

# HUGHES Backhaul Solutions

## Introduction

Cellular and WiMax operators worldwide are increasingly looking to expand into rural markets either because of universal service obligations or as a genuine new market opportunity. Often times these rural markets are located in difficult-to-serve areas where terrestrial fiber or microwave services are not readily available to support the backhaul links for these remote locations. Satellite, with its ability to very rapidly deploy broadband infrastructure, can play a key role in enabling these services. TDMA-based satellite solutions can be especially cost effective for these locations particularly when the traffic is light and/or intermittent.

## Satellite Backhaul Access Techniques

Satellite for backhaul trunking may be the best solution for a variety of reasons. First is that the time to implement a satellite backhaul connection is quite short as once the satellite station is installed, the service can begin immediately. Secondly, satellite can offer a significantly lower capex versus the cost of establishing (installing) and maintaining a terrestrial backhaul (every microwave hop must be built and maintained).

The most common implementation of satellite to date has been Single Channel Per Carrier (SCPC). SCPC is a circuit-based transport and is able to directly connect to E1/T1 interfaces for cellular backhaul base stations (without the need for interface converters). In addition, with higher order modulation schemes and “carrier in carrier” techniques, SCPC can provide excellent bandwidth efficiency for heavily loaded backhaul connections. From a traffic perspective, SCPC works well when the load per remote station is high (above 1 Mbps) and consistently loaded across all the links. Conversely, where the traffic is light (less than 1 Mbps) and variable, TDMA may offer the lowest cost solution.

The advantage of a TDMA solution is that multiple backhaul links can share the same satellite capacity. This is in contrast to SCPC solutions where the capacity is firmly allocated per link whether there is actual demand or not.

Hughes today offers a full range of satellite-based Radio Access Network (RAN) backhaul solutions that have been specifically designed for mobile operators to enable rapid and cost-effective service expansion into rural markets. These solutions provide high-quality links while optimizing space segment resource utilization by coupling the appropriate satellite technology with intelligent traffic optimization.

This paper examines the efficiencies of TDMA solutions for certain types of backhaul trunking. To demonstrate the suitability of certain applications for TDMA solutions, this paper calculates the total cost of ownership of both a TDMA and an SCPC solution and the payback period for the capital investment using SCPC with that of TDMA. For purposes of illustration, this paper assumes the mobile operator uses the GSM standard. However, Hughes solutions also support other technology standards such as CDMA and WiMax.

## Selecting the Right Hughes Technology

The HX System, which is based on DVB-S2 and TDMA, is the primary Hughes solution for cellular backhaul. As illustrated in Figure 1 where the traffic load is low per site, the HX System using TDMA is the right choice, but when the traffic load per site increases, the HX System combined with SCPC is the most appropriate solution. In many instances the best solution may be a combination of TDMA and SCPC technologies.

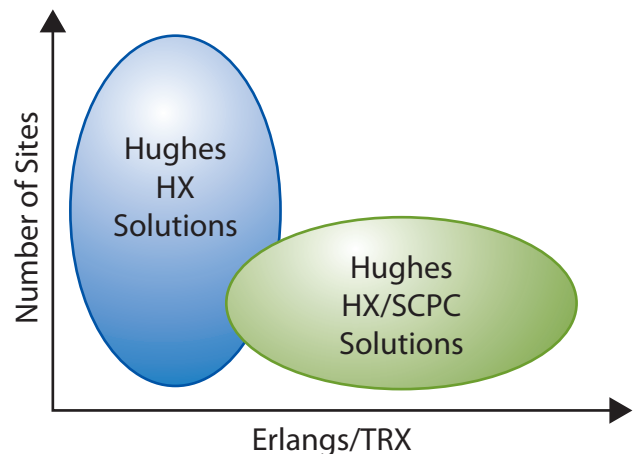


Figure 1: Hughes Solutions for RAN Backhaul.

### HX System for RAN Backhaul

The HX System offers operators who want to operate their own VSAT network for RAN backhaul, a cost-effective and scalable solution. Figure 2 illustrates the star architecture of the Hughes satellite RAN backhaul solution on the HX platform.

