

intarea Working Group  
Internet-Draft  
Intended status: Standards Track  
Expires: October 22, 2019

L. Li  
Y. Cui  
C. Liu  
J. Wu  
Tsinghua University  
F. Baker

J. Palet Martinez  
The IPv6 Company  
April 20, 2019

**DHCPv6 Options for Discovery NAT64 Prefixes**  
**draft-li-intarea-nat64-prefix-dhcp-option-02**

Abstract

Several IPv6 transition mechanisms require the usage of stateless or stateful translators (commonly named as NAT64) able to allow IP/ICMP communication between IPv4 and IPv6 networks.

Those translators are using either a default Well-Known Prefix (WKP), and/or one or several additional Network Specific Prefixes (NSP), which need to be configured into the nodes willing to use the translator. Different translators will likely have different IPv6 prefixes, to attract traffic to the correct translator. Thus, an automatic translator prefix discovery method is necessary.

This document defines a DHCPv6-based method to inform DHCPv6 clients the set of IPv6 and IPv4 prefixes it serves. This DHCPv6 option can be used by several transition mechanisms such as SIIT, 464XLAT, EAM.

Status of This Memo

This Internet-Draft is submitted in full conformance with the provisions of [BCP 78](#) and [BCP 79](#).

Internet-Drafts are working documents of the Internet Engineering Task Force (IETF). Note that other groups may also distribute working documents as Internet-Drafts. The list of current Internet-Drafts is at <https://datatracker.ietf.org/drafts/current/>.

Internet-Drafts are draft documents valid for a maximum of six months and may be updated, replaced, or obsoleted by other documents at any time. It is inappropriate to use Internet-Drafts as reference material or to cite them other than as "work in progress."

This Internet-Draft will expire on October 22, 2019.

## Copyright Notice

Copyright (c) 2019 IETF Trust and the persons identified as the document authors. All rights reserved.

This document is subject to [BCP 78](#) and the IETF Trust's Legal Provisions Relating to IETF Documents (<https://trustee.ietf.org/license-info>) in effect on the date of publication of this document. Please review these documents carefully, as they describe your rights and restrictions with respect to this document. Code Components extracted from this document must include Simplified BSD License text as described in Section 4.e of the Trust Legal Provisions and are provided without warranty as described in the Simplified BSD License.

## Table of Contents

<a href="#">1.</a>	Introduction . . . . .	<a href="#">2</a>
<a href="#">2.</a>	Requirements Language . . . . .	<a href="#">4</a>
<a href="#">3.</a>	New DHCPv6 Option . . . . .	<a href="#">4</a>
<a href="#">3.1.</a>	NAT64 Prefix List Option Format . . . . .	<a href="#">4</a>
<a href="#">3.2.</a>	NAT64 Prefix Option Format . . . . .	<a href="#">5</a>
<a href="#">4.</a>	Client Behavior . . . . .	<a href="#">6</a>
<a href="#">5.</a>	Message Flow Illustration . . . . .	<a href="#">7</a>
<a href="#">6.</a>	Security Considerations . . . . .	<a href="#">8</a>
<a href="#">7.</a>	IANA Considerations . . . . .	<a href="#">9</a>
<a href="#">8.</a>	Acknowledgements . . . . .	<a href="#">9</a>
<a href="#">9.</a>	References . . . . .	<a href="#">9</a>
<a href="#">9.1.</a>	Normative References . . . . .	<a href="#">9</a>
<a href="#">9.2.</a>	Informative References . . . . .	<a href="#">10</a>
	Authors' Addresses . . . . .	<a href="#">11</a>

## [1.](#) Introduction

Stateless IP/ICMP Translation (SIIT) [[RFC7915](#)], describes the basic translation mechanism (NAT64), which is actually used as the base for many of the related translation protocols.

Stateful NAT64 [[RFC6146](#)], describes a stateful IPv6 to IPv4 translation mechanism, which allows IPv6-only hosts to communicate with IPv4-only servers using unicast UDP, TCP, or ICMP, by means of IPv4 public addresses sharing, among multiple IPv6-only hosts. Unless otherwise stated, references in the rest of this document to NAT64 (function) should be interpreted as to Stateful NAT64.

