MOBILE BACKHAUL TRAFFIC STEERING (MBTS)

BACKHAUL OPTIMIZATION WITH TRAFFIC CONTROL

INTRODUCTION

This Technology Information Brief outlines the opportunity for Mobile Network Operators (MNOs) contemplating roll-out of a 4G/5G network overlay upon their existing 2G/3G networks to utilize the existing microwave backhaul network, instead of having to replace it. By utilizing XipLink's Optimization and TCP Acceleration solution, the new 4G/5G service can be delivered while realizing bandwidth savings across the existing and now optimized microwave links. Should the microwave link reach full capacity, then XipLink provides additional value by intelligently routing excess traffic over lower-cost alternative services such as MPLS, DSL, or satellite services in rural or remote areas.

KEY DIFFERENTIATORS

Proven Solution
Deployed by over 50 MNO's on thousands of base stations

Flexibility
Interoperates with any satellite modem, microwave radio & RAN

OPEX
Dramatically reduces backhaul bandwidth

QoE
Enhances subscribers' user experience

Latency
Mitigation of delay improves TCP throughput

Availability
Flexible prioritization of traffic types through an advanced hierarchical class-based QoS mechanism

EXECUTIVE SUMMARY

Mobile subscribers' consumption of data and video streaming continues to grow globally. Recent demand for social media video sharing has not only caused growth in download traffic, but also in upload traffic as well. MNOs have been addressing this increasing bandwidth demand by deploying 4G and now 5G technology. The advancement of 4G and 5G requires a flexible and cost-effective backhaul network to support increasing RAN capacity demands to satisfy mobile broadband experience, while simultaneously meeting the requirements for existing 2G/3G networks.

High Throughput Satellites (HTS) and Low Earth Orbit (LEO) satellites are lowering barriers for mobile network operators and facilitating the deployment of satellite backhaul in new ways. Better satellite economics and higher throughput now allow service providers to leverage satellite technology; not just in rural, hard-to-reach and remote areas, but also in suburban environments. This is particularly beneficial where terrestrial backhaul technology is available but may be subject to peak-hour congestion and traffic bottlenecks.

Mobile Backhaul Traffic Steering (MBTS) can be combined with other network-enhancing capabilities developed by XipLink, including backhaul optimization and throughput acceleration. XipLink MBTS is a highly flexible feature set not just meant for 4G/5G data but also useful for 2G/3G networks experiencing backhaul congestion or growth constraints on existing terrestrial links.

As mobile backhaul experts, XipLink closely monitors developments in mobile markets. XipLink's purpose is to create bandwidth-enhancing solutions with high ROI that solve or mitigate technical and economic constraints.

BEST-IN-CLASS RAN OPTIMIZATION & TCP ACCELERATION

The XipLink Advanced Cellular Compression (ACC) solution holds the leadership position for RAN Optimization and TCP Acceleration. It is a key component in XipLink's end-to-end mobile backhaul solution.

A major reason for this success is the field-proven 2G, 3G, 4G & 5G algorithms developed to lower OPEX and improve user experience. Globally, leading MNOs have deployed XipLink ACC to boost mobile backhaul throughput, by significantly reducing satellite or microwave bandwidth consumption across the RAN.

The software-based RAN optimization solution is fully virtualized and runs on COTS (commercial off-the-shelf) x86-based platforms, so XipLink customers are not locked into any single hardware vendor.

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XipLink's ACC is vendor agnostic. It provides instantaneous bandwidth and performance gains across all RAN vendors, including Ericsson, Huawei, ZTE, Nokia, and Parallel Wireless. This solution is designed to address the disadvantages associated with expensive and latency prone backhaul transport. It supports a comprehensive array of features that include **GTP Transparency**, **TCP Acceleration**, **Optimization**, **Security**, **Quality of Service (QoS)** and **Link Estimation**. These features are comprised of the following suite of functions.

GTP Transparency

Both 4G & 5G protocols encapsulate user data in GPRS Tunneling Protocol (GTP). To allow TCP Acceleration and Optimization, the solution dynamically discovers GTP Tunnel Endpoint IDs (TEIDs) and decodes the GTP to access users' data. Once TCP Acceleration and Optimization has been applied, user data is encoded back into the appropriate GTP tunnel.

