HX Multi-Star Mesh Feature

HUGHES HX System

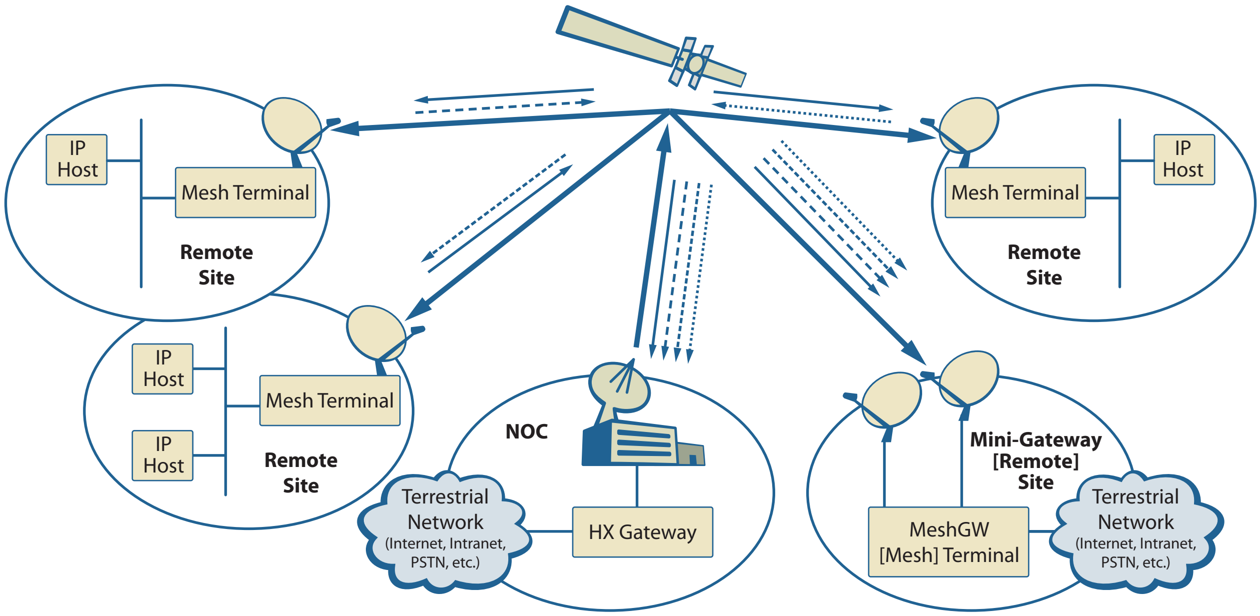

Figure 1. HX System Architecture for Mesh Connectivity

The HX System is an innovative IP broadband satellite system from Hughes that is specifically designed and optimized for small to medium networks that require high bandwidth, high quality of service (QoS) links. In addition, the HX System is designed to support specialized applications and connectivity requirements such as mobility and mesh.

The HX System provides advanced bandwidth management capabilities that allow operators the ability to custom design various Quality of Service (QoS) to meet customer Service Level Agreements (SLAs) on a per-remote site basis. Being a pure IP-based solution, the HX System incorporates a strong set of IP functions and features. Leveraging the DVB-S2-ACM transmission standard for the outbound channel, the HX System is able to achieve the best spectral efficiency and network availability of any TDM/TDMA network on the market. The HX System offers operators innovative bandwidth allocation options on a per-remote basis allowing them to develop a wider range of service plans for their end users. Network management is highly advanced and provides for remote Web access via a VPN that can be used by the operator as well as shared with end users.

HX Mesh

The Multi-Star Mesh feature was introduced into the HX System as part of HX System Release 2.0. As illustrated in Figure 1, the HX Gateway is capable of supporting mesh terminals that have the ability to receive TDMA transmissions from other HX mesh capable terminals. In addition, an innovative concept of a MeshGW (Mesh-gateway) remote site is introduced to support high volume mesh sites such as regional data centers as well as supporting Multi-Star mesh topologies. A MeshGW site provides hub-like connectivity to terrestrial infrastructure. The MeshGW provides support for multiple star subnetworks without requiring the implementation of a full blown hub that requires an HX Gateway including a DVB-S2 outroute.

