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Philip J. Nesser II
Nesser & Nesser Consulting
Andreas Bergstrom (Ed.)
Ostfold University College
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Introduction to the Survey of IPv4 Addresses in Currently Deployed IETF Standards

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Abstract

This document is a general overview and introduction to the v6ops IETF workgroup project of documenting all usage of IPv4 addresses in currently deployed IETF documented standards. It is broken into seven documents conforming to the current IETF areas. It also describes the methodology used during documentation, which type of RFCs that has been documented, and a concatenated summary of results.

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1.0 Introduction

This document is the introduction to a document set aiming to document all usage of IPv4 addresses in IETF standards. In an effort to have the information in a manageable form, it has been broken into 7 documents conforming to the current IETF areas (Application[1], Internet[2], Management & Operations[3], Routing[4], Security[5], Sub-IP[6] and Transport[7]). It also describes the methodology used during documentation, which type of RFCs that has been documented, and a concatenated summary of results.

1.1 Short Historical Perspective

There are many challenges that face the Internet Engineering community. The foremost of these challenges has been the scaling issue: how to grow a network that was envisioned to handle thousands of hosts to one that will handle tens of millions of networks with billions of hosts. Over the years this scaling problem has been managed, with varying degrees of success, by changes to the network layer and to routing protocols. (Although largely ignored in the changes to network layer and routing protocols, the tremendous advances in computational hardware during the past two decades have been of significant benefit in management of scaling problems encountered thus far.)

The first "modern" transition to the network layer occurred in during the early 1980's from the Network Control Protocol (NCP) to IPv4. This culminated in the famous "flag day" of January 1, 1983. IP Version 4 originally specified an 8 bit network and 24 bit host addresses, as documented in [RFC 760](#). A year later IPv4 was updated in [RFC 791](#) to include the famous A, B, C, D, & E class system.

Networks were growing in such a way that it was clear that a convention for breaking networks into smaller pieces was needed. In October of [1984 RFC 917](#) was published formalizing the practice of subnetting.

By the late 1980's it was clear that the current exterior routing protocol used by the Internet (EGP) was insufficiently robust to scale with the growth of the Internet. The first version of BGP was documented in 1989 in [RFC 1105](#).

Yet another scaling issue, exhaustion of the class B address space, became apparent in the early 1990s. The growth and commercialization of the Internet stimulated organisations requesting IP addresses in alarming numbers. By May of 1992 over 45% of the Class B space had been allocated. In early 1993 [RFC 1466](#) was published directing assignment of blocks of Class C's be given out instead of Class B's. This temporarily circumvented the problem of address space exhaustion, but had significant impact of the routing infrastructure.

The number of entries in the "core" routing tables began to grow exponentially as a result of [RFC 1466](#). This led to the implementation of BGP4 and CIDR prefix addressing. This may have circumvented the problem for the present but there are still potential scaling issues.

Growth in the population of Internet hosts since the mid-1980s would have long overwhelmed the IPv4 address space if industry had not supplied a circumvention in the form of Network Address Translators (NATs). To do this the Internet has watered down the underlying "End-to-End" principle.

In the early 1990's the IETF was aware of these potential problems and began a long design process to create a successor to IPv4 that would address these issues. The outcome of that process was IPv6.

The purpose of this document is not to discuss the merits or problems of IPv6. That is a debate that is still ongoing and will eventually be decided on how well the IETF defines transition mechanisms and how industry accepts the solution. The question is not "should," but "when."

[1.2 An Observation on the Classification of Standards](#)

It has become clear during the course of this investigation that there has been little management of the status of standards over the years. Some attempt has been made by the introduction of the classification of standards into Full, Draft, Proposed, Experimental, and Historic. However, there has not been a concerted effort to actively manage the classification for older standards. Standards are only classified as Historic when either a newer version of the protocol is deployed, it is randomly noticed that an RFC describes a long dead protocol, or a serious flaw is discovered in a protocol. Another issue is the status of Proposed Standards. Since this is the entry level position for protocols entering the standards process, many old protocols or non-implemented protocols linger in this status indefinitely. This problem also exists for Experimental RFCs. Similarly the problem exists

for the Best Current Practices (BCP) and For You Information (FYI) series of documents.

