XipLink LEO-Boost feature set

Enhance Application Performance. Improve Traffic Priority. Enable Consistent Service.

INTRODUCTION

Enterprises and service providers are increasingly deploying Low Earth Orbit (LEO) services to their remote locations to help meet this growing demand. LEO satellite services offer affordable high-speed internet access, significantly reduced latency, and rapid installation.

However, LEO satellite service performance faces several challenges that can impact user experience. While these satellites typically offer lower latency than traditional options, factors like satellite handoff and user mobility can lead to inconsistent latency, affecting real-time applications and performance. Additionally, environmental factors, such as adverse weather, can further degrade signal quality, while the need for specialized user equipment adds complexity to the user experience.

XipLink's XipOS solution empowers service providers to optimize application performance and ensure consistent service quality over LEO networks, delivering the best possible end-user experience. XipOS includes a comprehensive suite of features that deliver an industry-leading multi-path/multi-orbit SD-WAN solution. Key capabilities include link balancing and bonding, intelligent traffic steering, application-aware adaptive Quality of Service (QoS), TCP performance optimizations, as well as support for firewall, IPSec and IP routing.

This document highlights the features specifically designed to enhance application performance over LEO links and services. These features include **Real-time Link Intelligence**, **SCPS-TP rate control enhancements**, **Adaptive QoS and Application priority**, **Dynamic buffer management**, and **Selective stream duplication**.

REAL-TIME LINK INTELLIGENCE

XipOS real-time link intelligence, is a capability within XipLink's SD-WAN feature set, that is continuously monitoring the active link(s) for quality metrics including bandwidth, queue delay (each direction) and loss percentage. This supports automatic adaptation of the entire Quality of Service framework to dynamic and reconfigurable network topologies, available capacity and real-time link quality.

Real-time link intelligence enables XipOS to rapidly adapt to bandwidth changes, packet loss and delay. It is also used to control buffer bloat, thereby delivering enhanced QoE. Realtime monitoring uses multiple learning & predictive algorithms that operate at different levels, resulting in optimum performance and provides feedback to XipOS QoS engine, SCPS-TP algorithms and XipLink's Link Balancing & Bonding (LBB) function.

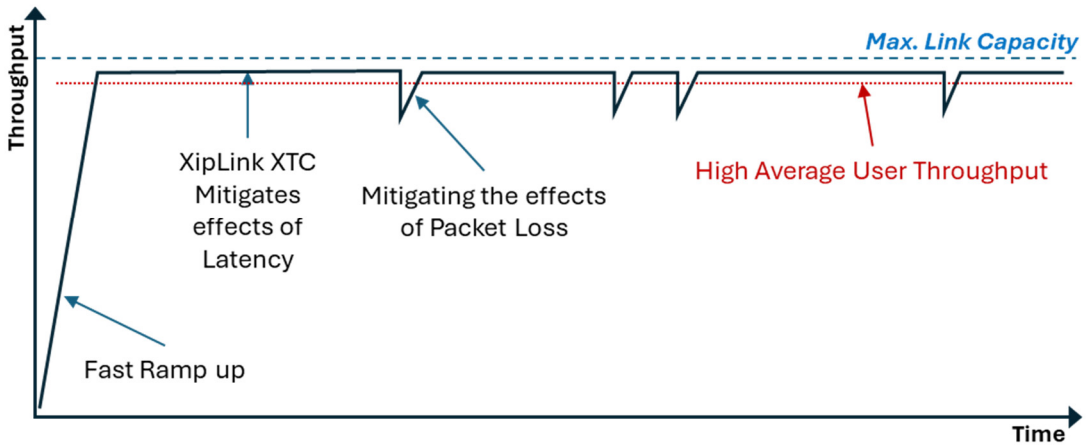
SPACE COMMUNICATION PROTOCOL STANDARD – TRANSPORT PROTOCOL (SCPS-TP) AND OPTIONAL ENHANCEMENTS

XipLink's SCPS-TP solution integrates advanced functionality developed over 20 years of engineering and proven commercial deployments, ensuring optimal utilization of available satellite bandwidth. In addition to TCP protocol acceleration, XipOS SCPS-TP features—combined with XipOS' real-time link intelligence—enhance TCP performance not only over traditional GEO-based networks but also across highly variable LEO bandwidth. Key SCPS-TP features and enhancements include:

XipLink Transport Control (XTC) Modes are rate control and congestion control algorithms that are used to maximize capacity on each wireless air interface, beyond the single identified default mechanism offered in a SCPS connection. As a result, XipOS can deliver significantly more throughput when the rate control algorithm is properly matched to the wireless network where the optimizer or software is installed.

