Client Dualstack Subnets in DNS Queries
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Abstract

During the period of IPv6 transition, IP-based Geolocation (GeoIP) applications are identified as a challenge and speed bump for ICPs (Internet Content Providers) to migrating their service to IPv6. Some studies and operational experiences show that the accuracy of IPv6 GeoIP is relatively poor in comparison to their IPv4 counterparts. This memo proposed to include client’s dualstack subnets into DNS queries to provide better IPv6 GeoIP.

REMOVE BEFORE PUBLICATION: The source of the document with test script is currently placed at GitHub [Dualstack-ECS-GitHub]. Comments and pull request are welcome.

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1. Introduction

During the period of IPv6 transition, IP-based Geolocation (GeoIP) applications are identified as a challenge and speed bump for ICPs (Internet Content Providers) to migrating their service to IPv6. The key issue on GeoIP is the accuracy which however vary between IPv4 and IPv6. Some studies and operational experiences [ipv6geo] show that the accuracy of IPv6 GeoIP is relatively poor in comparison to their IPv4 counterparts.

One typical example of GeoIP application in DNS field is that many authoritative nameservers today return different and tailored responses based on the perceived topological location of the users. If IPv6 GeoIP is not precise enough, the performance of topology-sensitive authoritative nameserver is poorer in IPv6 than IPv4. Users’ experience is impacted, and it may end up with hesitation for the authoritative DNS operator to update its DNS to Dual Stack. It is a problem.

To provide a better IPv6 tailored DNS response in dual-stack environment, this memo proposes to enable recursive server and Client to include their IPv4 and IPv6 subnets into ECS Option [RFC7871] in DNS queries. Authoritative nameservers can make a better use of this dual-stack subnet information for a tailored response.
2. GeoIP and its Challenge in IPv6

Knowing where your customer access your Internet service is very important in modern Internet. It can be used for geolocation-aware application to achieve service efficiency such as Ads pushing and service recommendation. It is useful for Global Server Load Balance (GSLB) such as DNS-based Content Distribution to achieve better network utilization and users experience. It is also vital for security policy and service access control usually referred as to Geoblocking.

One important geolocation used in Internet is IP-based Geolocation (GeoIP) which is usually collected and maintained by RIRs and ISPs when IP address block are registered, deployed and even traded. Generally there are mainly two categories of GeoIP: location of physical geography and location of network topology (or ISP network information). The former usually includes the country, region, city ZIP code, longitude and latitude of a particular IP. The later is mainly network information attached to a IP address like ISP registration information and AS number. Usually they are combined to generate a appropriate result for location-based application. For example, only knowing the ISP information of a IP address is not enough. GSLB application may have many servers located in the same ISP network but in different physical location. Precise physical location like city or street is of great help for this case.

The network information of IP address is accurate and deterministic which can be easily learnt from Whois database, route reviews and CIDR reports. However, the accuracy of physical location vary between IPv4 and IPv6 based on our experience. Since IPv4 has been used for many years, IPv4 GeoIP is relatively more accurate especially in the aspect of accuracy of physical geography location. In contrast IPv6 is newly deployed. The network information of a new IPv6 block may not be well documented or updated. Some evidence and study shows [ipv6geo] that the accuracy of IPv6 GeoIP is relatively poor in comparison to their IPv4 counterparts.

In addition, the huge space of IPv6 address, as the major merit of IPv6, however makes it impossible to gain precise location of each IP block by tracing them (tracert on each IP subnet). This approach is very common and efficient in IPv4 network for GSLB of large Internet company.

To the best knowledge of the authors, no evidence shows the available open GeoIP service providers take advantage of connection between IPv6 and IPv4 GeoIP, or try something like translating IPv6 GeoIP lookup to IPv4 GeoIP queries. Some GeoIP providers (like Maxmind) only go with IPv4 addresses that contain an embedded IPv4 address.
It is most likely that the Regional Whois Registry, online lookup services (like IP2Location.com) and off-line database (MaxMind GeoIP2) build separate systems between IPv4 and IPv6 without any reference or mapping.

3. Methodology and targeted Scenarios

It is an intuition that if IPv6 GeoIP is not as good as IPv4 GeoIP especially in terms of accuracy of physical location, why not take the physical location of the client's IPv4 subnet into consideration for the client's IPv6 GeoIP purpose?

There are two valid assumptions for this approach. One is that the lack of accurate physical location of IPv6 address is the main cause for poor IPv6 GeoIP. The second assumption is that the dual-stack host assigned with both IPv6 and IPv4 addresses has only one physical location which should be tied to its IPv4 and IPv6 GeoIP. Since IPv4 GeoIP database is relatively stable and more accurate, it is wise to map IPv6 and IPv4 subnet, and take IPv4 subnet as a certain key to search the IPv4 GeoIP database (especially for physical location) to deliver a better result as one optional result of IPv6 GeoIP information.

To take advantage of IPv4 GeoIP for IPv6 GeoIP purposes, the basic approach is to make IPv4 subnet visible for IPv6 geolocation-based applications. Existing practice shows that a topology-sensitive authoritative nameservers may receive a AAAA query from IPv4 transport, or receive a AAAA query with an ECS option FAMILY=1. It can utilize the perceived IPv4 subnet to respond an appropriate AAAA record according to client’s geolocation information based on IPv4 GeoIP database. However, when authoritative server received a AAAA query from IPv6 transport or a AAAA query with ECS option FAMILY=2, it can only rely on less accurate IPv6 GeoIP available.

Multihoming is an issue for clients using dual-stack ECS, because IPv4 and IPv6 addresses of a client or a site may be assigned by different upstream ISPs. However the physical location of IPv4 still informative and useful to enhance the accuracy of IPv6 GeoIP. For example, Client lived in city_1 (or street_1) may have two upstream ISP, ISP_1 for IPv6 network and ISP_2 for IPv4 network. The authoritative server can generate tailored AAAA response according to the location of ISP1 and city_1 (or street_1) which are retrieved from both IPv4 and IPv6 GeoIP database.

Different from ECS mainly applied on public DNS, the scenarios of Dual-stack ECS are mainly on stub-resolver and ISP’s resolver who are able to include their IPv4 and IPv6 subnet into DNS queries.
4. Dual-stack EDNS Client Subnet

Note that Dual-stack ECS is to be define, extend existing ECS or defined a new one. More effort should also be put on the behavior of authoritative server if the community think dual-stack ECS is a good idea.

5. Security Considerations

TBD

6. IANA considerations

No IANA considerations for this memo

7. Acknowledgments

8. References

[Dualstack-ECS-GitHub]  


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