To exemplify this point, there are 61 Full Standards, only 4 of which have been reclassified to Historic. There are 65 Draft Standards, 611 Proposed Standards, and 150 Experimental RFCs, of which only 66 have been reclassified as Historic. That is a rate of less than 8%. It should be obvious that in the more that 30 years of protocol development and documentation there should be at least as many (if not a majority of) protocols that have been retired compared to the ones that are currently active.

Please note that there is occasionally some confusion of the meaning of a "Historic" classification. It does NOT necessarily mean that the protocol is not being used. A good example of this concept is the Routing Information Protocol(RIP) version 1. There are many thousands of sites using this protocol even though it has Historic status. There are potentially hundreds of otherwise classified RFC's that should be reclassified.

2.0 Methodology

To perform this study each class of IETF standards are investigated in order of maturity: Full, Draft, and Proposed, as well as Experimental. Informational and BCP RFCs are not addressed. RFCs that have been obsoleted by either newer versions or as they have transitioned through the standards process are not covered. RFCs which have been classified as Historic are also not included.

Please note that a side effect of this choice of methodology is that some protocols that are defined by a series of RFC's that are of different levels of standards maturity are covered in different spots in the document. Likewise other natural groupings (i.e. MIBs, SMTP extensions, IP over FOO, PPP, DNS, etc.) could easily be imagined.

2.1 Scope

The procedure used in this investigation is an exhaustive reading of the applicable RFC's. This task involves reading approximately 25000 pages of protocol specifications. To compound this, it was more than a process of simple reading. It was necessary to attempt to understand the purpose and functionality of each protocol in order to make a proper determination of IPv4 reliability. The author has made every effort to make this effort and the resulting document as complete as possible, but it is likely that some subtle (or perhaps not so subtle) dependence was missed. The author encourage those familiar (designers, implementers or anyone who has an intimate knowledge) with any protocol to review the appropriate sections and make comments.

3.0 Summary of Results

In the initial survey of RFCs 175 positives were identified, out of a total of 871, broken down as follows:

Standards	32 of 65 or 49.23%
Draft Standards	14 of 59 or 23.73%
Proposed Standards	107 of 602 or 17.77%
Experimental RFCs	22 of 145 or 15.17%

Of those identified many require no action because they document outdated and unused protocols, while others are document protocols that are actively being updated by the appropriate working groups (SNMP MIBs for example).

Additionally there are many instances of standards that should be updated but do not cause any operational impact (STD 3/RFCs 1122 & 1123 for example) if they are not updated.

In this statistical survey, a positive is defined as a RFC containing an IPv4 dependency, regardless of context.

3.1 Application Area Specifications

In the initial survey of RFCs, 33 positives were identified out of a total of 257, broken down as follows:

Standards:	1 out of 20, or 5.00%
Draft Standards:	4 out of 25, or 16.00%
Proposed Standards:	19 out of 155 or 12.26%
Experimental RFCs:	10 out of 57 or 17.54%

For more information, please look at [\[1\]](#).

3.2 Internet Area Specifications

In the initial survey of RFCs 52 positives were identified out of a total of 186, broken down as follows:

Standards	17 of 24 or 70.83%
Draft Standards	6 of 20 or 30.00%
Proposed Standards	22 of 111 or 19.91%
Experimental RFCs	7 of 31 or 22.58%

For more information, please look at [\[2\]](#).

3.3 Operations & Management Area Specifications

In the initial survey of RFCs 36 positives were identified out of a total of 153, broken down as follows:

Standards	6 of 15 or 40.00%
Draft Standards	4 of 15 or 26.67%
Proposed Standards	26 of 112 or 23.21%
Experimental RFCs	0 of 11 or 0.00%

For more information, please look at [\[3\]](#).