TCP Acceleration

Today TCP represents more than 95% of mobile backhaul data traffic. TCP can have reduced data throughput and degradation of video streaming when encountering congestion, packet loss, jitter and latency. The XipLink TCP Acceleration feature significantly improves the performance of traffic on the RAN, which provides subscribers with increased throughput speed that fully utilizes the available bandwidth and improves quality of experience. The XipLink solution applies acceleration to both uploads and downloads, all TCP applications, and encrypted traffic (HTTPS).

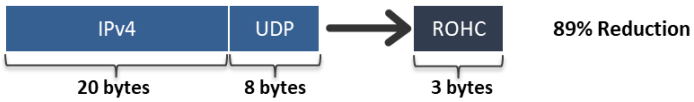
Additionally, TCP Acceleration can also manage bufferbloat across the RAN. It is common for routers to use buffers to handle bursts of traffic by slightly increasing latency as opposed to dropping packets, but excessive buffering can lead to packet delay variation (jitter) and reduce network throughput. This is known as "bufferbloat". XipLink's TCP Acceleration intelligently reduces bufferbloat. Once the solution detects too much data is being buffered for a specific subscriber, it will lower the data rate for the subscriber to give time for the buffer to reduce. This eliminates dropped packets and jitter frequently caused by bufferbloat, while minimizing buffer-induced latency and significantly improving the user experience.

Optimization

XipLink's RAN optimization solution processes mobile traffic using a multi-stage optimization algorithm. This algorithm is designed specifically for mobile networks and delivers bandwidth savings up to 50%, with up to 90% packet rate reduction. This algorithm leverages mobile and network transport domain expertise. The stages are defined as:

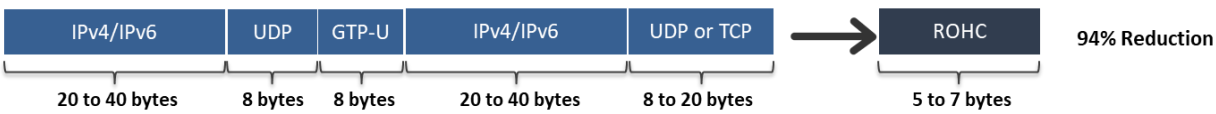
Robust Header Compression (ROHC) 2G & 3G Iub

ROHC removes unnecessary headers and treats the upload and download backhaul paths independently. Since headers have large constant fields (per stream) ROHC will omit and replace these.



GTP Header Compression (GTP-HC) 3G Iuh, 4G & 5G

In 4G/5G backhaul networks, multiple IP header chains are present in an IP packet. The XipLink header compression schemes will compress all header chains inside and outside the GTP header. Header chains for 4G & 5G can be 76 to 116 bytes depending on inner and outer IP versions.



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Packet Coalescing

Packet Coalescing is used to group multiple header-compressed packets together into a single packet. Header-compressed packets are concatenated within the coalesced packet. This allows the IP headers of individual packets to be compressed within an ultra-lightweight shell that provides route-ability and the same DSCP mark as the packets it contains. Since fewer packets are sent, overheads are reduced, resulting in considerable bandwidth savings. Coalescing is efficient and effective for mobile backhaul voice traffic as bandwidth savings of up to 50% can be achieved on small packets.

Payload Compression

Proprietary lossless compression algorithms, specifically designed for mobile signaling and data packet service, are applied to all outgoing WAN traffic.

Byte Caching

Byte Caching is a technique which stores repeating byte sequences in a rapid-access data cache, allowing XipLink to replace these repeating strings with small tokens to significantly reduce the amount of bandwidth required over WAN links.

The typical bandwidth savings resulting from XipLink's multi-stage optimization algorithm are the following:

Typical Optimization Results in OpEx Savings	
Voice	**40% to 50%**
Data Upload	**20% to 45%**
Data Download	**10% to 35%**

Security

MNOs may require end-to-end backhaul security to protect user data, voice, and signaling. XipLink provides a Decrypt-Optimize-Encrypt (DOE) function to preserve the security of the backhaul link while still offering Optimization and TCP Acceleration. This results in increased throughput and performance.

The DOE feature follows the 3GPP IPsec for authenticating and encrypting the IP packets during communication between the eNodeB and core network. Also supported is CMPv2 (Certificate Management Protocol), which is used by MNOs at the gateways to authenticate the link by using Public Key Infrastructure (PKI).

