points to assign.

2.3. IPv4 Protocol Field

[RFC3692] allocates two experimental code points (253 and 254) for the IPv4 Protocol field.

2.4. IPv4 Source and Destination Addresses

2.4.1. IPv4 Unicast

No experimental IPv4 addresses are defined. For certain experiments, the address ranges set aside for Private Internets in [RFC1918] may be useful. It is not appropriate to use other special-purpose IPv4 addresses [RFC3330] for experimentation.

At the time of this writing, some Internet Registries have policies allowing experimental assignments from number spaces that they control. Depending on the experiment, the registry, and their policy, this may be an appropriate path to pursue.

2.4.2. IPv4 Multicast

The globally routable group 224.0.1.20 is set aside for experimentation. For certain experiments, the administratively scoped multicast groups defined in [RFC2365] may be useful. This document assigns a single link-local scoped group, 224.0.0.254, and a single scope-relative group, 254.

2.5. IPv4 Option Type Field

This document assigns a single option number, with all defined values of the "copy" and "class" fields, resulting in four distinct option type codes. See Section 8 for the assigned values.

3. Fields in the IPv6 Header

The IPv6 header [RFC2460] contains the following fields that carry values assigned from IANA-managed name spaces: Version, Traffic Class, Next Header, Source and Destination Address. In addition, the IPv6 Hop-by-Hop Options and Destination Options extension headers include an Option Type field with values assigned from an IANA-managed name space. The IPv6 Routing Header contains a Type field for which there is not currently an explicit IANA assignment policy.

3.1. IP Version Field in the IPv6 Header

The Version field in IPv6 packets is always 6.

3.2. IPv6 Traffic Class Field

[RFC2474] defines Pool 2 (all code points xxxx11, where 'x' refers to either '0' or '1') as Experimental/Local Use, so no additional code points should be needed. The ECN field [RFC3168] has no free code points to assign.

3.3. IPv6 Next Header Field

[RFC3692] allocates two experimental code points (253 and 254) for the IPv6 Next Header field.

3.4. IPv6 Source and Destination Addresses

3.4.1. IPv6 Unicast Addresses

[RFC2928] defines a set of IPv6 addresses for testing and experimental usage:

> The block of Sub-TLA IDs assigned to the IANA (i.e., 2001:0000::/29 - 2001:01F8::/29) is for assignment for testing and experimental usage to support activities such as the 6bone, and for new approaches like exchanges.

However, at this writing, there are no RFC3692-style experimental IPv6 addresses assigned. [HUSTON05] creates an IANA registry that may in the future contain such assignments. For certain experiments, Unique Local Addresses [RFC4193] may be useful. It is not appropriate to use addresses in the documentation prefix [RFC3849] for experimentation.

At the time of this writing, some Internet Registries have policies allowing experimental assignments from number spaces that they control. Depending on the experiment, the registry, and their policy, this may be an appropriate path to pursue.

3.4.2. IPv6 Multicast Addresses

The group FF0X::114 is set aside for experimentation at all scope levels. Smaller scopes may be particularly useful for experimentation, since they are defined not to leak out of a given defined boundary, which can be set to be the boundary of the experiment. For certain experiments, other multicast addresses with the T (non-permanently-assigned or "transient" address) bit [RFC4291] set may be useful.

3.5. IPv6 Hop-by-Hop and Destination Option Fields

This document assigns a single option type, with all possible values of the "act" and "chg" fields, resulting in eight distinct option type codes. See Section 8 for the assigned values.

3.6. IPv6 Routing Header Routing Type

This document assigns two values for the Routing Type field in the IPv6 Routing Header, 253 and 254.

4. Fields in the IPv4 ICMP Header

This document assigns two ICMPv4 type numbers, 253 and 254. ICMPv4 code values are allocated per type, so it's not feasible to assign experimental values in this document.

5. Fields in the IPv6 ICMP Header

[RFC4443] includes experimental ICMPv6 type values for Informational (200, 201) and Error (100, 101) message types. ICMPv6 code values are allocated per type, so it's not feasible to assign experimental values in this document.

5.1. IPv6 Neighbor Discovery Fields

The IPv6 Neighbor Discovery header [RFC2461] contains the following fields that carry values assigned from IANA-managed name spaces: Type, Code, and Option Type.

5.1.1. IPv6 Neighbor Discovery Type

The Neighbor Discovery Type field is the same as the ICMPv6 Type field. See Section 5 for those code points.

5.1.2. IPv6 Neighbor Discovery Code

The ICMPv6 Code field is not used in IPv6 Neighbor Discovery, so no experimental code points are necessary.

5.1.3. IPv6 Neighbor Discovery Option Type

This document assigns two IPv6 Neighbor Discovery Option Types, 253 and 254.

6. Fields in the UDP Header

Two system ports, 1021 and 1022, have been reserved for experimentation for UDP and TCP.

7. Fields in the TCP Header

7.1. TCP Source and Destination Port Fields

Two system ports, 1021 and 1022, have been reserved for experimentation for UDP and TCP.

