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Softwires Network Address Translation (SNAT)
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Abstract

Service providers (ISPs) are interested in reducing the use of IPv4 in their internal networks because of the anticipated exhaustion of the IPv4 address space. Softwires Network Address Translation (SNAT) combines IPv4 NAT and IPv4-in-IPv6 softwires to carry IPv4 traffic through the ISP network that uses only IPv6 service. Multiple subscribers are multiplexed through a single external global IPv4 address, reducing the total number of IPv4 addresses in use by the ISP to support Internet traffic to those subscribers.

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1. Introduction

Service providers (ISPs) are interested in reducing the use of IPv4 in their internal networks because of the anticipated exhaustion of the IPv4 address space. Reducing the use of IPv4 addresses will allow the conservation of addresses assigned to the ISP for use in specific places where IPv4 is required. One way of reducing the use of IPv4 addresses is to deploy IPv6 to replace IPv4 in internal networks.

Softwires Network Address Translation (SNAT) combines IPv4 NAT [[RFC3022](#)] and IPv4-in-IPv6 softwire to carry IPv4 traffic through the ISP network where only IPv6 is deployed. [RFC 4925](#) [[RFC4925](#)] describes the two initial softwires WG problem statements, "Hubs and Spokes" ([Section 2](#)) and "Mesh" ([Section 3](#)). The problem that this document addresses is more narrowly scoped than either of these two initial problem statements, focusing on IPv4 over IPv6 only and the specific needs of a large ISP network facing scaling issues from lack of [RFC 1918](#) address space for all of its devices. It most closely resembles the "converse case" of that depicted in Figure 2, Case 2, of [RFC 4925](#) (except that the Host may be IPv4-only, rather than Dual Stack as depicted, and the portion of the network labeled "IPv4-only" is likely larger than that implied in the diagram). SNAT multiplexes multiple subscribers through a single IPv4 address, reducing the total number of IPv4 addresses in use by the ISP to support Internet traffic to those subscribers.

Elements of SNAT are inspired by the proposal from NTT to deploy dual IPv4 NAT and the proposal from Comcast to use IPv4-IPv6-IPv4 translation. SNAT retains the characteristics of IPv4-IPv4 NAT, rather than introducing IPv4-IPv6 translation, while saving IPv4 addresses in the ISP core network. This document has been submitted to foster discussion about these mechanisms for IPv4 address space conservation.

SNAT requires one IPv4-in-IPv6 softwire per subscriber. These softwires will require configuration and special effort for reliability, as well as resources for scaling at the ISP endpoint for potentially thousands or even millions of softwires. SNAT also requires additional functions in subscriber CPEs.

2. Requirements Language

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in [RFC 2119](#) [[RFC2119](#)].

3. Terminology

This document uses softwires terminology described in [Section 1.1 of RFC 4925](#) throughout. The reader is expected to refer to this document for a number of terms and abbreviations. In addition to the terminology defined in [RFC 4925](#), this document defines the following terms:

HGW: Home gateway; the gateway between the subscriber network and the ISP network

Subscriber host or host: A host attached to a subscriber network

SPSWE: Service provider softwire endpoint; the endpoint of the softwires in the ISP network

4. Problem statement and requirements

The motivation for SNAT is to reduce the number of IPv4 addresses in use in an ISP network. The reduction is achieved in two ways:

- o Use NAT to multiplex subscribers through a single global IPv4 address
- o Use softwires to provide IPv4 service through an ISP core network that uses only IPv6 addresses

The following requirements were considered in the design of SNAT:

- o Provide IPv4 service to CPE through NAT similar to familiar NAT in use today
- o Minimize the use of global IPv4 addresses for subscriber IPv4 service
- o Eliminate the use of IPv4 addresses (global or [RFC 1918](#)) within the ISP as much as possible
- o No changes to subscriber CPEs (hosts attached to the subscriber network)

5. SNAT Architecture

As illustrated in Figure 1, SNAT consists of three components: the subscriber home gateway (HGW), the service provider softwire endpoint (SPSWE) and a softwire between the SI in the HGW and the SC in the

SPSWE. The SPSWE performs IPv4-IPv4 NAT translations to multiplex multiple subscribers through a single global IPv4 address. Overlapping address spaces used by subscribers are disambiguated through the identification of tunnel endpoints.