Quality of Service (QoS)

Mobile backhaul requires Service Level Agreement (SLA) performance criteria for availability, packet delay, jitter, and packet loss. SLA performance elements such as packet delay and jitter are especially important to sustain VoLTE services. The XipLink solution helps MNOs to increase the performance of their wireless backhaul links and enables them to adhere to service level obligations (SLA's).

Addressing backhaul requirements also requires advanced Quality of Service (QoS) capabilities to ensure that the end subscriber's Quality of Experience (QoE) is consistent with MNO service plans. It is also important to ensure that the mobile network is reliable and continues to operate during network-impacting events such as packet loss or weather impairments that may reduce bandwidth on the backhaul links. XipLink's QoS enforces fine-grained control of users, groups, applications, and services to ensure the defined SLA is delivered upon through hierarchical and user-defined QoS. Real-time and historical statistics support the validation of SLA compliance.

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Link Estimation

Part of XipLink's QoS is the Link Estimation feature that automatically discovers the available bandwidth and measures the quality of a link. This will ensure optimal network performance and utilization. Link Estimation is ideal for microwave or satellite links using Adaptive Coding & Modulation (ACM) that operate at maximum throughput under clear sky conditions and decrease bandwidth gradually under rain fade.

TCP acceleration relies on network metrics for optimal user experience. The most important metric is the available bandwidth for one or more TCP sessions. The available bandwidth is governed by XipLink's QoS mechanism, which can be changed dynamically on any class while carrying traffic. For optimal performance and to ensure priority QoS enforcement for specific traffic, the maximum transmit rate should be set to the current available bandwidth of a link. Otherwise, a TCP session might not utilize all available bandwidth, or it can cause retransmissions due to overdriving of a link, which would degrade the throughput and end user experience. Link Estimation allows MBTS to automatically determine and track the correct maximum sending rate while adjusting the QoS hierarchy accordingly over time.

INTRODUCTION OF 4G/5G OVERLAY NETWORKS

The most common type of 4G/5G network deployment is delivered as an overlay on an existing 2G and/or 3G network. In most developing markets the communications requirements of the customer base have been satisfied with basic voice and EDGE connectivity for the past decade at the very least.

Given that fiber links are typically used for urban backhaul, you may be wondering why backhaul efficiency is important. The answer is that while initial 4G/5G deployments tend to be urban, once networks are operational there is a push to deploy further out to the suburbs and beyond. In these locations, the existing backhaul tends to use microwave or leased line services. In this case, the cost to upgrade is a function of capacity and distance, and this can make service deployment uneconomical or marginal.

When network planners look at 4G/5G overlay in suburban or rural areas the first issue they face involves how to backhaul traffic to the core network. If there is an existing microwave or leased line serving a 2G or 3G base station it is likely to be a reasonably narrow band. A typical 2G BTS might be served by a 4 - 20 Mbps link, depending on the number of TRXs.

ECONOMIC SOLUTION – OPTIMIZATION WITH TRAFFIC-AWARE ROUTING

Given the narrow-band nature of these 2G backhaul networks, the question remains: can anything be done when deploying 4G/5G to avoid having to start again with a new backhaul network to deliver the required broadband capacity to the cell sites? The answer is 'yes' – by using the MBTS technology developed by XipLink. Using the XipLink MBTS and Optimization appliance we can do three things at once that permit the MNO to re-use the existing backhaul when adding a 4G/5G overlay:

1. Optimize the Existing Backhaul: Capacity may be filled with voice traffic and signaling information. However, the quality is good, latency is minimal, availability is good, and the CapEx is written off. By optimizing the 2G/3G traffic we can regain 20% to 50% of existing backhaul capacity.

2. Traffic-Aware Routing: Route the 4G/5G traffic used for signaling and VoLTE over the freed-up capacity while optimizing it in the same way as the existing 2G/3G traffic. For VoLTE traffic this can make a huge difference in the capacity required, as more than 40% of the traffic is comprised of packet headers.

3. Least-Cost Routing: Route the 4G/5G data traffic over a low-cost alternate route. At the same time, it is possible to optimize traffic and provide the TCP Acceleration, where required, to compensate for higher jitter/latency delivered by low-cost backhaul technologies, such as DSL, MPLS or satellite.