The translation of the packet headers is done using the IP/ICMP translation algorithm defined in [[RFC7915](#)] and algorithmically translating the IPv4 addresses to IPv6 addresses and vice versa,



following [\[RFC6052\]](#).

464XLAT [\[RFC6877\]](#) describes an architecture that provides IPv4 connectivity across a network, or part of it, when it is only natively transporting IPv6. [\[RFC7849\]](#) already suggest the need to support the CLAT function in order to ensure the IPv4 service continuity in IPv6-only cellular deployments. The 464XLAT architecture uses IPv4/IPv6 translation, described in [\[RFC6144\]](#), and standardized in [\[RFC6052\]](#), [\[RFC7915\]](#), and [\[RFC6146\]](#). In the 464XLAT architecture, the CLAT (customer-side NAT46 translator) must determine which among potentially several PLAT (provider-side NAT64 translator) IPv6 prefixes to use in order to send a packet to the PLAT that provides the connectivity to its destination.

[\[RFC7050\]](#) describes a mechanism to learn the PLAT-side IPv6 prefix for protocol translation by DNS64 [\[RFC6147\]](#). Although it supports multiple PLAT-side prefix by responding with multiple AAAA records to a DNS64 query, it does not support mapping IPv4 prefixes to IPv6 prefix, which would be required, for example, if one PLAT has connectivity to the general Internet following a default route, another has connectivity to a BGP peer, and a third has connectivity to a network using private addressing [\[RFC1918\]](#). Therefore, in the scenario with multiple PLATs, [\[RFC7050\]](#) does not directly support destination-based IPv4 routing among PLATs; instead, the DNS64 database must contain equivalent information. It also requires the additional deployment of DNS64 service in customer-side networks, which is not required in 464XLAT deployment. Indeed, this scenario, which may become very common in wired access networks, has not even been considered by [\[RFC7051\]](#).

464XLAT is in fact, a very frequent usage case of Stateful NAT64 and actually the predominant one in cellular networks. As indicated in [\[I-D.ietf-v6ops-nat64-deployment\]](#), it is expected that in some scenarios, DNS64 is not used, so mandating the use of [\[RFC7050\]](#) in those cases it is not a sensible approach.

Explicit Address Mappings for Stateless IP/ICMP Translation [\[RFC7757\]](#) extends SIIT with an Explicit Address Mapping (EAM) algorithm to facilitate stateless IP/ICMP translation between arbitrary (non-IPv4-translatable) IPv6 endpoints and IPv4.

Furthermore, [\[I-D.ietf-v6ops-nat64-deployment\]](#) and [\[I-D.ietf-v6ops-transition-ipv4aas\]](#) show that there is an increasing demand for deployment of NAT64/464XLAT in broadband networks, which may use PCP [\[RFC7225\]](#), to learn the NAT64 prefixes, however is not widely deployed. Instead, DHCPv6/DHCPv6-PD [\[RFC8415\]](#) is the predominant provisioning protocol for broadband CEs (Customer Edge Routers).



DHCPv6/DHCPv6-PD is also supported in 3GPP specifications for cellular networks ([RFC6459], [RFC7066], [RFC7849]), even if today is not predominant, but it is expected that the deployment of cellular broadband services will use it, as it is the only standard way to provide shorter prefixes to CEs through the cellular interphase.

Finally, even if [RFC7051] discarded DHCPv6 as one of the interesting choices for learning the NAT64 prefix, the deployment considerations have evolved, and in fact there is a new Router Advertising option ([I-D.ietf-6man-ra-pref64]), which provides an alternative in some cases, which is complementary to the one suggested by this document.

Consequently, this document proposes a method for the discovery of the NAT64 prefix, based on DHCPv6, which is widely deployed and supported in customer networks. It defines two new DHCPv6 options for use by a DHCPv6 client to discover the NAT64 IPv6 prefix(es). Also, the proposed mechanism can deal with the scenario with multiple independent DNS64 databases supporting separate translators.

## 2. Requirements Language

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "NOT RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in BCP 14 [RFC2119] [RFC8174] when, and only when, they appear in all capitals, as shown here.

## 3. New DHCPv6 Option

### 3.1. NAT64 Prefix List Option Format

The NAT Prefix List Option is a container for NAT64 Prefix Option(s). A NAT64 Prefix List Option MAY contain multiple NAT64 Prefix Options.