The MeshGW is capable of receiving TDMA transmissions and sits in the center of a “star” providing connectivity to terrestrial infrastructure external to the HX System. However, like a regular remote site, it only listens to the DVB-S2 outroute and transmits via star mode to the central HX Gateway. The term MeshGW refers to the set of HX System satellite equipment (for example, a set of Mesh Terminals and ancillary control equipment acting as a unit) located at the regional MeshGW site. The MeshGW design is highly scalable in that it allows an operator to easily increase capacity by inserting more mesh capable terminals. A single LAN Interface is provided from the MeshGW site for interconnection to local site infrastructure. Traffic management and load balancing across the various terminals that constitute the MeshGW is done automatically.

Bandwidth Management of the HX System

In providing both mesh and star connections, the HX System allows operators to easily provision a variety of services including Constant Bit Rate (CBR) (similar to SCPC), and Minimum Committed Information Rate (CIR) with maximum limits and “best effort” services. Importantly, the HX System is able to structure these service offerings on a per remote basis.

The advanced bandwidth management capabilities of the HX System represent some of the most powerful features of the HX System for a satellite network operator. The HX system is designed to provide efficient, high-speed transport of IP traffic. Hughes developed features that have been incorporated into each HX terminal improve performance, response time, and bandwidth efficiency. In addition, IP routing and QoS features contribute towards making HX a robust full-featured solution.

The HX System employs advanced bandwidth management techniques that provide for the following types of services:

- **CBR Services (virtual leased line services):** The HX System provisions predefined channel capacity, asymmetrically (outbound rates different from inbound rates) between the HX Gateway and the HX remote terminals.
- **Adaptive CBR Services:** The HX System allocates channel capacity whereby the initial amount allocated is fixed (low jitter). If the terminal needs additional amounts of capacity, and it is available, the HX System continues to allocate additional capacity until either the maximum rate for the remote is reached or the network resources are exhausted.
- **Guaranteed CIR Services:** HX remotes are allocated capacity whereby the initial amount is set at a configurable minimum and that additional capacity is always available up to a guaranteed amount. Beyond the guaranteed amount up to the maximum rate, the allocation is in a best effort basis. Under this scheme, outbound/inbound capacity for a remote terminal between the guaranteed rate and the maximum rate is provided as needed but subject to the constraints of the network load.

The HX System includes network management tools that advise the operator how much capacity has been consumed by various service plans. In this way an operator can intelligently load the network and understand to what extent the network is “oversubscribed.”

Constant Bit Rate Services

Under this scheme, a remote is configured to consume a CBR and this bit rate is configured independently for the outbound and inbound directions. For example a remote could be configured for 512 kbps CIR outbound and 256 kbps CIR inbound. Additionally, the remote can be configured to deallocate the bandwidth and return to the common pool if the channel has been idle for a configurable period of time.

CBR Services operate similarly to Single Channel per Carrier (SCPC) links as the assigned capacity per channel is fixed based on the configuration of the link.

Adaptive CBR

CIR Services with Step Increments are capacity allocation services where a remote is allocated capacity based on the following parameters:

- **Minimum CIR** – This is the amount of capacity that will be immediately allocated to a remote terminal at the initiation of a data session. This minimum CIR is low jitter as the capacity is assigned to the remote terminal until the CIR session terminates. Termination of the CIR session is based on configurable idle period.
- **Maximum Rate** – This is the maximum amount of capacity that the terminal is allocated.
- **Threshold Level** – This is level of usage that, when exceeded, the remote terminal is allocated additional fixed amount of bandwidth (the "Step Increment" below). The threshold level is defined in terms of % of the usage of the current amount of capacity assigned to the terminal. For example, if the threshold level is 80%, the remote terminal is allocated an additional "step increment" of capacity if the utilization of the current capacity assignment exceeds 80%.
- **Step Increment** – This is the fixed amount of capacity, in kbps, that is allocated to a remote terminal as it requires more than the "Minimum CIR" amount of capacity. The HX System uses the "Threshold Level" (defined above) to determine when to allocate additional Step Increments. The HX System continues to allocate Step Increments up to the Maximum Rate of the terminal or until the available capacity of the inroute group is exhausted.
- **Session activity timeout** – This is the period of time after which the terminal is inactive (no IP traffic) that the session is disconnected and the capacity freed up for other terminals to access.

