Network Working Group   JP. Dionne
Internet-Draft   S. Perreault
Intended status: Informational   Viagenie
Expires: February 7, 2013   T. Tsou
                                             Huawei Technologies (USA)
                                                        August 6, 2012

Gap Analysis for IPv4 Sunset
draft-ietf-sunset4-gapanalysis-00

Abstract

   Sunsetting IPv4 refers to the process of turning off IPv4
   definitively. It can be seen as the final phase of the migration to
   IPv6. This memo analyses difficulties arising when sunsetting IPv4,
   and identifies the gaps resulting in additional work.

   described in the Simplified BSD License.

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1. Introduction

The final phase of the migration to IPv6 is the sunset of IPv4, that
is turning off IPv4 definitively on the attached networks and on the
upstream networks.

Some current implementations behavior make it hard to sunset IPv4.
Additionally, some new features could be added to IPv4 to make its
sunsetting easier. This document analyzes the current situation and
proposes new work in this area.

2. Related Work

[RFC3789], [RFC3790],[RFC3791], [RFC3792], [RFC3793], [RFC3794],
[RFC3795] and [RFC3796] contain surveys of IETF protocols with their
IPv4 dependencies.

3. Remotely Disabling IPv4

3.1. Indicating that IPv4 connectivity is unavailable

PROBLEM 1: When an IPv4 node boots and requests an IPv4 address
            (e.g., using DHCP), it typically interprets the absence
            of a response as a failure condition even when it is not.

PROBLEM 2: Home router devices often identify themselves as default
            routers in DHCP responses that they send to requests
            coming from the LAN, even in the absence of IPv4
            connectivity on the WAN.

One way to address these issues is to send a signal to an dual-stack
node that IPv4 connectivity is unavailable. Given that IPv4 shall be
off, the message must be delivered through IPv6.

3.2. Disabling IPv4 in the LAN

PROBLEM 3: IPv4-enabled hosts inside an IPv6-only LAN can auto-
            configure IPv4 addresses [RFC3927] and enable various
            protocols over IPv4 such as mDNS
            [I-D.cheshire-dnsext-multicastdns] and LLMNR [RFC4795].
            This can be undesirable for operational or security
            reasons, since in the absence of IPv4, no monitoring or
            logging of IPv4 will be in place.

PROBLEM 4: IPv4 can be completely disabled on a link by filtering it
            on the L2 switching device. However, this may not be
            possible in all cases or complex to deploy. For example,
            an ISP is often not able to control the L2 switching
            device in the subscriber home network.

One way to address these issues is to send a signal to an dual-stack
node that auto-configuration of IPv4 addresses is undesirable, or
that direct IPv4 communications between nodes on the same link should
not take place.

This problem was described in [RFC2563], which standardized a DHCP
option to disable IPv4 address auto-configuration. However, using
this option requires running an IPv4 DHCP server, which is contrary
to the goal of IPv4 sunsetting. An equivalent way of signalling this
over IPv6 is necessary,, using either Router Advertisements or
DHCPv6.

Furthermore, it could be useful to have L2 switches snoop this
signalling and automatically start filtering IPv4 traffic as a
consequence.

Finally, it could be useful to publish guidelines on how to safely
block IPv4 on an L2 switch.

4. Client Connection Establishment Behavior

PROBLEM 5: Happy Eyeballs [RFC6555] refers to the multiple
            approaches to dual-stack client implementations that try
            to reduce connection setup delays by trying both IPv4 and
            IPv6 paths simultaneously. Some implementations
            introduce delays which provide an advantage to IPv6,
            while others do not [Huston2012]. The latter will pick
            the fastest path, no matter whether it is over IPv4 or
            IPv6, directing more traffic over IPv4 than the other
            kind of implementations. This can prove problematic in
            the context of IPv4 sunsetting, especially for Carrier-
            Grade NAT phasing out.

PROBLEM 6: getaddrinfo() [RFC3493] sends DNS queries for both A and
            AAAA records regardless of the state of IPv4 or IPv6
            availability. The AI_ADDRCONFIG flag can be used to
            change this behavior, but it relies on programmers using
            the getaddrinfo() function to always pass this flag to
            the function. The current situation is that in an IPv6-
            only environment, many useless A queries are made.

   Recommendations on client connection establishment behavior that
   would facilitate IPv4 sunsetting is therefore appropriate.

5. **Disabling IPv4 in Operating System and Applications**

   PROBLEM 7: Completely disabling IPv4 at runtime often reveals
               implementation bugs. Hard-coded dependencies on IPv4
               abound, such as on the 127.0.0.1 address assigned to the
               loopback interface. It is therefore often operationally
               impossible to completely disable IPv4 on individual
               nodes.

   PROBLEM 8: In an IPv6-only world, legacy IPv4 code in operating
               systems and applications incurs a maintenance overhead
               and can present security risks.

   It is possible to completely remove IPv4 support from an operating
   system as has been shown by the work of Bjoern Zeeb on FreeBSD.
   [Zeeb] Removing IPv4 support in the kernel revealed many IPv4
   dependencies in libraries and applications.

   It would be useful for the IETF to provide guidelines to programmers
   on how to avoid creating dependencies on IPv4, how to discover
   existing dependencies, and how to eliminate them. Having programs
   and operating systems that behave well in an IPv6-only environment is
   a prerequisite for IPv4 sunsetting.

6. **IANA Considerations**

   None.

7. **Security Considerations**

   TODO

8. **Acknowledgements**

   TODO

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Authors' Addresses

   Jean-Philippe Dionne
   Viagenie
   246 Aberdeen
   Quebec, QC G1R 2E1
   Canada

   Phone: +1 418 656 9254
   Email: jean-philippe.dionne@viagenie.ca
   URI: http://viagenie.ca

   Simon Perreault
   Viagenie
   246 Aberdeen
   Quebec, QC G1R 2E1
   Canada

   Phone: +1 418 656 9254
   Email: simon.perreault@viagenie.ca
   URI: http://viagenie.ca

   Tina Tsou
   Huawei Technologies (USA)
   2330 Central Expressway
   Santa Clara, CA 95050
   USA

   Phone: +1 408 330 4424
   Email: tina.tsou.zouting@huawei.com