The format of the NAT64 Prefix List Option is:

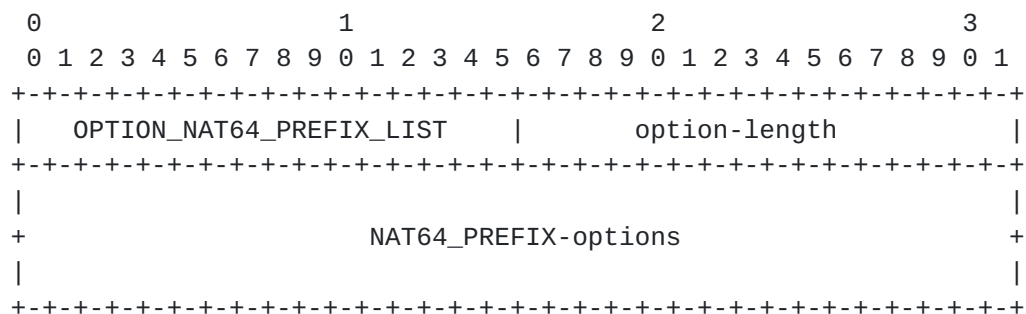


Figure 1: The format of NAT64 Prefix List option



- o option-code: OPTION\_NAT64\_PREFIX\_LIST (TBA1)
- o option-length: length of NAT64\_PREFIX-options, specified in octets.
- o NAT64\_PREFIX-options: one or more OPTION\_NAT64\_PREFIX options.

### 3.2. NAT64 Prefix Option Format

The NAT64 Prefix Option is encapsulated in the NAT64 Prefix List Option. This option allows the mapping of destination IPv4 address ranges (contained in the IPv4 Prefix List) to a NAT64 IPv6 prefix. If there is more than one such prefix, each prefix comes in its own option, with its associated IPv4 prefix list. In this way, the DHCPv6 client can select the NAT64 with the corresponding destination IPv4 address.

The format of the NAT64 Prefix Option is:

