GeoFeed in the wild: A case study on StarlinkISP.net

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1. Introduction

Low-earth-orbit (LEO) satellite networks, exemplified by SpaceX's Starlink, Eutelsat's OneWeb, Amazon's Project Kuiper and Telesat's Lightspeed and followed by others, have revolutionized the Internet access, particularly in rural areas, in the air and on the sea, where traditionally Internet access technologies are unavailable, too costly, very limited or simply impossible. Besides lower latency and higher capacity on the ground, LEO networks also introduce new challenges such as frequent satellite handover. For example, Starlink hands over every 15 seconds, fixed at the 12th, 27th, 42nd and 57th seconds off each minute. With a different satellite and likely ground station, the latency between user terminal (i.e., dish) and user's home point-of-presence (PoP) changes greatly, which confuses TCP congestion control algorithms (i.e., a sudden latency increase leads to premature timeout and decrease results in packet reordering and duplicate acknowledgment). TCP and QUIC adjustment and bitrate adaptation are used to improve protocol and application performance over LEO networks [1].

Another feature introduced by satellite networks is a user can be very far away from their PoP to the Internet, especially when inter-satellite links are used. To better serve the user with geo-relevant contents (e.g., local TV, weather, news and ads), IP geolocation (IP-geo) is needed, also for content distribution rights and service differentiation. Traditional IP-geo relies on whois (but only at IP address registration and organization level), DNS (but not all IP addresses have PTR records and not all PTR records have correct, meaningful geo-hints such as airport and CLLI code), and inference from known landmarks (e.g., by minimal latency), however, none of them are pervasive and conclusive enough. Thus GeoFeed is proposed and gradually adopted by Internet service providers (ISPs) [2,3]. Normally GeoFeed contains IP address blocks with prefix length, two-letter country code, state/province/region, and city, and is published and updated by ISPs at certain websites and announced in whois (e.g., the geofeed entry). With a well-maintained and updated GeoFeed, content providers can serve customers properly according to the client's IP address. ***But is it really the case on the real Internet today?***

2. A case study on StarlinkISP.net

However, the adoption, quality and use of GeoFeed vary a lot among network and content providers. This position paper focuses on StarlinkISP.net, the ISP of Starlink, a division of SpaceX, as an emerging global ISP with more than 7 million users in more than 150 countries by August 2025, with its own access (LEO satellite) and backbone (terrestrial) networks. Starlink's backbone address space is 149.19.108/23 and 206.224.64/19, without meaningful PTR record (and corresponding IPv6 addresses with the same host.starlinkisp.net), and customer address space is named customer.{PoP's extended CLLI code}.pop.starlinkisp.net in both IPv4 and v6. Furthermore, Starlink GeoFeed is published at [4]. For example, a Starlink dish in Victoria, BC, Canada has a temporary, external public IPv4 address (170.203.207.244/21) and a unique CGNAT address (100.76.147.112/10), as well as various IPv6 addresses through SLAAC and DHCP prefix delegation, with PTR customer.sttlwax1.pop.starlinkisp.net indicating the Seattle, WA, USA PoP and "170.203.207.0/24,CA,CA-BC,Vancouver" in the GeoFeed.

Through GeoFeed, Starlink users shall receive geo-relevant contents. However, we have seen a lot of user complaints, particularly on Reddit r/Starlink, about sudden change of external IP addresses (which is unavoidable for CGNAT and even public IP users, or when crossing PoP boundaries as Starlink is yet to support PoP-level mobility) and irrelevant contents such as local TV channels, weather, news and ads. Upon close inspection, some are due to user errors but there are considerable instances due to Starlink and content providers on how to provision and use GeoFeed, which motivates the research leading to this position paper. By archiving StarlinkISP's GeoFeed at [5] since 2024, we have observed a list of issues. First, GeoFeed at Starlink, likely other ISPs too, is still a manual process, prone to human errors (e.g., wrongly listed Calgary in BC instead of Alberta, Kansas City in Kansas not Missouri State, and inconsistent spelling such as both Brasilia and Brasília in the same GeoFeed at the same time). A proper review, commonly adopted at other ISPs such as T-Mobile, can eliminate such errors.

