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Locating Session Initiation Protocol (SIP) Servers in a Dual-Stack IP Network
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Abstract

RFC 3263 defines how a Session Initiation Protocol (SIP) implementation, given a SIP Uniform Resource Identifier (URI), should locate the next-hop SIP server using Domain Name System (DNS) procedures. As SIP networks increasingly transition from IPv4-only to dual-stack, a quality user experience must be ensured for dual-stack SIP implementations. This document updates the DNS procedures described in RFC 3263 for dual-stack SIP implementations in preparation for forthcoming specifications for applying Happy Eyeballs principles to SIP.

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1. Introduction

The Session Initiation Protocol (SIP, [RFC3261]) and the additional documents that extended it provide support for both IPv4 and IPv6. However, this support does not fully extend to the highly hybridized environments that are characteristic of the transitional migratory phase from IPv4 to IPv6 networks. During this phase, many server and client implementations run on dual-stack hosts. In such environments, a dual-stack host will likely suffer greater connection delay, and by extension an inferior user experience, than an

IPv4-only host. The need to remedy this diminished performance of dual-stack hosts led to the development of the Happy Eyeballs [RFC6555] algorithm, which has since been implemented in many protocols and applications.

This document updates the DNS lookup procedures of RFC 3263 [RFC3263] in preparation for the specification of the application of Happy Eyeballs to SIP to provide enhanced performance, and consequently user experience, in highly hybridized dual-stack SIP networks. The procedures described herein are such that a dual-stack client should look up both A and AAAA records in DNS and then select the best way to set up a network flow. The details of how the latter is done is considered out of scope for this document. See the Happy Eyeballs algorithm and implementation and design considerations in RFC 6555 [RFC6555] for more information about issues with setting up dual-stack network flows.

Section 4 of this document clarifies the interaction of [RFC3263] with [RFC6157].

2. Terminology

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].

RFC 3261 [RFC3261] defines additional terms used in this document that are specific to the SIP domain such as "proxy", "registrar", "redirect server", "user agent server" or "UAS", "user agent client" or "UAC", "back-to-back user agent" or "B2BUA", "dialog", "transaction", and "server transaction".

This document uses the term "SIP server" that is defined to include the following SIP entities: user agent server, registrar, redirect server, a SIP proxy in the role of user agent server, and a B2BUA in the role of a user agent server.

This document also uses the following terminology to make clear distinction between SIP entities supporting only IPv4, only IPv6 or supporting both IPv4 and IPv6:

IPv4-only UA/UAC/UAS: An IPv4-only UA/UAC/UAS supports SIP signaling and media only on the IPv4 network. It does not understand IPv6 addresses.

IPv6-only UA/UAC/UAS: An IPv6-only UA/UAC/UAS supports SIP signaling and media only on the IPv6 network. It does not understand IPv4 addresses.

IPv4/IPv6 UA/UAC/UAS: A UA/UAC/UAS that supports SIP signaling and media on both IPv4 and IPv6 networks; such a UA/UAC/UAS is known (and will be referred to in this document) as a "dual-stack" [RFC4213] UA/UAC/UAS.

The term "address records" means the DNS records which translate a domain name into addresses within the address family(ies) that the entity supports (as A records provide IPv4 addresses and AAAA records provide IPv6 addresses), regardless of whether the address family was defined before or after this document was approved.

3. DNS Procedures in a Dual-Stack Network

This specification introduces two normative DNS lookup procedures. These are designed to improve the performance of dual-stack clients in IPv4/IPv6 networks.

3.1. Dual-Stack SIP UA DNS Record Lookup Procedure

Once the transport protocol has been determined, the procedure for discovering an IP address if the TARGET is not a numeric IP address but the port is explicitly stated in the URI, is detailed in Section 4.2 of RFC 3263 [RFC3263]. The piece relevant to this discussion is:

> If the TARGET was not a numeric IP address, but a port is present in the URI, the client performs an A or AAAA record lookup of the domain name. The result will be a list of IP addresses, each of which can be contacted at the specific port from the URI and transport protocol determined previously.