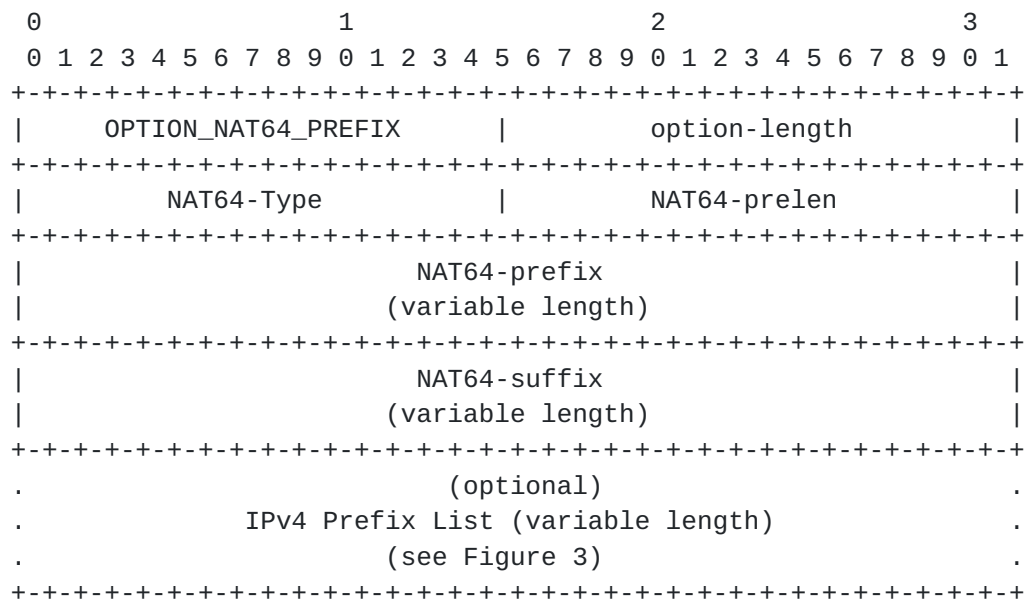


Figure 2: The format of NAT64 Prefix option





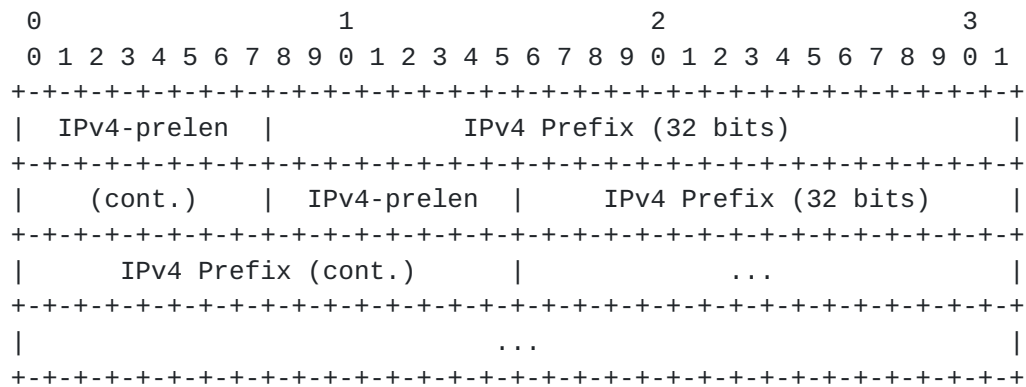


Figure 3: The format of IPv4 Prefix List field

- o option-code: OPTION\_NAT64\_PREFIX (TBA2)
- o type-field: NAT64-Type (TBA3)
- o option-length: 1 + length of NAT64-prefix + length of IPv4 Prefix List, specified in octets.
- o NAT64-pren: length of NAT64-prefix.
- o NAT64-prefix: The NAT64 IPv6 prefix to be used by the DHCPv6 client for the IPv6 address synthesis.
- o NAT64-suffix: The NAT64 suffix to be used by the DHCPv6 client for the IPv6 address synthesis. Not used in case of using the WKP (i.e., 64:ff9b::/96) or any other NSP (Network-Specific Prefix) which a length of 96 bits (/96).
- o IPv4 Prefix List: This is an optional field. The format of the IPv4 Prefix List is shown in Figure 3. It is a list of zero or more IPv4 Prefixes. Each entry is formed by IPv4-pren and IPv4 Prefix. The total length of the field is 5\*number of IPv4 prefixes.
- o IPv4-pren: the length of the IPv4 Prefix.
- o IPv4 Prefix: the destination-based IPv4 Prefix. The length is 4 octets.

#### 4. Client Behavior

The client requests the OPTION\_NAT64\_PREFIX\_LIST option using the Option Request option (ORO) in every Solicit, Request, Renew, Rebind, and Information-request message. The NAT64-Type field defines the mechanism being used. If the DHCPv6 server includes the



OPTION\_NAT64\_PREFIX\_LIST option in its response, the DHCPv6 client may use the contained NAT64-prefix to translate the destination IPv4 address into the destination IPv6 address.

When receiving the OPTION\_NAT64\_PREFIX option with IPv4 Prefix List, the DHCPv6 client MUST record the received IPv6 prefix and the corresponding IPv4 prefixes in IPv4 Prefix List. When receiving the OPTION\_NAT64\_PREFIX option without IPv4 Prefix List, the DHCPv6 client MUST treat the IPv6 prefix and the default IPv4 prefix 0.0.0.0/0 as one of the records.

If the DHCPv6 client loses contact with the DHCPv6 server, the DHCPv6 client SHOULD clear the prefix(es) it learned from the DHCPv6 server.

When translating the destination IPv4 address into the destination IPv6 address, DHCPv6 client MUST search an IPv4 routing database using the longest-match-first rule and select the IPv6 prefix offering that IPv4 prefix.

## 5. Message Flow Illustration

The figure below shows an example of message flow for a Client learning IPv6 prefixes using DHCPv6.

In this example, two IPv6 prefixes are provided by the DHCPv6 server. The first IPv6 prefix is 2001:db8:122:300::/56, the corresponding IPv4 prefixes are 192.0.2.0/24 and 198.51.100.0/24. The second IPv6 prefix is 2001:db8:122::/48, the corresponding IPv4 prefix is 192.0.2.128/25.

When the DHCPv6 client receives the packet with destination IPv4 address 192.0.2.1, according to the rule of longest prefix match, the NAT64 with IPv6 prefix 2001:db8:122::/48 is chosen. In the same way, the NAT64 with IPv6 prefix 2001:db8:122::/48 is chosen.