Guaranteed CIR

Guaranteed CIR Services provides capacity allocation services whereby a remote is allocated capacity based on the following parameters:

- **Minimum CIR** – This is the amount of capacity that is immediately allocated a remote terminal at the initiation of a data session. This minimum CIR is low jitter as the capacity is assigned to the remote terminal until the CIR session terminates. Termination of the CIR session is based on idle period.
- **Guaranteed CIR** – This is the amount of capacity that is guaranteed to be available to the terminal should it be requested.
- **Maximum Rate** – This is the maximum amount of capacity that the terminal is allocated. Between the Guaranteed Rate and the maximum rate the capacity allocation is on a best effort basis.
- **Session activity timeout** – This is the period of time after which the terminal is inactive (no IP traffic) that the session is disconnected and the capacity freed up for other terminals to access.

Figure 2 illustrates the CIR feature of the HX System. Figure 3 illustrates the Guaranteed CIR service. In this access mode the remote is provided the Minimum CIR as soon as any traffic activity is detected. Once the remotes actual bandwidth utilization exceeds the configured threshold percent of the Min CIR value, the remote gets allocated Guaranteed CIR amount of bandwidth. If additional bandwidth is required over the Guaranteed CIR value, the remote is assigned the additional bandwidth using the best effort allocation algorithm. The remote can never be assigned more than the Max CIR bandwidth.

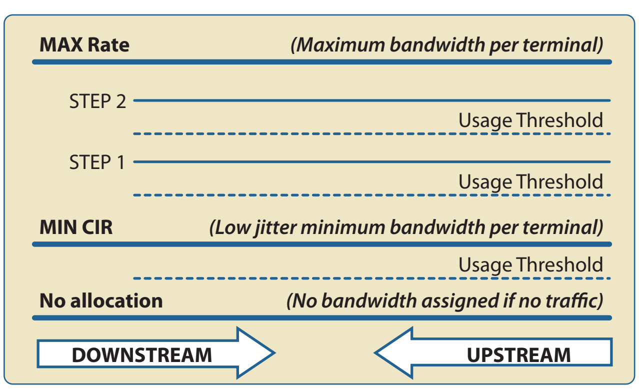

Figure 2. HX System CIR Feature

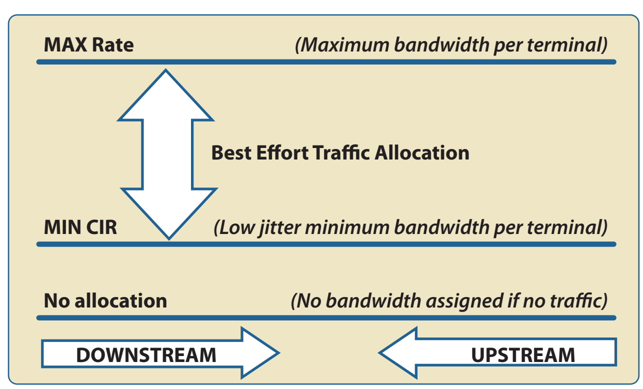

Figure 3. Guaranteed CIR Services

Best Effort Services

When a terminal is configured for best effort services the terminal is provided capacity based on a combination of the following factors:

- **Backlog amount:** This is the terminal's estimation of how much capacity it needs at any given time
- **Available IQoS (network group) capacity:** This is the amount of available network capacity that the system is using to allocate best effort capacity

The IQoS plan defines the maximum amount of capacity available to a group of remotes as they access the best effort capacity. The HX System supports multiple IQoS plans and this allows an operator to provide different levels of best effort services to different groups of Customers.

Traffic Prioritization

With any network, it is vital to be able to apply prioritization to ensure that business critical applications do not suffer due to bandwidth contention with nonvital applications. The HX System can be configured to prioritize both inbound and outbound traffic based on IP parameters. The prioritization within IP traffic can be based on source or destination IP address, TCP/UDP port numbers, DSCP tag values, etc. This allows prioritization based on a server or application level.