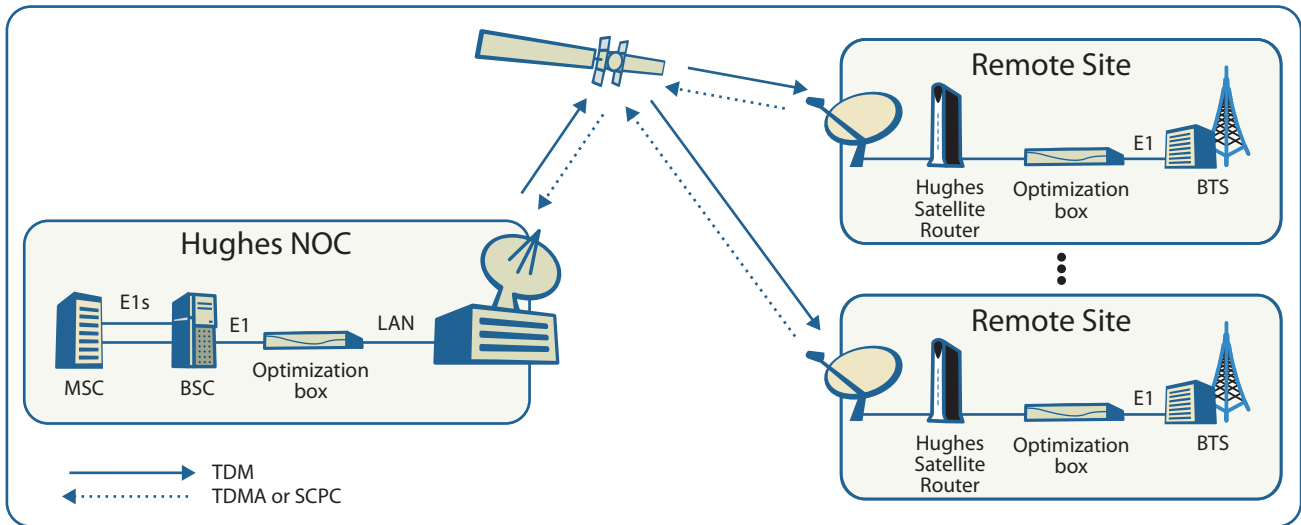


Figure 2: Star Architecture of Hughes Satellite RAN Backhaul Solution.

The HX System supports high-quality, jitter-free bandwidth in a very cost-effective and scalable configuration. Individual remote terminals can be configured for guaranteed inroute bandwidth while maintaining multiple priority levels.

The HX System can be operated in star or mesh mode. When operated in star mode, the HX Gateway will multicast a high-speed IP channel to all the HX remote terminals. HX remote terminals communicate back to the HX Gateway using FD/TDMA channels. The HX Gateways are fully redundant and incorporate advanced bandwidth management features. The HX remote terminals are rack mountable and support high-speed inroutes of up to 9.6 Mbps.

Additionally, the HX System is capable of supporting mesh connections for traffic that does not need to be routed through a central hub. Many backhaul connections are from a small number (5-15) of Base Transceiver Stations (BTSs) to a single Base Station Controller (BSC). HX mesh connectivity is an ideal solution for this type of backhaul requirements as the HX System can implement a direct, single-hop connection from the BTS locations into the BSC location, as illustrated in Figure 3. The HX MeshGW station is a fully-redundant HX Gateway station that enables high availability and complete network management for BSC locations. As the HX MeshGW enables single-hop connectivity to BTS locations, the need for a terrestrial backhaul connection is eliminated.

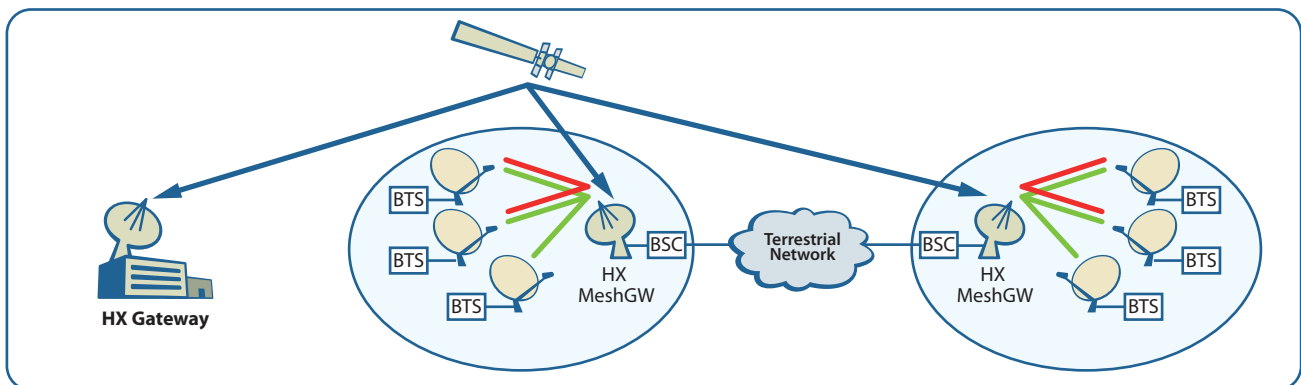


Figure 3. HX System Mesh Connectivity.