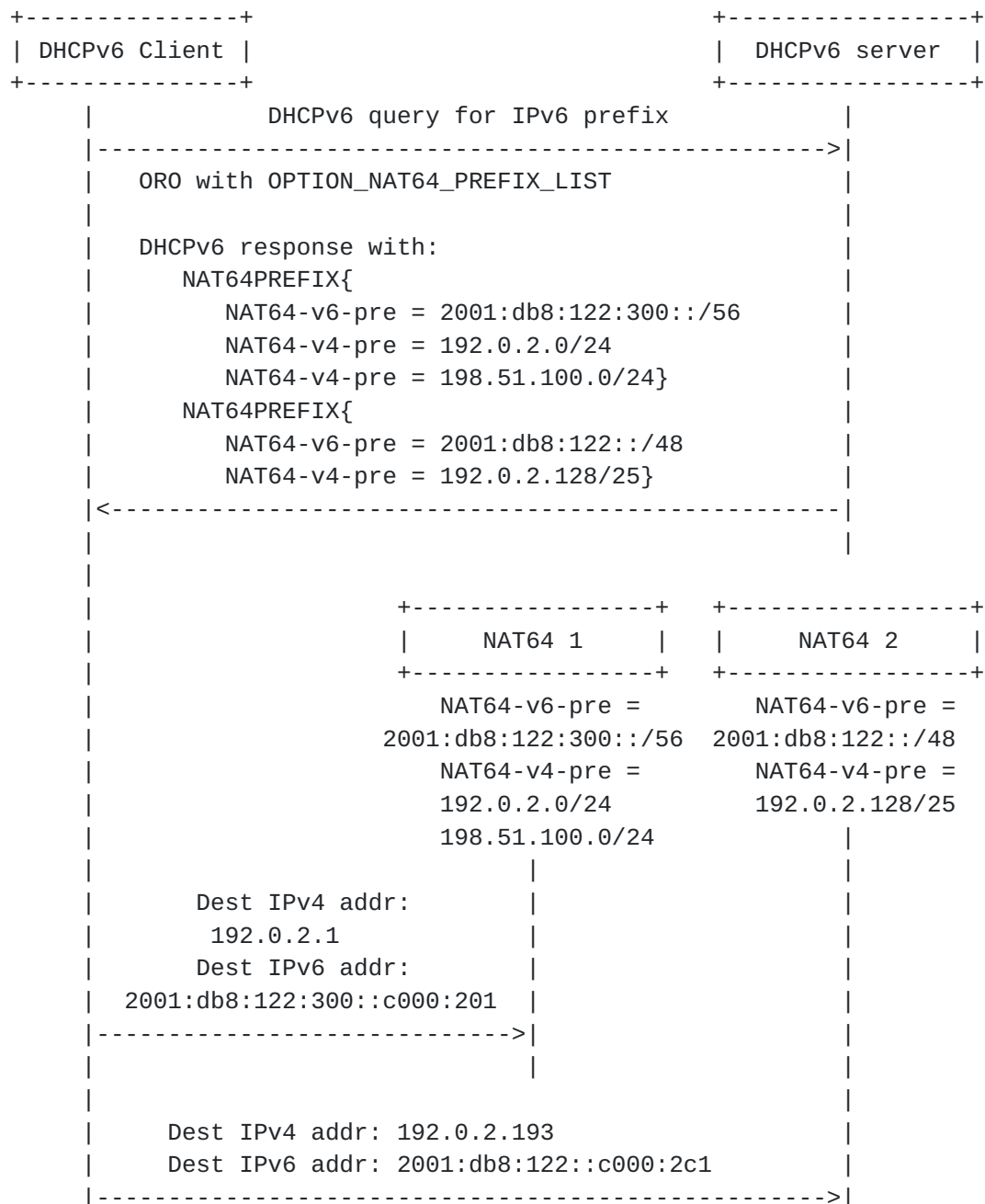


Figure 4: The example figure of the process procedure

## 6. Security Considerations

Considerations for security in this type of environment are primarily around the operation of the DHCPv6 protocol and the databases it uses.

