

Web Packaging for Bringing Broadband Internet to People in Underserved and Unserved Areas

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Satellite broadband serves a crucial role in bridging the digital divide by connecting under-served and unserved areas where terrestrial infrastructure is infeasible. Current satellite broadband communications are dominated by satellites in geosynchronous orbit (GEO). Since GEO satellites orbit about 36,000 km above the earth, GEO satellite broadband has long latency. Also, regulatory constraints in various regions limit the available bandwidth and permitted transmission power.

Minimum Round Trip Time (RTT) in a typical GEO satellite system is around 500 milli-seconds due to the propagation delay alone. A study by Mike Belshe showed that RTT between a web client and a web server matters much more than bandwidth for faster page load time: improvement in page load time diminishes as the data rate increases beyond 5 Mbps at a fixed RTT, while page load times improve with the decreasing RTT at a fixed bandwidth. This is because a web page requires about 70 requests and the number of domains per page is about 20 according to the HTTP Archive. Therefore, page load time could be significantly longer in a high RTT Internet service network such as GEO satellite broadband.

The transport layer also suffers over a high RTT link. Most of the TCP implementations are not optimized for high bandwidth delay product satellite links and off-the-shelf TCP suffers the following: startup delay to increase the congestion window, limited congestion window and/or limited socket buffer size at steady state and loss recovery delay.

As a result, GEO satellite broadband relies on web acceleration techniques to reduce page load time. Caching and HTTP prefetching proxies on the satellite terminal cache static web resources and prefetch dynamic content in real time. However, prefetching and caching by web acceleration proxies will no longer work as HTTPS is adopted by most web sites.

Moreover, TCP Performance Enhancing Proxies (PEP) have alleviated degraded TCP performance in satellite broadband. The recent introduction of QUIC introduces more difficulties for satellite links. With HTTP over QUIC, it is not possible to accelerate HTTP by prefetching and caching nor to accelerate TCP by TCP PEPs.

We fully understand that transition to HTTPS and subsequently to QUIC are necessary steps to provide security and privacy to users, to protect against pervasive monitoring, and to defend against tampering and ossification of network protocols by middle boxes. We therefore support a solution to improve the performance over high bandwidth delay product satellite links without making any changes to end-to-end encryption.

Web packaging brings new potential possibilities to improve the performance in satellite broadband in the post-HTTPS and post-QUIC Internet. Web packaging can provide official delegation of content, can

ensure that the content cannot be tampered with, and can also provide privacy to users with encrypted transport. Given the official delegation by content providers, web pages and content can be prefetched and cached by satellite terminals during off-peak hours when the bandwidth is available. They can also be efficiently broadcast by the satellite to the terminals whenever bandwidth is available, and the terminals can selectively receive and cache them according to the needs of the local users. Using off-the-shelf web agents with support for web packaging, when a user in satellite broadband visits a web page, it can be served from the cache in the satellite terminal to the user with guaranteed authenticity and integrity instantly thereby making web pages and content available most of time regardless of any disadvantaged link conditions and providing the best QoE to a user.

There is a great concern in the community on the potential use of web packaging for market power consolidation and further monopoly if content owners delegate the content only to a small number of web companies. Therefore, it is highly recommended to extend the delegation beyond a handful of big Internet companies and offer it to small players, such as Satellite Broadband providers, to prevent web packaging from making the Internet more monopolized and less democratic.

Satellite broadband is seen as an effective and compelling solution to overcome the digital divide. Rural Internet, cellular backhaul and community WiFi are all existing services achieving that goal today. As explained above, the QoE of these valuable services may significantly degrade as QUIC and HTTPS become widespread. Web packaging with official delegation and integrity protection can be a win-win solution to the problem. With an open and fair use of web packaging technology, a child in a remote village or a person on an island can enjoy the Internet comparable to people with fiber and 5G links in cities. Therefore, we strongly support the open web packaging for all initiative.