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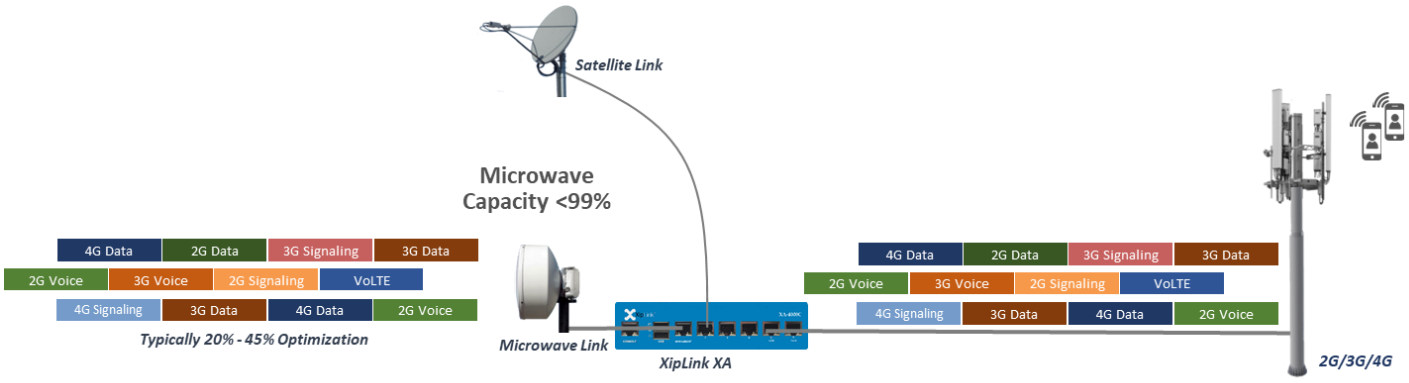

Figure 1. MBTS will optimize the backhaul link and keep all traffic on microwave if capacity is under 100%

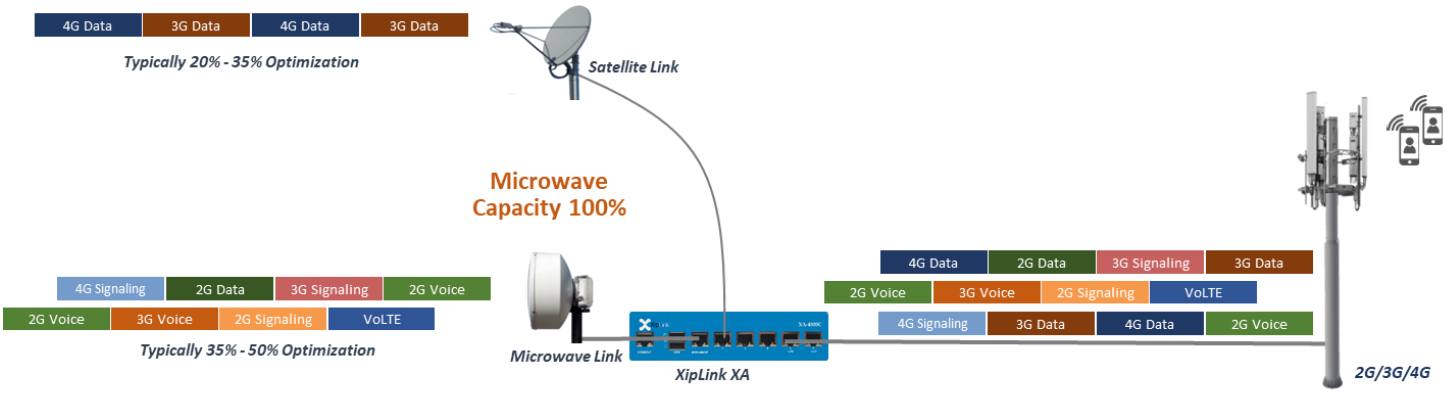

Figure 2. XipLink MBTS allows MNO to re-use existing microwave links for high-value voice and signaling traffic while using low-cost backhaul such as HTS satellite, MPLS, or DSL for data traffic.

NO NETWORKING CHANGES

All these functions can be implemented without having to alter the existing network or layer 3 topology as MBTS is transparent, operating at layer 2. It is also transparent in the sense that all the optimizations applied to the traffic by the remote XipLink features are undone at the core network end of the links. Therefore, the traffic looks identical arriving at the core as it did when it left the remote BTS or eNodeB. XipLink MBTS, Optimization and TCP Acceleration are implemented on carrier-grade hardware with built-in bypass relays, so network availability is not compromised.