In the DHCPv6 server, should the database be compromised, it will deliver incorrect data to its DHCPv6 clients. In the DHCPv6 client,



should its database be compromised by attack or polluted by an incorrect DHCPv6 server database, it will route data incorrectly. In both cases, the security of the systems and their databases is an operational matter, not managed by protocol.

However, the operation of the DHCPv6 protocol itself is also required to be correct - the server and its clients must recognize valid requests and reject invalid ones. Therefore, DHCPv6 exchanges MUST be secured as described in [RFC8415].

## 7. IANA Considerations

IANA should allocate two DHCPv6 option codes for use by OPTION\_V6\_PLATPREFIX\_LIST and OPTION\_V6\_PLATPREFIX from the "Option Codes" table. Similarly, a request to IANA for assigning the NAT64-Type field codes. The following initial values are assigned in this document (values are 16-bit unsigned intergers).

Name	Value	RFC
-----+-----+-----		
Unspecified	0x00	<a href="#">RFC6052</a>
SIIT	0x01	<a href="#">RFC7915</a>
Stateful NAT64	0x02	<a href="#">RFC6146</a>
EAM-SIIT	0x03	<a href="#">RFC7757</a>

## 8. Acknowledgements

The authors will like to recognize the inputs from Tore Anderson in a previous version of this work. Mohamed Boucadair provided very significant inputs.

## 9. References

### 9.1. Normative References

- [RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", [BCP 14](#), [RFC 2119](#), DOI 10.17487/RFC2119, March 1997, <<https://www.rfc-editor.org/info/rfc2119>>.
- [RFC6877] Mawatari, M., Kawashima, M., and C. Byrne, "464XLAT: Combination of Stateful and Stateless Translation", [RFC 6877](#), DOI 10.17487/RFC6877, April 2013, <<https://www.rfc-editor.org/info/rfc6877>>.
- [RFC8174] Leiba, B., "Ambiguity of Uppercase vs Lowercase in [RFC 2119](#) Key Words", [BCP 14](#), [RFC 8174](#), DOI 10.17487/RFC8174, May 2017, <<https://www.rfc-editor.org/info/rfc8174>>.





- [RFC8415] Mrugalski, T., Siodelski, M., Volz, B., Yourtchenko, A., Richardson, M., Jiang, S., Lemon, T., and T. Winters, "Dynamic Host Configuration Protocol for IPv6 (DHCPv6)", [RFC 8415](#), DOI 10.17487/RFC8415, November 2018, <<https://www.rfc-editor.org/info/rfc8415>>.

## 9.2. Informative References

- [I-D.ietf-6man-ra-pref64] Colitti, L., Kline, E., and J. Linkova, "Discovering PREF64 in Router Advertisements", [draft-ietf-6man-ra-pref64-00](#) (work in progress), March 2019.
- [I-D.ietf-v6ops-nat64-deployment] Palet, J., "Additional NAT64/464XLAT Deployment Guidelines in Operator and Enterprise Networks", [draft-ietf-v6ops-nat64-deployment-05](#) (work in progress), April 2019.
- [I-D.ietf-v6ops-transition-ipv4aas] Palet, J., Liu, H., and M. Kawashima, "Requirements for IPv6 Customer Edge Routers to Support IPv4 Connectivity as-a-Service", [draft-ietf-v6ops-transition-ipv4aas-15](#) (work in progress), January 2019.
- [RFC1918] Rekhter, Y., Moskowitz, B., Karrenberg, D., de Groot, G., and E. Lear, "Address Allocation for Private Internets", [BCP 5](#), [RFC 1918](#), DOI 10.17487/RFC1918, February 1996, <<https://www.rfc-editor.org/info/rfc1918>>.
- [RFC6052] Bao, C., Huitema, C., Bagnulo, M., Boucadair, M., and X. Li, "IPv6 Addressing of IPv4/IPv6 Translators", [RFC 6052](#), DOI 10.17487/RFC6052, October 2010, <<https://www.rfc-editor.org/info/rfc6052>>.
- [RFC6144] Baker, F., Li, X., Bao, C., and K. Yin, "Framework for IPv4/IPv6 Translation", [RFC 6144](#), DOI 10.17487/RFC6144, April 2011, <<https://www.rfc-editor.org/info/rfc6144>>.
- [RFC6146] Bagnulo, M., Matthews, P., and I. van Beijnum, "Stateful NAT64: Network Address and Protocol Translation from IPv6 Clients to IPv4 Servers", [RFC 6146](#), DOI 10.17487/RFC6146, April 2011, <<https://www.rfc-editor.org/info/rfc6146>>.
- [RFC6147] Bagnulo, M., Sullivan, A., Matthews, P., and I. van Beijnum, "DNS64: DNS Extensions for Network Address Translation from IPv6 Clients to IPv4 Servers", [RFC 6147](#), DOI 10.17487/RFC6147, April 2011, <<https://www.rfc-editor.org/info/rfc6147>>.