Section 4.2 of RFC 3263 [RFC3263] also goes on to describe the procedure for discovering an IP address if the TARGET is not a numeric IP address, and no port is present in the URI. The piece relevant to to this discussion is:

> If no SRV records were found, the client performs an A or AAAA record lookup of the domain name. The result will be a list of IP addresses, each of which can be contacted using the transport protocol determined previously, at the default port for that transport. Processing then proceeds as described above for an explicit port once the A or AAAA records have been looked up.

Happy Eyeballs [RFC6555] documents that looking up the "A or AAAA record" is not an effective practice for dual-stack clients and that it can add significant connection delay and greatly degrade user experience. Therefore, this document makes the following normative addendum to the DNS lookup procedures of Section 4.2 of RFC 3263

[RFC3263] for IPv4/IPv6 hybrid SIP networks and recommends it as a best practice for such dual-stack networks:

> The dual-stack client SHOULD look up all address records (i.e., for all address family(ies) that it supports) for the domain name and add the resulting addresses to the list of IP addresses to be contacted. A client MUST be prepared for DNS lookups to return addresses in families that it does not support; such addresses MUST be ignored as unusable and the supported addresses used as specified herein.

3.2. Indicating Address Family Preference in DNS SRV Records

The Happy Eyeballs algorithm [RFC6555] is particularly effective when dual-stack client applications have significant performance differences in their IPv4 or IPv6 network paths. In this common scenario it is often necessary for a dual-stack client to indicate a preference for either IPv4 or IPv6. A service may use DNS SRV records to indicate such a preference for an address family. This way, a server with a high-latency and/or low-capacity IPv4 tunnel may indicate a preference for being contacted using IPv6. A server that wishes to do this can use the lowest SRV priority to publish hostnames that only resolve in IPv6 and the next priority with host names that resolve in both address families.

4. Clarification of RFC 6157

Section 5 of [RFC6157] specifies that the addresses from the address records for a single target DNS name for a server's DNS name must be contacted in the order specified by the Source and Destination Address Selection algorithms defined in [RFC6724] (the successor of [RFC3484]). Typically, this is done by using the getaddrinfo() function to translate the target DNS name into a list of IPv4 and/or IPv6 addresses in the order in which they are to be contacted, as that function implements [RFC6724].

Thus, if SRV lookup on the server's DNS name is successful, the major ordering of the complete list of destination addresses is determined by the priority and weight fields of the SRV records (as specified in [RFC2782]) and the (minor) ordering among the destinations derived from the "target" field of a single SRV record is determined by [RFC6724].

For example, consider a server with DNS name example.com, with TCP transport specified. The relevant SRV records are:

```
_sip._tcp.example.com.  300 IN SRV 10 1 5060 sip-1.example.com.
_sip._tcp.example.com.  300 IN SRV 20 1 5060 sip-2.example.com.
```

The address records for sip-1.example.com, as ordered by [RFC6724], are

```
sip-1.example.com.  300 IN AAAA 2001:0db8:58:c02::face
sip-1.example.com.  300 IN AAAA 2001:0db8:c:a06::2:cafe
sip-1.example.com.  300 IN AAAA 2001:0db8:44:204::d1ce
sip-1.example.com.  300 IN A 192.0.2.45
sip-1.example.com.  300 IN A 203.0.113.109
sip-1.example.com.  300 IN A 198.51.100.24
```

and the address records for sip-2.example.com, as ordered by [RFC6724], are:

```
sip-2.example.com.  300 IN AAAA 2001:0db8:58:c02::dead
sip-2.example.com.  300 IN AAAA 2001:0db8:c:a06::2:beef
sip-2.example.com.  300 IN AAAA 2001:0db8:44:204::c0de
sip-2.example.com.  300 IN A 192.0.2.75
sip-2.example.com.  300 IN A 203.0.113.38
sip-2.example.com.  300 IN A 198.51.100.140
```

