End-User Mapping: Next Generation Request Routing for Content Delivery – Public Review

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To speed web delivery, websites use content delivery networks (CDNs) to deliver content from servers around the world. How does the CDN direct a client to a nearby server? One approach is to use DNS to return different IP addresses depending on which client queries. This approach is complicated by the DNS architecture, in which the CDN's authoritative name server communicates only with the client's local recursive resolver (LDNS), not the client, and so knows the LDNS IP address, but not the client IP address. If an LDNS only serves clients with similar network locations, then the CDN can direct to a server that should work well for all users. Unfortunately for DNS-based redirection, some LDNS, including public resolvers like Google Public DNS and OpenDNS, serve distributed clients. For such an LDNS, a CDN cannot use standard DNS to select a server that will be optimal for all clients.

Partly to overcome this limitation, some content providers have turned to anycast to direct client traffic using BGP routing, rather than DNS redirection.

To instead overcome the challenge within DNS, a number of companies proposed the edns-client-subnet DNS extension (currently an IETF draft) in which an LDNS passes a prefix of the client's IP address to the authoritative name server. Previous work showed some CDNs had adopted the extension, but little was publicly known about the performance improvements it enabled.

This Experience Track paper describes Akamai's rollout of end-user (as opposed to LDNS) redirection using edns-client-subnet. While the challenge of mapping clients based on their LDNS was well known, one of this paper's contributions is quantifying the problem for, in essence, all Internet clients in an era that has seen the rise of public resolvers. The paper then measures the performance improvement seen by clients of public resolvers once Akamai started using end-user mapping. To make the results relevant beyond the particulars of Akamai's deployment, the paper finishes with a study that compares, for different CDN sizes, the impact of adding more sites versus enabling end-user mapping.

The SIGCOMM Program Committee was *very enthusiastic* about this Experience Track paper: the results are new to the research community and based on real client measurements, and even few companies can make the measurements afforded by Akamai's high query volume and large worldwide server deployment. The paper presents actual production performance and load numbers, rather than obfuscating them.

Despite the enthusiasm, the Program Committee mentioned minor limitations. First, the results are not surprising. However, quantifying performance at this scale is valuable and a great use of the Experience Track. Second, the paper does not detail Akamai's mapping system. Beyond not addressing how Akamai selects the server for a client, the paper does not describe how Akamai decides the prefix length granularity for a particular edns-client-subnet reply. Third, the paper only evaluates end-user mapping for open resolvers (where it is most valuable), because most other LDNS have not adopted edns-client-subnet. Will the paper's performance projections for these other LDNS be realized in practice, given that they require adoption by LDNS that currently have CDN-unfriendly deployments?

This paper demonstrates that end-user mapping allowed Akamai to overcome a known limitation with DNS redirection and improve user performance, providing new data in the debate over what CDN designs make the most sense in different contexts. When is anycast or DNS redirection better? What are the tradeoffs in having servers in many ISP-hosted locations versus a small number of well-connected locations? At what granularity should a CDN make mapping decisions, what measurements should drive those decisions, and how often should they be updated? Different CDNs have arrived at different answers. Similar to Akamai, Google has a large number of locations, selected by DNS and edns-client-subnet. Anycast is experiencing a surge, with a recent Microsoft paper describing its move from a 3rd party DNS-based CDN to its own anycast CDN, accompanied by an expansion to more locations, and LinkedIn presenting a similar shift. Evidence even suggests that some CDNs combine approaches, as with EdgeCast using edns-client-subnet to hand out one from a set of anycast addresses. Anycast enthusiasts argue that it avoids the mapping overhead and LDNS-induced inaccuracies of DNS redirection. This paper's approach improves mapping accuracy at the cost of increased overhead. Will the impressive results in this paper spur further adoption of edns-client-subnet by LDNS and by CDNs?