MBTS has visibility into subscribers' traffic contained within the GTP tunnels and identifies individual TCP sessions for each application running on a mobile device. With the intelligence to manage each TCP session, the solution can determine the best route to steer a specific TCP session and assure all traffic for this session remains on the same network link. This ensures reliable RAN transmission for many sessions over multiple links.

The MBTS feature can be configured to operate on both uplink and downlink directions, or just on the downlink as in many cases the existing uplink is not saturated. Therefore, MBTS can work as a one-way or two-way backhaul-enhancing application. One additional advantage when using satellites as an offload transport is that base stations do not need to be reconfigured for high latency. This is because delay-sensitive applications, namely signaling and voice, are carried over the primary terrestrial backhaul channel.

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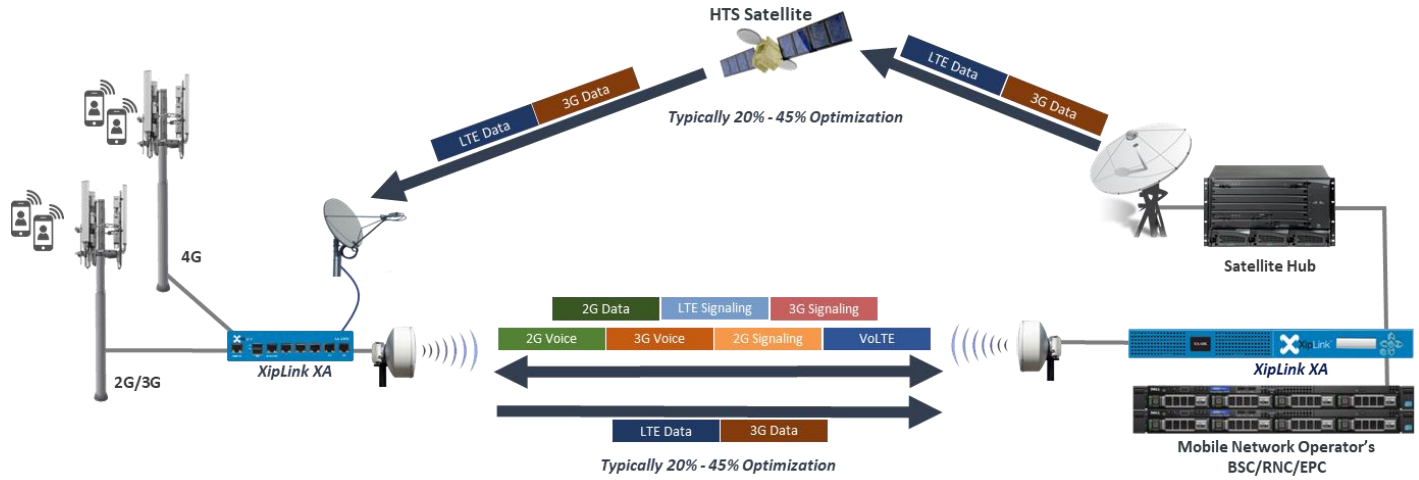

Figure 3. XipLink MBTS is configured to overflow the download data to satellite only. All upload traffic will stay on the microwave.

Finally, we come to the key issue of cost. XipLink MBTS makes it technically feasible to use low-cost data backhaul while also re-using existing backhaul to build a 4G/5G data overlay on an existing 2G/3G network.

OTHER USE CASES

The same feature set can be used to support use cases other than data offload, depending on configuration settings, for example:

One scenario is when remote sites are connected using expensive C-band satellite capacity. Use of C-band capacity has the key advantage of functioning almost perfectly during rain-fade, whereas lower cost Ku and Ka band capacity can have significantly degraded availability due to climate conditions. Using XipLink MBTS would provide optimization of all the backhaul traffic while allowing high-value signaling and voice traffic to be routed via C-band equipment, while lower-value data traffic can be routed via Ku or Ka band capacity.