- [RFC6459] Korhonen, J., Ed., Soininen, J., Patil, B., Savolainen, T., Bajko, G., and K. Iisakkila, "IPv6 in 3rd Generation Partnership Project (3GPP) Evolved Packet System (EPS)", [RFC 6459](#), DOI 10.17487/RFC6459, January 2012, <<https://www.rfc-editor.org/info/rfc6459>>.
- [RFC7050] Savolainen, T., Korhonen, J., and D. Wing, "Discovery of the IPv6 Prefix Used for IPv6 Address Synthesis", [RFC 7050](#), DOI 10.17487/RFC7050, November 2013, <<https://www.rfc-editor.org/info/rfc7050>>.
- [RFC7051] Korhonen, J., Ed. and T. Savolainen, Ed., "Analysis of Solution Proposals for Hosts to Learn NAT64 Prefix", [RFC 7051](#), DOI 10.17487/RFC7051, November 2013, <<https://www.rfc-editor.org/info/rfc7051>>.
- [RFC7066] Korhonen, J., Ed., Arkko, J., Ed., Savolainen, T., and S. Krishnan, "IPv6 for Third Generation Partnership Project (3GPP) Cellular Hosts", [RFC 7066](#), DOI 10.17487/RFC7066, November 2013, <<https://www.rfc-editor.org/info/rfc7066>>.
- [RFC7225] Boucadair, M., "Discovering NAT64 IPv6 Prefixes Using the Port Control Protocol (PCP)", [RFC 7225](#), DOI 10.17487/RFC7225, May 2014, <<https://www.rfc-editor.org/info/rfc7225>>.
- [RFC7757] Anderson, T. and A. Leiva Popper, "Explicit Address Mappings for Stateless IP/ICMP Translation", [RFC 7757](#), DOI 10.17487/RFC7757, February 2016, <<https://www.rfc-editor.org/info/rfc7757>>.
- [RFC7849] Binet, D., Boucadair, M., Vizdal, A., Chen, G., Heatley, N., Chandler, R., Michaud, D., Lopez, D., and W. Haeflner, "An IPv6 Profile for 3GPP Mobile Devices", [RFC 7849](#), DOI 10.17487/RFC7849, May 2016, <<https://www.rfc-editor.org/info/rfc7849>>.
- [RFC7915] Bao, C., Li, X., Baker, F., Anderson, T., and F. Gont, "IP/ICMP Translation Algorithm", [RFC 7915](#), DOI 10.17487/RFC7915, June 2016, <<https://www.rfc-editor.org/info/rfc7915>>.

Authors' Addresses



Lishan Li  
Tsinghua University  
Beijing 100084  
P.R.China

Phone: +86-15201441862  
Email: lilishan9248@126.com

Yong Cui  
Tsinghua University  
Beijing 100084  
P.R.China

Phone: +86-10-6260-3059  
Email: yong@csnet1.cs.tsinghua.edu.cn

Cong Liu  
Tsinghua University  
Beijing 100084  
P.R.China

Phone: +86-10-6278-5822  
Email: gnocuil@gmail.com

Jianping Wu  
Tsinghua University  
Beijing 100084  
P.R.China

Phone: +86-10-6278-5983  
Email: jianping@cernet.edu.cn

Fred Baker  
Goleta, CA 93117  
United States

Email: fredbaker.ietf@gmail.com



Jordi Palet Martinez  
The IPv6 Company  
Molino de la Navata, 75  
La Navata - Galapagar, Madrid 28420  
Spain

Email: [jordi.palet@theipv6company.com](mailto:jordi.palet@theipv6company.com)

URI: <http://www.theipv6company.com/>