As a fast-growing ISP, Starlink constantly acquires IP address blocks from others, and also frequently shuffles address blocks among its users. Human errors occur often. For example, when the new Montreal, QC, Canada PoP went live in August 2025, many eastern Canadian Starlink users were moved from the New York City PoP to Montreal, as reflected in their PTR record, which is still used by some content providers as GeoFeed is not universally available. More than one month later, some Starlink users are still bumped between the New York City (nwyynyx1) and Montreal (mntlcan1) PoP according to their PTR record, with IPv6 PTR in San Jose, CA, USA (snjecax1), while traceroute reveals they have been always with the Montreal PoP for both IPv4 and IPv6 since August 2025. It is a clear error exposed to the world. Furthermore, GeoFeed geo-granularity is highly inconsistent (most only at country level, while the US at PoP level with additional entries for Montana and Maine users associated with the Calgary and Montreal PoP, and similarly in Australia). A Starlink dish inside the Arctic Circle is listed as Vancouver, more than 2400km away, according to StarlinkISP's GeoFeed.

In addition to user and provider errors and granularity issues, a more pressing issue is that GeoFeed is not timestamped and does not have a time-to-live (TTL) field like DNS, while GeoFeed, similar to DNS, is frequently cached (too long) nowadays. When Starlink shuffles IP address blocks among users, users complain that they are geo-located to faraway states, countries and even continents, even if Starlink updates its GeoFeed correctly, for a few days and even weeks, as their content provider used the cached GeoFeed for too long. Some content providers misused PTR records even when GeoFeed is available. Although the GeoFeed RFC [2] hinted the use of timestamp by HTTP cache control fields such as Expires and max-age, HTTP semantics may not be consistent with GeoFeed, especially as many GeoFeed files are hosted by third-parties (e.g., GitHub) without HTTP header control. Starlink does export its GeoFeed timestamp in a separate file at [6] but does not document and publicize it and previously updated the timestamp periodically instead of on updates. Without a proper TTL, content or geolocation providers may have to refresh it very often causing high overhead at both the network and IP-geo provider side, or risk serving with an outdated GeoFeed if only refreshing weekly or even daily.

3. Broader impact

It shall be noted such issues are not unique to Starlink only. A passenger aboard a Porter Airlines flight from Victoria to Ottawa, ON, Canada found their inflight WiFi provided by Viasat associated with the Denver, CO, USA PoP. For Ookla, it relies on GeoFeed to pick the speedtest.net servers in Toronto where Porter Airlines is headquartered, while Cloudflare and Google serve the same passenger's request in their Denver data centers. *Which approach is more appropriate?* This discrepancy reveals a

common assumption under the current Internet architecture, i.e., users are close to their PoP to the Internet, which has been invalidated by many satellite networks, especially when geosynchronous equatorial orbit (GEO) satellites or inter-satellite links are used (and to some extent for terrestrial mobile Internet providers too). For Starlink, DNS PTR, if presented correctly, indicates the PoP location, and GeoFeed, if updated correctly with reasonable granularity, indicates the user location. These two locations can be very far away, e.g., African Starlink users initially were associated with European PoPs. With new PoPs going alive in Africa, some contents are still served in Europe or further.

4. Recommendations

Thus, IAB and IETF shall consider to introduce meta (control) information together with the GeoFeed, similar to the DNS SOA record, instead of relying on external hints such as HTTP Expires or max-age header. One backward compatible approach is to have the TTL (in seconds) and timestamp (e.g., Unix epoch in seconds) info in the first line of a GeoFeed file as a comment (e.g., #3600@1234567890!), which is allowed by the current RFC [2]. GeoFeed providers must provide an embedded timestamp in GeoFeed and set a proper TTL before the next update. GeoFeed consumers, e.g., content or IP-geo providers, shall crosscheck the embedded timestamp and respect the declared TTL, and refresh for a newer version when appropriate. Furthermore, IAB and IETF shall give guidance on the geo-granularity of GeoFeed, e.g., at a city or metropolitan level, consistently among terrestrial and non-terrestrial providers. Starlink dish contains a GPS receiver, but cannot expose the user's exact GPS location unless explicit consent. When permitted, the devices on the local network can retrieve the dish's GPS coordinates, so some guideline on how to use such info is needed, likely beyond IAB and IETF.

5. Conclusions

In summary, GeoFeed is very important in today's Internet to assist geo-relevant content delivery and service differentiation, however, the adoption, quality and use of GeoFeed vary a lot among network and content providers, and shall be greatly improved for a more correct, accurate and consistent user experience, and IAB and IETF can play an important role in this process. Although this position paper focuses on a case study on StarlinkISP.net, given its fast growth, it demonstrates some of the intrinsic weaknesses and problems in the current GeoFeed RFC and practice. More importantly, the assumption that users and their PoP are close enough cannot be guaranteed in today's Internet with the emerging non-terrestrial networks. Thus we call for IAB and IETF, together with network, content and IP-geo providers, to come up with appropriate guidelines. As an academic research group, even though interacting with Starlink which also adopted our research tools and bug fixes in their mobile app and backbone network, we have limited persuading power, as GeoFeed is not on Starlink's high priority list.

References

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