Figure 4 illustrates how the HX System prioritizes traffic across the satellite link.

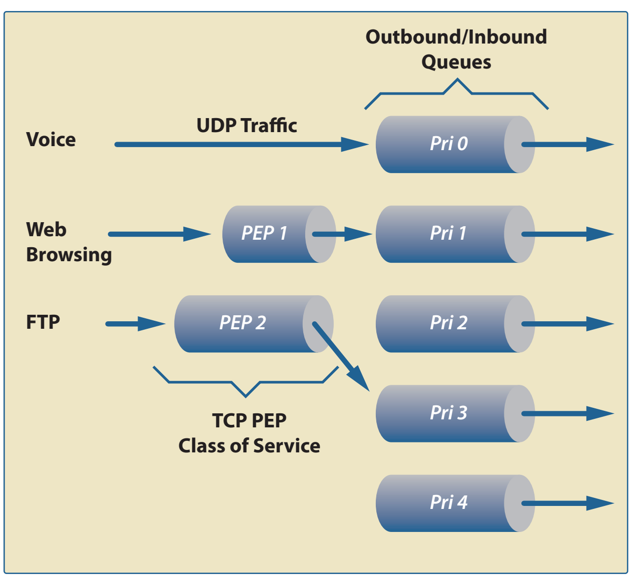

Figure 4. HX System Prioritization

The HX System can utilize the following rules for the prioritization of traffic:

- Source IP address range
- Destination IP address range
- TCP/UDP port number
- Diffserv Code Point bits

Multi-Star Mesh Overview

This chapter provides a high level overview of the HX System Multi-Star Mesh feature.

Customer Applications

The HX System Multi-Star Mesh feature is designed to support the following connectivity needs:

- Single-hop VoIP connectivity from terminal site to terminal site (for example, for rural telephony or private network telephony)
- Single-hop GSM (and similar mobile standard) backhaul connectivity from terminal site to terminal site (for example, for BTS to regional BSC, or equivalent, connectivity)
- Single-hop videoconferencing connectivity from terminal site to terminal site
- Single-hop data connectivity from terminal site to terminal site

The HX System Multi-Star Mesh feature supports the following topologies:

- Systemwide peer-to-peer connectivity (basic mesh)
- Terminal-to-regional terminal connectivity (Multi-Star Mesh)

As illustrated by Figure 5 and Figure 6, systemwide peer-to-peer connectivity can actually be viewed as a single region case of terminal-to-regional terminal connectivity where full intraregion mesh is enabled.

Multi-Star Connectivity

Figure 6 illustrates Multi-Star (aka multi-gateway) mesh connectivity. A Multi-Star topology is required when there is a need to support multiple, regional star networks without having to deploy an HX Gateway within each region and,