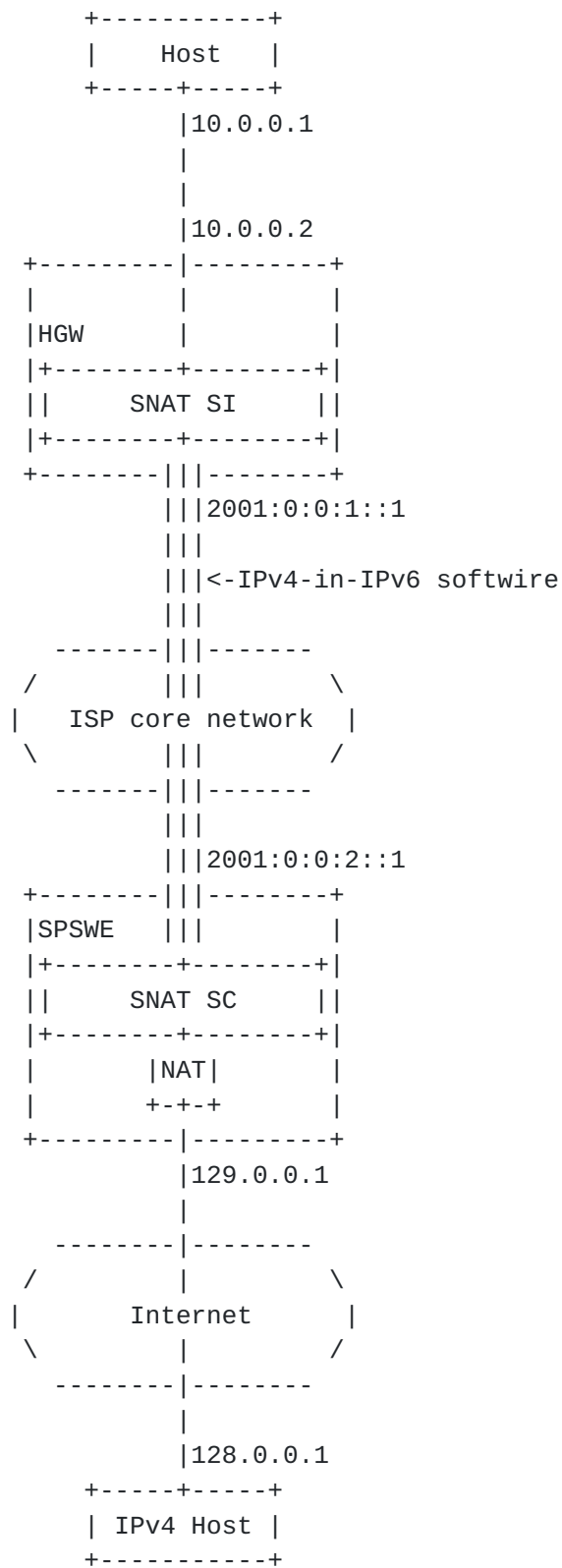


Figure 1: SNAT Architecture

The resulting solution accepts an IPv4 datagram that is translated into an IPv4-in-IPv6 softwire datagram for transmission across the softwire. At the corresponding endpoint, the IPv4 datagram is decapsulated, and the translated IPv4 address is inserted based on a translation from the softwire.

6. Example message flow

In the example shown in Figure 2, the translation tables in the SPSWE is configured to forward between IP/TCP (10.0.0.1/10000) and IP/TCP (129.0.0.1/5000). That is, a datagram received by the HGW from the CPE at address 10.0.0.1, using TCP DST port 10000 will be translated a datagram with IP SRC address 129.0.0.1 and TCP SRC port 5000 in the Internet.