Dynamic Rate Control (DRC) Mode is specified as the default congestion control mechanism for a SCPS connection over a wireless network. DRC is typically recommended when the available bandwidth is unknown or varies widely, often on dynamic TDMA or DVB-RCS networks, particularly at remote sites.

Delay-based Rate Control (DBRC) mode is a delay-based algorithm like TCP Vegas, with proprietary improvements, that dynamically discovers the available bandwidth and then anticipates and reduces the output rate before congestive loss occurs. XipOS uses DRC to rapidly determine the available bandwidth and will either increase or decrease TCP output as the available bandwidth varies. This rapid convergence is accomplished by calculating buffering that occurs within the network using Volume Based algorithms. XipOS DBRC then rapidly controls the output TCP flow rate to minimize bufferbloat and ensure that the smallest buffers are not overrun, which would cause packet loss.



XipLink Optimized TCP performance over a typical satellite link

Fast Start technology enables data requests to be sent in the initial connection opening, allowing for single round-trip time for connection setup and web object fetches while maintaining data integrity. XipLink's fast start is based on the efficient integration of RFC 1644. Standard TCP meanwhile uses a 3-way handshake before data communications can begin. The benefits of fast start

are most apparent for communications where multiple connections are used together in sequence, such as HTTP and various client-server applications.

Selective Negative Acknowledgements (SNACK) allow for swift response to packet loss. Communications can continue robustly even at very high bit error rates. This makes XipLink Multi-Orbit SD-WAN solution very resilient to rain fade and other weather conditions. SNACK is more bit-efficient than SACK and is more effective against multiple losses in a bandwidth-delay product, which is common with wireless communication interference loss.

Acknowledgment Frequency Reduction (AFR) reduces the number of acknowledgments the receiver will send back as data is received. When activated, it will use a delayed acknowledgement time instead of the TCP-described every second packet. Acknowledgements can be reduced to as much as is practical, further saving satellite capacity.

DYNAMIC BUFFER MANAGEMENT (BUFFER BOOST)

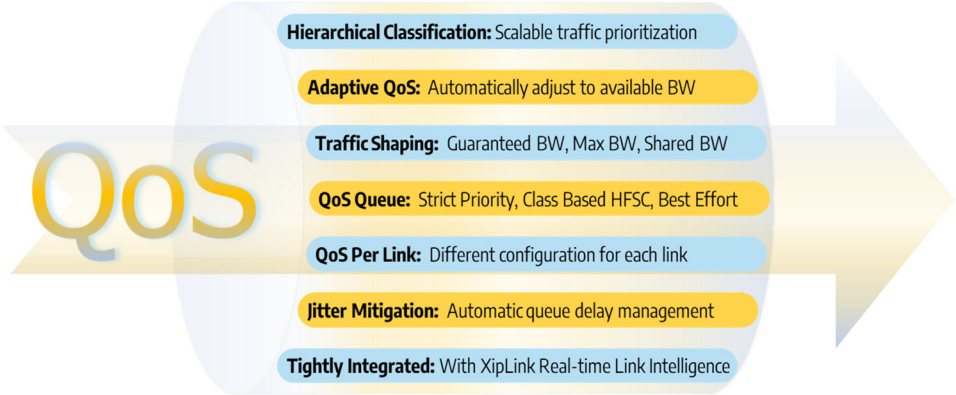
Buffers are dynamically resized based on demand and available link bandwidth, ensuring optimum use of computer resources and sustained peak throughput, including specific buffer boost for LEO links. Statically allocated buffers introduce buffering delay when the connection count increases or cannot scale to make full use of the bandwidth when there are few connections.