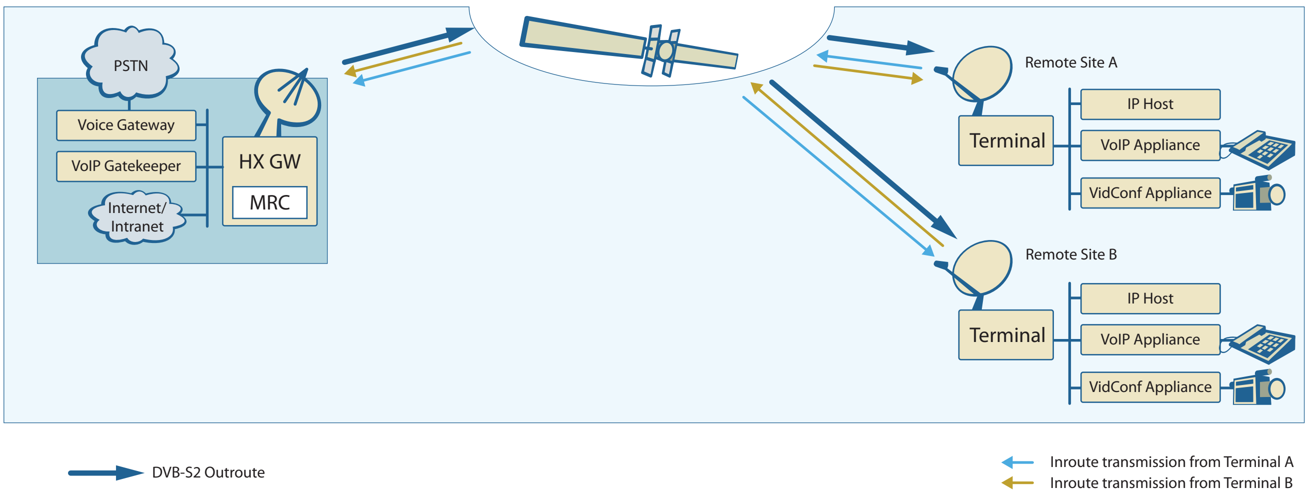

Figure 5. HX System Basic Star and Mesh Network

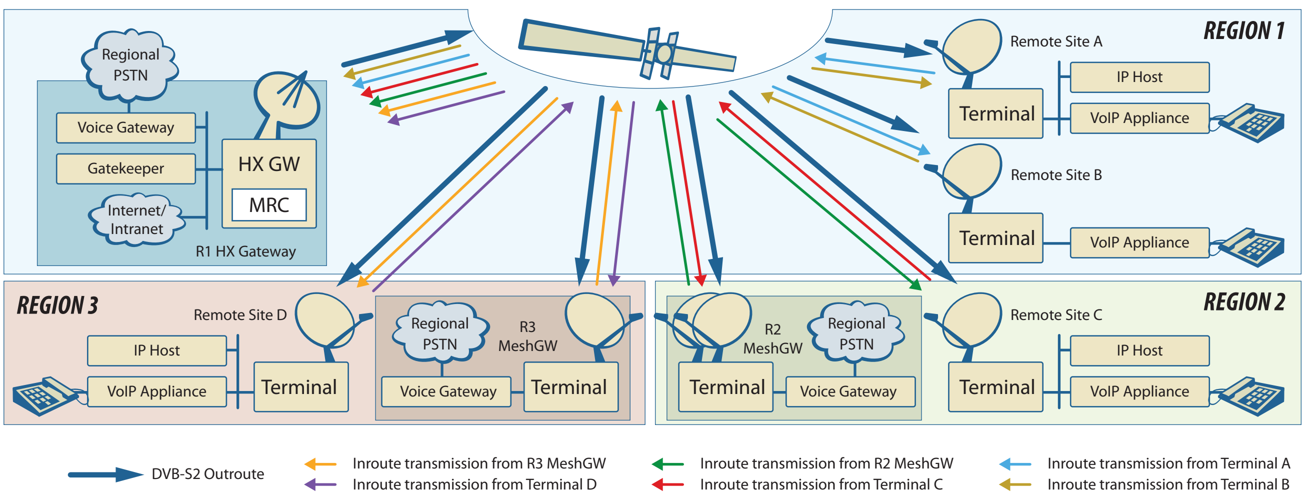

Figure 6. HX System Multi-Star Mesh Network

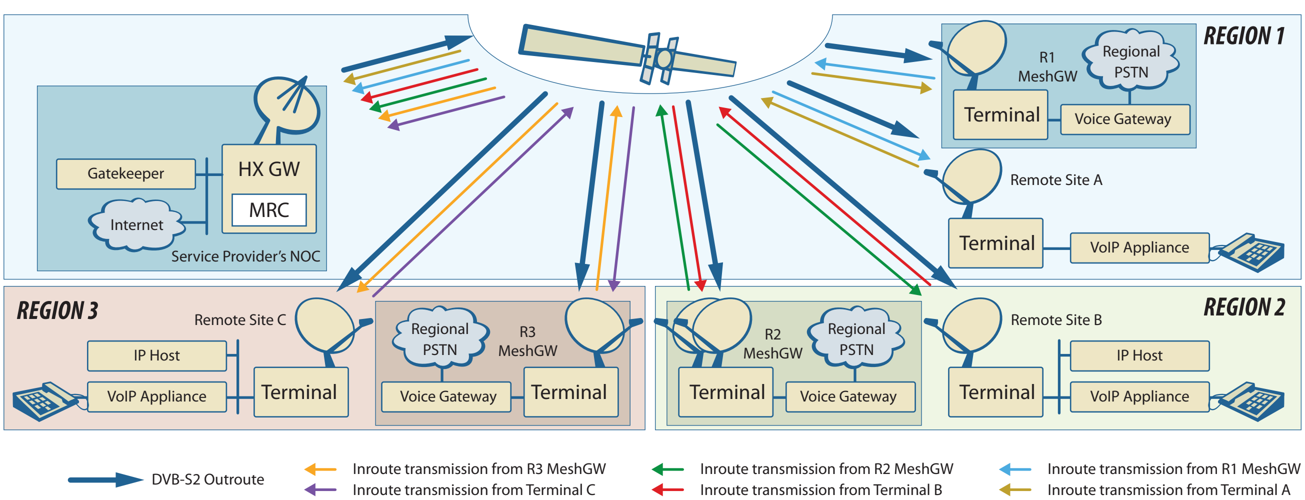

Figure 7. HX System Multi-Star Mesh Network with a Non-Regional HX Gateway

more importantly, without deploying a separate DVB-S2 outroute for each region. The need for regional star networks is driven by connectivity requirements, that is, a desire (or, sometimes, a legal requirement) to not send traffic to a central site and then backhaul it to the regional centers. Note that, in actual application the regions may or may not overlap geographically, depending on the criteria used to define a region.

In the Multi-Star topology, the HX Gateway is typically deployed at one of the regional gateway sites (as shown in Figure 6), but this is not required. As shown in Figure 7, the HX Gateway may be deployed at an independent site (for example, a service provider‘s existing hub). At each regional gateway site except the one (if any) collocated with the hub, a MeshGW is deployed to receive mesh connections from the remote site terminals in the region. Typically, the remote site terminals are set up to connect to only their regional MeshGW and the HX Gateway at the hub. However, as indicated above, the system is capable of also allowing any-to-any terminal connectivity within a region, if desired by the operator.

Multi-Star Mesh Feature Overview

The HX System is inherently a hub and spoke (that is, star) satellite system. The HX System Multi-Star Mesh feature extends the HX System to support direct, on demand, single satellite hop (as opposed to double hop via the hub) connectivity between terminal sites. An HX System Mesh Terminal is capable of simultaneously receiving traffic from both the HX System Gateway at the hub and other Mesh Terminals. At a regional gateway site, a MeshGW is deployed provide the interface to the PSTN and to accommodate larger amount of traffic. The MeshGW is modularly scalable, which may be required because the connectivity needs of a MeshGW site, both in terms of bandwidth and in terms of number of mesh peers, can be significantly larger than that supported by a Mesh Terminal. The MeshGW may also be configured as redundant or nonredundant based on the availability requirements.