Figure 2: Outbound Datagram

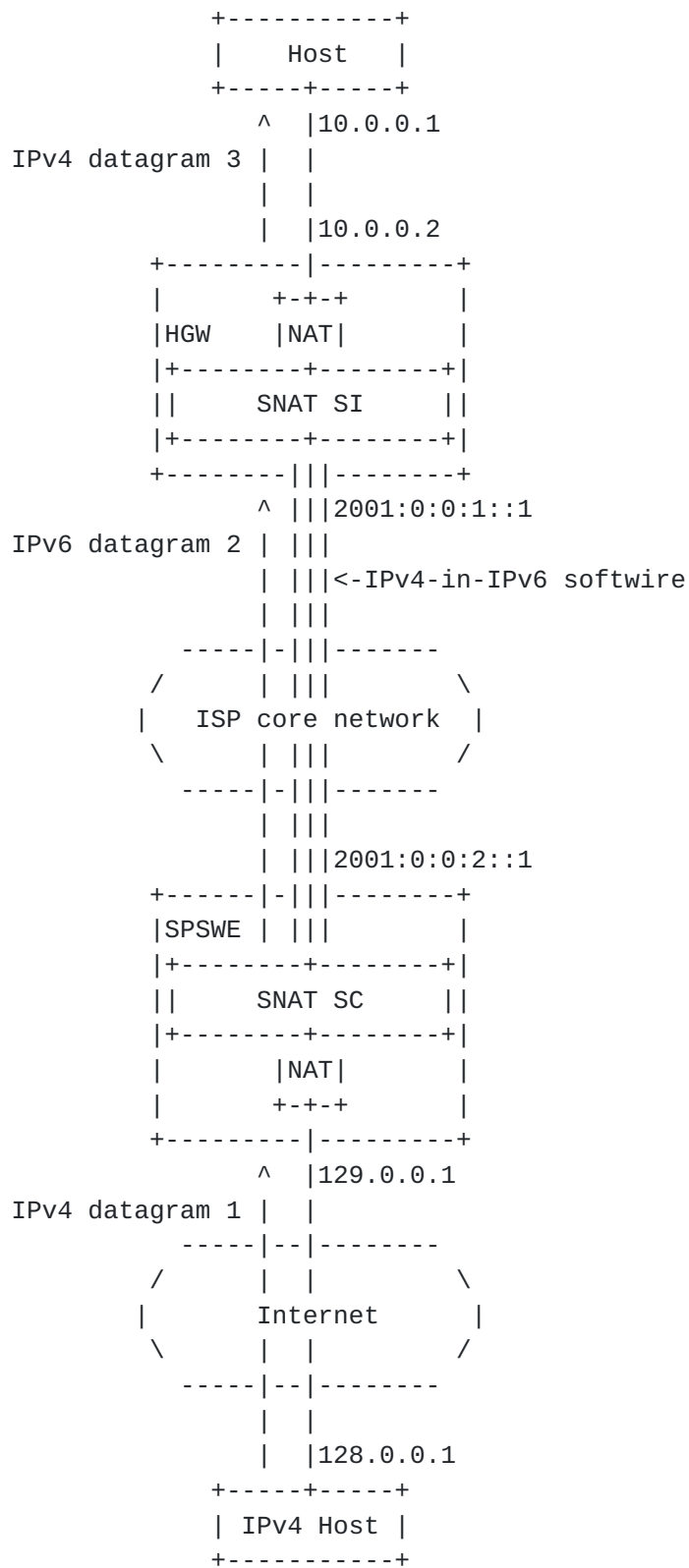
Datagram		Header field	Contents
IPv4 datagram 1		IPv4 Dst	128.0.0.1
		IPv4 Src	10.0.0.1
		TCP Dst	80
		TCP Src	10000
IPv6 Datagram 2		IPv6 Dst	2001:0:0:2::2
		IPv6 Src	2001:0:0:1::1
		IPv4 Dst	128.0.0.1
		IPv4 Src	10.0.0.1
		TCP Dst	80
		TCP Src	10000
IPv4 datagram 3		IPv4 Dst	128.0.0.1
		IPv4 Src	129.0.0.1
		TCP Dst	80
		TCP Src	5000

Datagram header contents

When datagram 1 is received by the HGW, the SI function encapsulates the datagram in datagram 2 and forwards it to the SPSWE over the softwire.