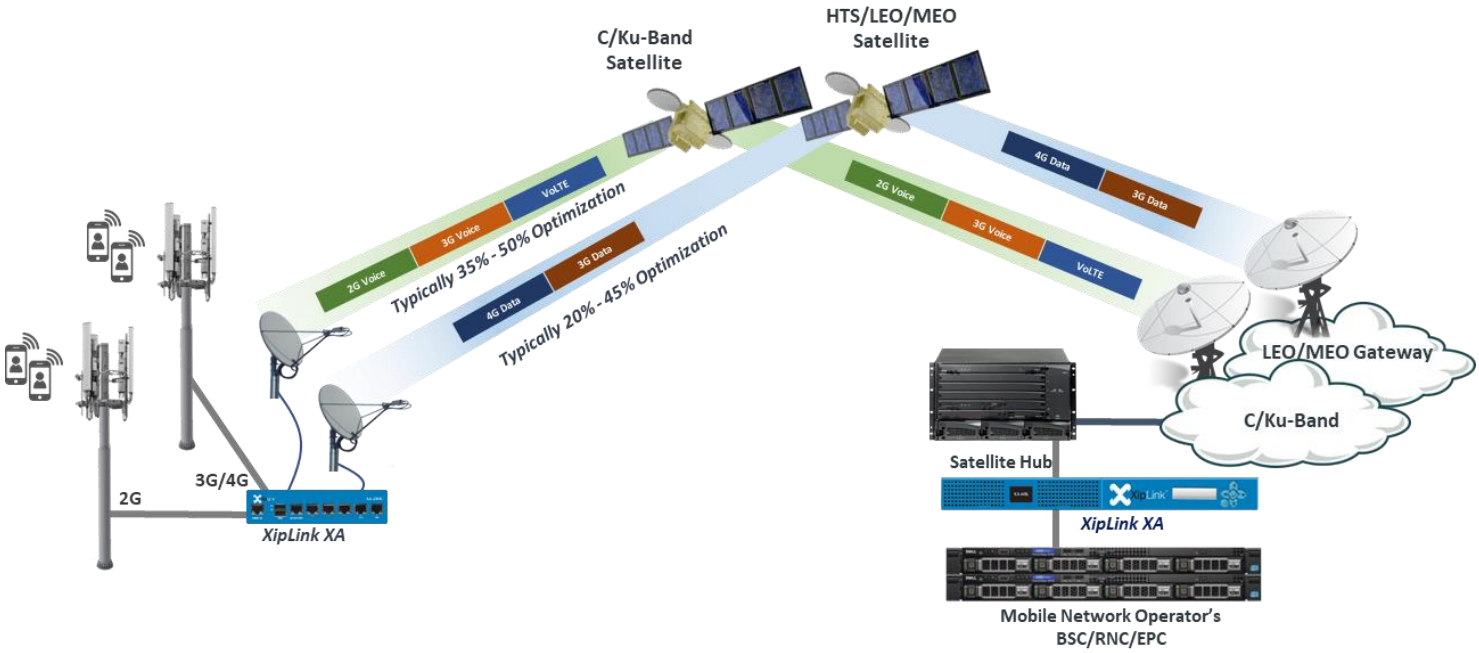

Figure 4. Using XipLink MBTS to carry voice and signaling traffic via highly reliable C-band satellite and sending data via best-effort Ka band satellite.

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For disaster recovery applications the feature can be set to forward all traffic over a primary link – with or without optimization, as required – and to switch to an backup link in the event of failure of the primary link. The alternate link can also be optimized and accelerated if required (for example, to enable a satellite link to be used as a backup). When the alternate link is not in use, zero traffic is passed. This makes it possible to use economical 'on-demand' type services.

CONCLUSION

In summary – the XipLink MBTS system enables mobile operators to economically deploy 4G/5G overlay networks without needing to completely replace existing backhaul systems. MBTS is highly flexible and can be used to offload 2G/3G/4G/5G data also.

Extracting years of extra service from existing backhaul transmission networks through advanced optimization techniques helps to reduce CapEx requirements. At the same time, optimization techniques allow for the use of lower-cost alternatives for data backhaul while maintaining signaling and voice traffic on existing links. This makes the XipLink MBTS system vital for commercial mobile network development.

ABOUT XIPLINK, INC.

XipLink is the leading independent global technology provider for wireless link optimization using standards based SCPS-TP protocol acceleration, streaming data compression and Internet optimizations to deliver a better wireless experience over stressed communication links. XipLink is a privately-owned company with headquarters in Montreal, Quebec (Canada), integration facilities in Ashburn, Virginia (USA) and field personnel worldwide.

To learn more about how Mobile Network Operators can utilize XipLink for their backhaul links to expand coverage of 4G/5G networks, bring new connectivity to unserved areas and protect existing markets, visit: www.xiplink.com

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