A Mesh Terminal includes two types of receivers. The first is the standard TDM receiver used to receive traffic from the HX Gateway at the hub via a DVB-S2 outroute. The second type of receiver provides the ability for the Mesh Terminal to receive one or more inbound TDMA channels, thus allowing the terminal to receive bursts transmitted by other Mesh Terminals. A Mesh Resource Controller (MRC) in the HX Gateway dynamically coordinates connectivity between Mesh Terminals.

Figure 8 shows the link layer connectivity of two Mesh Terminals and the HX Gateway. (The Mesh Terminal could also be a MeshGW. This is transparent at the link layer.) A DVB-S2 outroute is transmitted by the HX Gateway. The outroute carries hub to remote site user traffic to the terminals as well monitoring and control signaling (for example, timing synchronization, inroute bandwidth assignments, etc.) and management signaling (for example, SNMP queries, software download, etc.) to the terminals. Each terminal has a single MF-TDMA transmitter that it uses to send inroute traffic to both the HX Gateway (star) and other terminals (mesh). Each terminal also has an MF-TDMA receiver capable of receiving inroute user traffic from other terminals (mesh). The MF-TDMA receiver can listen to multiple TDMA channels at the same time that results in improved traffic performance as the probability for blocking is low. The HX Gateway also has its traditional set of inroute MF-TDMA receivers for receiving (star) remote site to hub user traffic as well as control and management signaling sent by the terminals. In addition to receiving the star traffic, the HX Gateway also listens to the mesh bursts sent by the terminals to extract mesh related inroute signaling information, provide feedback for closed loop power control, etc. As indicated above, the Mesh Resource Controller in the HX Gateway coordinates mesh connectivity between terminals providing information to the terminals as to which inroutes to listen to receive mesh data from other terminals.