Thus, the complete list of destination addresses has this ordering:

```
2001:0db8:58:c02::face
2001:0db8:c:a06::2:cafe
2001:0db8:44:204::d1ce
192.0.2.45
203.0.113.109
198.51.100.24
2001:0db8:58:c02::dead
2001:0db8:c:a06::2:beef
2001:0db8:44:204::c0de
192.0.2.75
203.0.113.38
198.51.100.140
```

In particular, the destination addresses derived from sip-1.example.com and those derived from sip-2.example.com are not interleaved; [RFC6724] does not operate on the complete list. This would be true even if the two SRV records had the same priority and were (randomly) ordered based on their weights, as the address records of two target DNS names are never interleaved.

5. Security Considerations

This document introduces two new normative procedures to the existing DNS procedures used to locate SIP servers. While both of these procedures are optimizations designed to improve the performance of dual-stack clients, neither introduces any new security considerations.

The specific security vulnerabilities, attacks and threat models of the various protocols discussed in this document (SIP, DNS, SRV records, Happy Eyeballs requirements and algorithm, etc.) are well documented in their respective specifications.

6. IANA Considerations

This document does not require any actions by IANA.

7. Acknowledgments

The authors would like to acknowledge the support and contribution of the SIP Forum IPv6 Working Group. This document is based on a lot of tests and discussions at SIPit events, organized by the SIP Forum.

This document has benefited from the expertise and review feedback of many participants of the IETF DISPATCH and SIPCORE WG mailing lists as well as those on the SIP Forum IPv6 Task Group mailing list. The authors wish to specifically call out the efforts and express their gratitude for the detailed and thoughtful comments and corrections of Dan Wing, Brett Tate, Rifaat Shekh-Yusef, Carl Klatsky, Mary Barnes, Keith Drage, Cullen Jennings, Simon Perreault, Paul Kyzivat, Adam Roach, and Richard Barnes.

8. Revision History

[Note to RFC Editor: Please remove this entire section upon publication as an RFC.]

8.1. Changes from draft-ietf-sipcore-dns-dual-stack-04 to draft-ietf-sipcore-dns-dual-stack-05

Simplified the acknowledgments.

Improve wording and punctuation.

Rewrote Section 4 based on critiques on the Sipcore list. Included an example by Adam Roach.

Replaced "RR's" with "records" per suggestion by Jean Mahoney.

8.2. Changes from draft-ietf-sipcore-dns-dual-stack-03 to draft-ietf-sipcore-dns-dual-stack-04

Changed the "updates" specification to add RFC 3263 and remove RFC 6157.

Added Simon Perreault to the acknowledgments.

Minor wording changes.

8.3. Changes from draft-ietf-sipcore-dns-dual-stack-02 to draft-ietf-sipcore-dns-dual-stack-03

Described the relationship to RFC 3263 as "update", since the existing wording in 3263 is not what we want. Arguably, the new wording is what was intended in 3263, but the existing wording either does not say that or says it in a way that is easily misunderstood.

Described the relationship to RFC 6157 as "clarification", since the described interaction between 3263 and 6157 appears to be the only reasonable interpretation.

Revised wording, punctuation, and capitalization in various places.

Clarified that this draft does not document Happy Eyeballs for SIP, but is preparatory for it.

Attempted to use "update" for text that is definitively a change to the preexisting text and "clarify" for text that is a more clear statement of the (presumed) intention of the preexisting text.

Removed normative words from section 1, the introduction.

Copied definition of "address records" from RFC 2782 (SRV records) to allow the specifications to expand automatically to include any new address families.

Relocated the text requiring a client to ignore addresses that it discovers in address families it does not support from section 4.2 (which describes why the situation arises) to section 4.1 (which describes how clients look up RRs).

Clarified the interaction with RFC 6157 (source and destination address selection in IPv6) to specify what must have been intended: The major sort of the destinations is the ordering determined by priority/weight in the SRV records; the addresses derived from a single SRV record's target are minorly sorted based on RFC 6157.

Removed editor's name from the acknowledgments list.

9. References

9.1. Normative References

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9.2. Informative References

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