When it receives datagram 2, the SC in the SPSWE hands the IPv4 datagram to the NAT, which determines from its translation table that the datagram received on Softwire_1 with TCP SRC port 10000 should be translated to datagram 3 with IP SRC address 129.0.0.1 and TCP SRC port 5000.

Figure 3 shows an inbound message received at the SPSWE. When the NAT function in the SPSWE receives datagram 1, it looks up the IP/TCP DST in its translation table. In the example in Figure 3, the NAT translates the TCP DST port to 10000, sets the IP DST address to 10.0.0.1 and hands the datagram to the SC for transmission over Softwire_1. The SI in the HGW decapsulates IPv4 datagram from the inbound softwire datagram, and forwards it to the host.



The postamble.

- o Datagram 1 is received on the SPSWE translator network interface. The translator looks up the IPv4-address/port pair in its

translator table, rewrites the IPv4 destination address to 10.0.0.1 and the TCP source port to 10000, and hands the datagram to the SE to be forwarded over the software.

- o The IPv4 datagram is received on the HGW SI. The SI function extracts the IPv4 datagram and the HGW forwards datagram 3 to the host.

Software/IPv4/Port	IPv4/Port
Software_1/10.0.0.1/TCP 10000	129.0.0.1/TCP 5000

SPSWE translation table

8. Supporting multiple subscribers through one IPv4 address

One key advantage of SNAT is the ability to provide Internet access for multiple subscribers through a single global IPv4 address. The SPTE table can be configured to translate traffic from multiple customers through one global IPv4 address. Even a small degree of multiplexing, as few as five subscribers through each global IPv4 address, would give ISPs sufficient IPv4 address space to continue and grow operations until IPv6 is more fully deployed.

9. Setting up state

The translation tables in the SPSWE can be set up dynamically by outbound traffic from a CPE. When the SPSWE receives the initial datagram in a new flow, there will be no corresponding IPv4-address/port pair for that flow in the SPSWE NAT translation table. The NAT selects an unused outbound TCP port, adds the resulting mapping to the NAT translation table, performs the appropriate translation and forwards it to the destination.

The resulting table entry is now in place for translation of returning inbound traffic.

The translation table can also be configured manually, which would allow, for example, traffic to be forwarded to servers on subscriber networks. However, because multiple subscribers may be supported through a single IPv4 address, only one of those subscribers would be able to have statically assigned external server address through the NAT/software.

10. Analysis and Future Work

There are several opportunities for future work on SNAT:

- o SNAT requires provisioning of a softwire from each HGW to an SPSWE. This document should include a description of at least one provisioning mechanism. Candidates include a new DHCP option and anycast.
- o SNAT requires an IPv4-in-IPv6 softwire for each subscriber, and NAT for each flow from the subscriber. What are the effects of scaling this architecture to millions of subscribers?
- o Security issues have not been considered
- o How can the configuration of the IPv4-in-IPv6 softwire be automated?
- o What is the interaction between SNAT and native IPv6 service to the subscriber?

11. Change log

This section shall be removed prior to publication of this document as an RFC.

11.1. Revision -01

- o Eliminated the NAT function in the HGW, which simplifies forwarding IPv4 datagrams over the IPv6 softwire between the HGW and the SPSWE.
- o Added DHCP as a mechanism for tunnel endpoint discovery.

12. Contributors

Mark Townsley suggested elimination of a NAT function in the HGW.

Bernie Volz and Carlos Pignataro provided substantive and editorial review of [draft-droms-softwires-snat-00](#).

13. IANA Considerations

This memo includes no requests to IANA.

14. Security Considerations

Security considerations must be developed.

15. References

15.1. Normative References

- [RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", [BCP 14](#), [RFC 2119](#), March 1997.
- [RFC3775] Johnson, D., Perkins, C., and J. Arkko, "Mobility Support in IPv6", [RFC 3775](#), June 2004.

15.2. Informative References

- [RFC3022] Srisuresh, P. and K. Egevang, "Traditional IP Network Address Translator (Traditional NAT)", [RFC 3022](#), January 2001.
- [RFC4925] Li, X., Dawkins, S., Ward, D., and A. Durand, "Softwire Problem Statement", [RFC 4925](#), July 2007.

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