## Key Features of the HX System Satellite RAN Backhaul Solution

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- Transparent to cellular traffic—supports GSM and CDMA
- Shares voice channels across network, hence more efficient than SCPC links for thin route backhaul connections
- Optimizes cellular traffic using qualified optimization vendors and also supports 2G, 2.5G, and 3G protocols
- Network management through SNMP/IP
- High-quality, low-jitter bandwidth
- Works with all major cellular equipment vendors

## Key Benefits of the HX System

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- Use of FD/TDMA for cost-effective space segment access
- Simple and economical network expansion
  - Add more channels without any remote hardware change
  - Remote equipment competitively priced
  - No upgrade required to the standard HX Gateway
- End-to-end management of network
- Easy integration with other Hughes platforms for service expansion
- High-speed inroutes up to 9.6 Mbps
- Strong QoS features enabling low-jitter dynamic assignment of adaptive bit rate bandwidth allocation based on dynamic
- Mesh connectivity with HX MeshGW stations enabling cost-effective, single-hop connections for BSC-to-BTS traffic

## Bandwidth Optimizer Overview

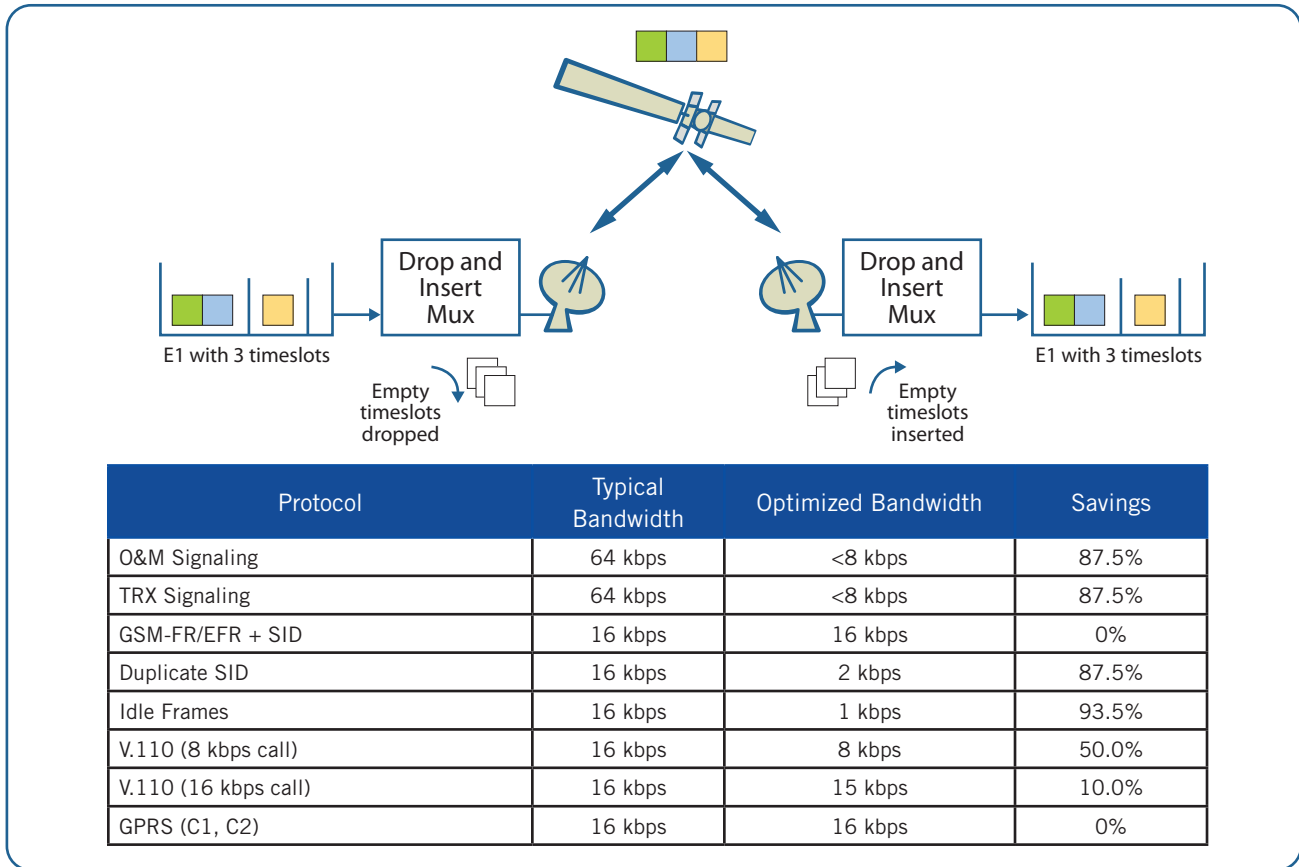
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For applications such as GSM where the backhaul traffic is not already IP, the Hughes solution for RAN backhaul incorporates an appliance that not only converts the traffic to IP for transmission over satellite, but also optimizes both the data and control channels to significantly reduce the traffic sent over the space link. Key functions of the optimizer are:

- Reducing voice channel bandwidth
  - Silence/idle frames are suppressed at the source and regenerated at the destination
- Optimizing A.bis signaling bandwidth
  - TRX signaling data is extracted out of TRX channels and statistically multiplexed

The above techniques deliver up to 50 percent bandwidth savings over traditional SCPC links.

The following table shows the typical savings for various A.bis protocols.



Hughes has conducted extensive integration and certification testing with many of the industry-leading IP optimizers including;

- Memotec CX-U series of optimizers
- Memotec NetPerformer-II optimizer
- Sevis 6000 series

In addition, Hughes has successfully integrated with the IP-enabled Ericsson Packet Abis product, as well as various IP-enabled Pico cells from Huawei and ZTE.

## Bandwidth Sizing Example

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For non-IP backhaul traffic such as GSM, the Hughes solution of implementing an IP optimizer can provide dramatic bandwidth efficiencies over a clear channel implementation using SCPC technology. Consider the following example:

### General requirements:

Number of BTS: 30

Erlangs per BTS: 5

Blocking Rate: 1%

### If the network is supported using SCPC technology, operator will have to provision:

- 30 SCPC links; each link will need to support 11 trunks
- Total trunk lines in network =  $30 \times 11 = 330$
- Bandwidth per line (assumes optimization feature added) = 10 kbps
- Total full duplex bandwidth =  $330 \times 10 = 3.3$  Mbps

### If the network is supported using TDM/TDMA technology, operator will have to provision:

- One TDM outbound carrier, one TDMA inbound carrier
- To support aggregate  $30 \times 5 = 150$  Erlangs on a single carrier in each direction
  - Total trunk lines required = 170 lines (benefit of a single carrier)
- Optimized bandwidth per line = 10 kbps
- Total full duplex bandwidth required = 1.7 Mbps

### Benefits of the Hughes TDMA Solution:

- The Hughes solution results in significant space segment savings over the SCPC solution
- Savings calculated above excludes potential savings due to busy hour differences across BTS
- A Hughes solution also provides central management, resulting in additional operational cost savings

Mobile operators should note that while SCPC vendors may claim their solutions offer higher order modulation than TDM/TDMA solutions, the Erlang calculations are still done on an individual link level in an SCPC architecture. This means that the modulation efficiency is offset by the higher number of trunks required to support the same amount of traffic in an SCPC network.

As the above calculation shows, a TDM/TDMA solution is more efficient due to its ability to statistically multiplex the cellular traffic across the entire network instead of over a specific point-to-point link. However, mobile operators must ensure that the chosen TDM/TDMA solution has the ability to provide high-quality, low-jitter bandwidth to support their cellular traffic.

The Hughes HX and HN Systems support guaranteed high-quality, jitter-free bandwidth that is well suited for cellular backhaul. In addition, Hughes solutions include certified third-party A.bis optimizers that provide further optimization of the A.bis links.

## Conclusion

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The Hughes HX System provides many benefits for RAN backhaul applications. With efficient FD/TDMA channels and a highly scalable architecture, the HX System provides a low total cost of ownership. The ability to support a combination of TDMA and SCPC based on traffic patterns, means that operators can implement the most cost-effective access scheme. Additionally, the HX System has been successfully integrated with almost all the major backhaul equipment manufacturers, ensuring operators of a successful implementation using the HX System.

For more information on the HX System and its capabilities, visit [www.hughes.com](http://www.hughes.com).

## Proprietary Statement

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