XipOS real-time Link Intelligence continuously monitors the link quality, loss percentage, and delay that is a very common with LEO links and provides feedback to the buffer management algorithm with XipOS. XipLink's SD-WAN solution uses advanced memory management technology that can scale efficiently to support hundreds of thousands of simultaneous TCP connections, eliminating the symptoms and root cause of buffer bloat.

ADAPTIVE QUALITY OF SERVICE (QOS) AND APPLICATION PRIORITY

XipLink XipOS offers a highly flexible and configurable Quality of Service (QoS) solution that adapts to available bandwidth, ensuring optimal traffic and memory management. This is ideal for mission-critical or performance-sensitive TCP applications that require guaranteed bandwidth. Some of the key QoS features include:

Application Priority Fair Access Policy: One of the key benefits of XipOS QoS is its ability to prioritize applications over Low Earth Orbit (LEO) services. Typical LEO services treat all applications equally, which can lead to performance issues with critical traffic, such as voice signaling and control, especially during congestion or service degradation. In contrast, XipOS' can bypass Starlink's FAP and give control to XipOS' QoS to prioritize critical traffic, ensuring consistent application performance even in challenging LEO environments.



Multiple QoS Queue Support: XipOS supports various configurations, including Strict Priority, Class-Based, and Best Effort, allowing for tailored traffic management.

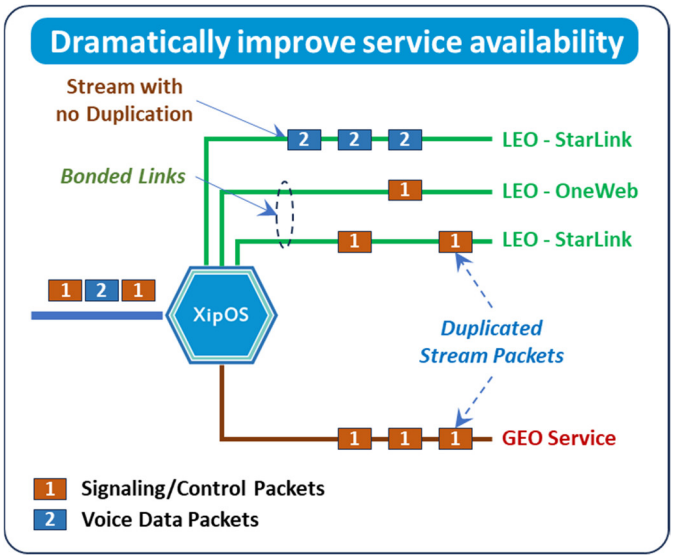
Multi-Path Network Capabilities: In a multi-path network, QoS configurations can be applied per link, enabling separate queues and bandwidth management options such as Guaranteed Bandwidth, Maximum Bandwidth, and Shared Bandwidth.

Advanced Queue Delay Management: XipLink's sophisticated delay management minimizes jitter, significantly enhancing the user experience for jitter-sensitive traffic.

SELECTIVE STREAM DUPLICATION

LEO services can present challenges, such as inconsistent performance due to lossy links and limited QoS controls. This inconsistency can disrupt applications requiring a stable connection, such as voice and video communications, often leading to poor service quality and breaches of Service Level Agreements (SLAs).

XipLink's selective stream duplication addresses these challenges by allowing the duplication of any high-value and/or impairment-sensitive streams, across one or more links, on an application-by-application basis. This feature is particularly valuable for ensuring the reliability of control plane traffic. By duplicating control plane packets, critical applications such as voice and video sessions can maintain their integrity even in the face of network disruptions. The combination of more robust GEO links with LEO links, when used for duplicating control-plane traffic, enhances overall service reliability. As a result, users experience significantly improved service quality and greater assurance of SLA compliance.



Selective stream duplication is a powerful tool for enhancing availability of mission-critical traffic in single path or multi-path environments, increasing resiliency and availability of critical applications for end users. This functionality is ideal for ensuring resilience of signaling or control plane packets for high value voice/video real-time applications.

XipOS advanced features and functions mentioned above are specifically fine-tuned to optimize performance over LEO links, ensuring enterprise-class services and an exceptional user experience. When combined with XipOS's full suite of capabilities, they deliver an industry-leading, gigabit-class, multi-path/multi-orbit SD-WAN solution that is simple to use, high-performance and cost-effective.