7.2. Reserved Bits in TCP Header

There are not enough reserved bits to allocate any for experimentation.

7.3. TCP Option Kind Field

Two TCP options, 253 and 254, have been reserved for experimentation with TCP Options.

8. IANA Considerations

The new assignments are summarized below.

IPv4 Multicast Addresses (multicast-addresses (224.0.0/24) Local Network Control Block section) (Section 2.4.2)

Group Address	Name
224.0.0.254	RFC3692-style Experiment (*)

IPv4 Multicast Addresses (multicast-addresses relative addresses section) (Section 2.4.2)

Relative	Description
254	RFC3692-style Experiment (*)

IPv4 Option Numbers (ip-parameters initial section) (Section 2.5)

Copy	Class	Number	Value
0	0	30	30
0	2	30	94
1	0	30	158
1	2	30	222

IPv6 Option Types (ipv6-parameters Section 5.b.) (Section 3.5)

HEX	act	chg	rest
0x1e	00	0	11110
0x3e	00	1	11110
0x5e	01	0	11110
0x7e	01	1	11110
0x9e	10	0	11110
0xbe	10	1	11110
0xde	11	0	11110
0xfe	11	1	11110

IPv6 Neighbor Discovery Option Formats (icmpv6-parameters) (Section 5.1.3)

Type	Description
253	RFC3692-style Experiment 1 (*)
254	RFC3692-style Experiment 2 (*)

IPv6 Routing Header Routing Types (ipv6-parameters Section 5.c.) (Section 3.6)

Type	Description
253	RFC3692-style Experiment 1 (*)
254	RFC3692-style Experiment 2 (*)

ICMPv4 Type Numbers (icmp-parameters) (Section 4)

Type	Name
253	RFC3692-style Experiment 1 (*)
254	RFC3692-style Experiment 2 (*)

System Port Numbers (port-numbers) (Sections 6 and 7.1)

Keyword	Decimal	Description
exp1	1021/udp	RFC3692-style Experiment 1 (*)
exp1	1021/tcp	RFC3692-style Experiment 1 (*)
exp2	1022/udp	RFC3692-style Experiment 2 (*)
exp2	1022/tcp	RFC3692-style Experiment 2 (*)

TCP Option Numbers (tcp-parameters) (Section 7.3)

Kind	Length	Meaning
253	N	RFC3692-style Experiment 1 (*)
254	N	RFC3692-style Experiment 2 (*)

Each of these registrations is accompanied by the following footnote:

(*) It is only appropriate to use these values in explicitly-configured experiments; they MUST NOT be shipped as defaults in implementations. See RFC 3692 for details.

9. Security Considerations

Production networks do not necessarily support the use of experimental code points in IP headers. The network scope of support for experimental values should carefully be evaluated before deploying any experiment across extended network domains, such as the public Internet. The potential to disrupt the stable operation of the network hosting the experiment through the use of unsupported experimental code points is a serious consideration when planning an experiment using such code points.

Security analyzers such as firewalls and network intrusion detection monitors often rely on unambiguous interpretations of the fields described in this memo. As new values for the fields are assigned, existing security analyzers that do not understand the new values may fail, resulting in either loss of connectivity, if the analyzer declines to forward the unrecognized traffic, or in loss of security if it does forward the traffic and the new values are used as part of an attack. Assigning known values for experiments can allow such analyzers to take a known action for explicitly experimental traffic.

Because the experimental IPv4 options defined in Section 2.5 are not included in the IPsec AH [RFC4302] calculations, it is not possible for one to authenticate their use. Experimenters ought to keep this in mind when designing their experiments. Users of the experimental IPv6 options defined in Section 3.5 can choose whether or not the option is included in the AH calculations by choosing the value of the "chg" field.

When experimental code points are deployed within an administratively self-contained network domain, the network administrators should ensure that each code point is used consistently to avoid interference between experiments. When experimental code points are used in traffic that crosses multiple administrative domains, the

experimenters should assume that there is a risk that the same code points will be used simultaneously by other experiments and thus that there is a possibility that the experiments will interfere. Particular attention should be given to security threats that such interference might create.

10. References

10.1. Normative References

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[RFC3168] Ramakrishnan, K., Floyd, S., and D. Black, "The Addition of Explicit Congestion Notification (ECN) to IP", RFC 3168, September 2001.

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[RFC4193] Hinden, R. and B. Haberman, "Unique Local IPv6 Unicast Addresses", RFC 4193, October 2005.

[RFC4291] Hinden, R. and S. Deering, "IP Version 6 Addressing Architecture", RFC 4291, February 2006.

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[RFC4443] Conta, A., Deering, S., and M. Gupta, "Internet Control Message Protocol (ICMPv6) for the Internet Protocol Version 6 (IPv6) Specification", RFC 4443, March 2006.

10.2. Informative References

[HUSTON05] Huston, G., "Administration of the IANA Special Purpose Address Block", Work in Progress, December 2005.

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