[3.4](#) Routing Area Specifications

In the initial survey of RFCs, 22 positives were identified out of a total of 44, broken down as follows:

Standards	3 of 3 or 100.00%
Draft Standards	1 of 2 or 50.00%
Proposed Standards	13 of 29 or 44.83%
Experimental RFCs	6 of 11 or 54.54%

For more information, please look at [\[4\]](#).

[3.5](#) Security Area Specifications

In the initial survey of RFCs 4 positives were identified out of a total of 124, broken down as follows:

Standards	0 of 1 or 0.00%
Draft Standards	1 of 3 or 33.33%
Proposed Standards	1 of 102 or 0.98%
Experimental RFCs	2 of 18 or 11.11%

For more information, please look at [\[5\]](#).

[3.6](#) Sub-IP Area Specifications

In the initial survey of RFCs, 0 positives were identified out of a total of 7, broken down as follows:

Standards	0 of 0 or 0.00%
Draft Standards	0 of 0 or 0.00%
Proposed Standards	0 of 6 or 0.00%
Experimental RFCs	0 of 1 or 0.00%

For information about the Sub-IP Area standards, please look at [\[6\]](#).

[3.7](#) Transport Area Specifications

In the initial survey of RFCs 25 positives were identified out of a total of 104, broken down as follows:

Standards	3 of 5 or 60.00%
Draft Standards	0 of 2 or 0.00%
Proposed Standards	17 of 82 or 20.73%
Experimental RFCs	4 of 15 or 26.67%

For more information, please look at [\[7\]](#).

[4.0](#) Discussion of "Long Term" Stability of Addresses on Protocols

In attempting this analysis it was determined that a full scale analysis is well beyond the scope of this document. Instead a short discussion is presented on how such a framework might be established.

A suggested approach would be to do an analysis of protocols based on their overall function, similar (but not strictly) to the OSI network reference model. It might be more appropriate to frame the discussion in terms of the different Areas of the IETF.

The problem is fundamental to the overall architecture of the Internet and its future. One of the stated goals of the IPng (now IPv6) was "automatic" and "easy" address renumbering. An additional goal is "stateless autoconfiguration." To these ends, a substantial amount of work has gone into the development of such protocols as DHCP and Dynamic DNS. This goes against the Internet age-old "end-to-end principle."

Most protocol designs implicitly count on certain underlying principles that currently exist in the network. For example, the design of packet switched networks allows upper level protocols to ignore the underlying stability of packet routes. When paths change in the network, the higher level protocols are typically unaware and uncaring. This works well since whether the packet goes A-B-C-D-E-F or A-B-X-Y-Z-E-F is of little consequence.

In a world where endpoints (i.e. A and F in the example above) change at a "rapid" rate, a new model for protocol developers should be considered. It seems that a logical development would be a change in the operation of the Transport layer protocols. The current model is essentially a choice between TCP and UDP, Neither of these protocols provides any mechanism for an orderly handoff of the connection if and when the network endpoint (IP) addresses changes. Perhaps a third major transport layer protocol should be developed, or perhaps updated TCP & UDP specifications that include this function might be a better solution.

There are many, many variables that would need to go into a successful development of such a protocol. Some issues to consider are: timing principles; overlap periods as an endpoint moves from address A, to addresses A & B (answers to both), to only B; delays due to the

recalculation of routing paths, etc...

5.0 Security Consideration

This memo examines the IPv6-readiness of specifications; this does not have security considerations in itself.

6.0 Acknowledgements

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7.0 References

7.1 Normative

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[8.0](#) Authors' Addresses

Please contact the author with any questions, comments or suggestions at:

Philip J. Nesser II
Principal
Nesser & Nesser Consulting
[13501](#) 100th Ave NE, #5202
Kirkland, WA 98034

Email: phil@nesser.com
Phone: +1 425 481 4303
Fax: +1 425 482 9721

Andreas Bergstrom (Editor)
Ostfold University College
Email: andreas.bergstrom@hiof.no
Address: Rute 503 Buer
N-1766 Halden
Norway

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