Figure 9 shows the connectivity for a MeshGW that is comprised of Mesh Terminal baseband units and ancillary control equipment. At the network layer, the MeshGW supports a single IP subnet and, therefore, is indistinguishable from a Mesh Terminal. However, as shown, each of the remote site Mesh Terminals may be connected at the link layer to a different based band unit within the MeshGW. The Mesh Resource Controller is responsible for coordinating the transmit resources of the various Mesh Terminal baseband units in the MeshGW. The mesh receiver resources are internally managed by the specialized software within the MeshGW.

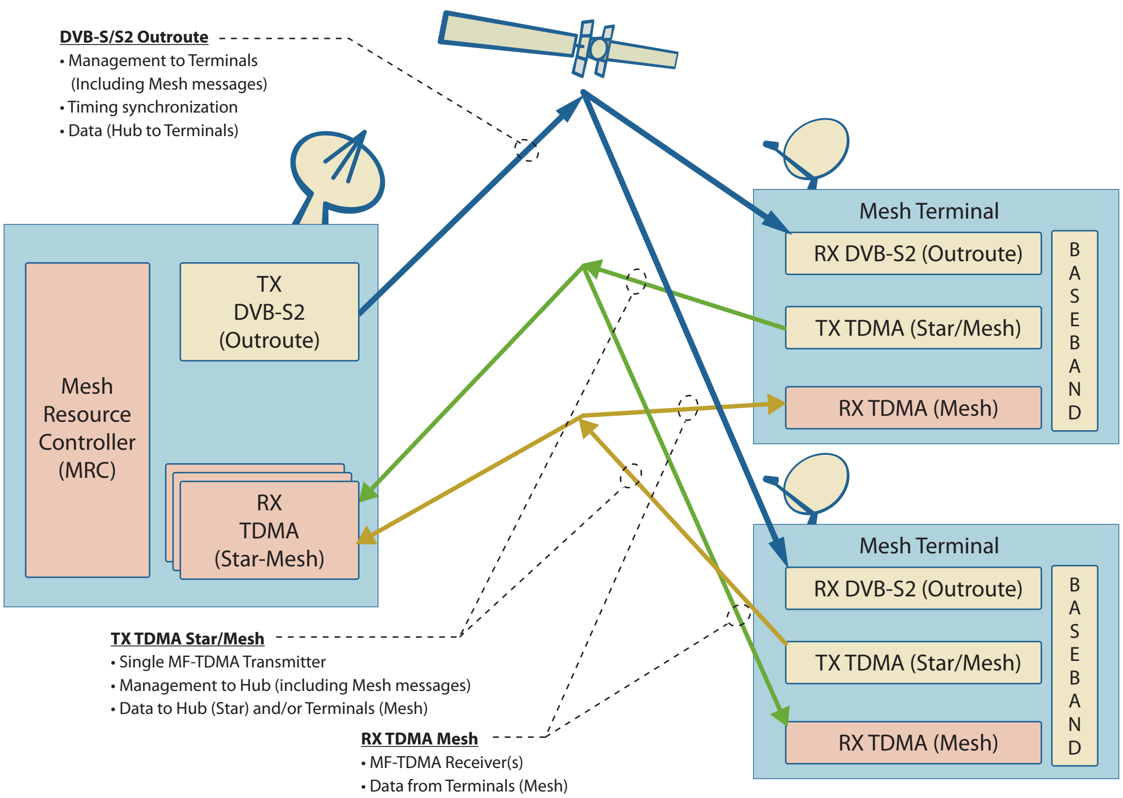

Figure 8. HX System Star and Mesh TX and RX Connectivity

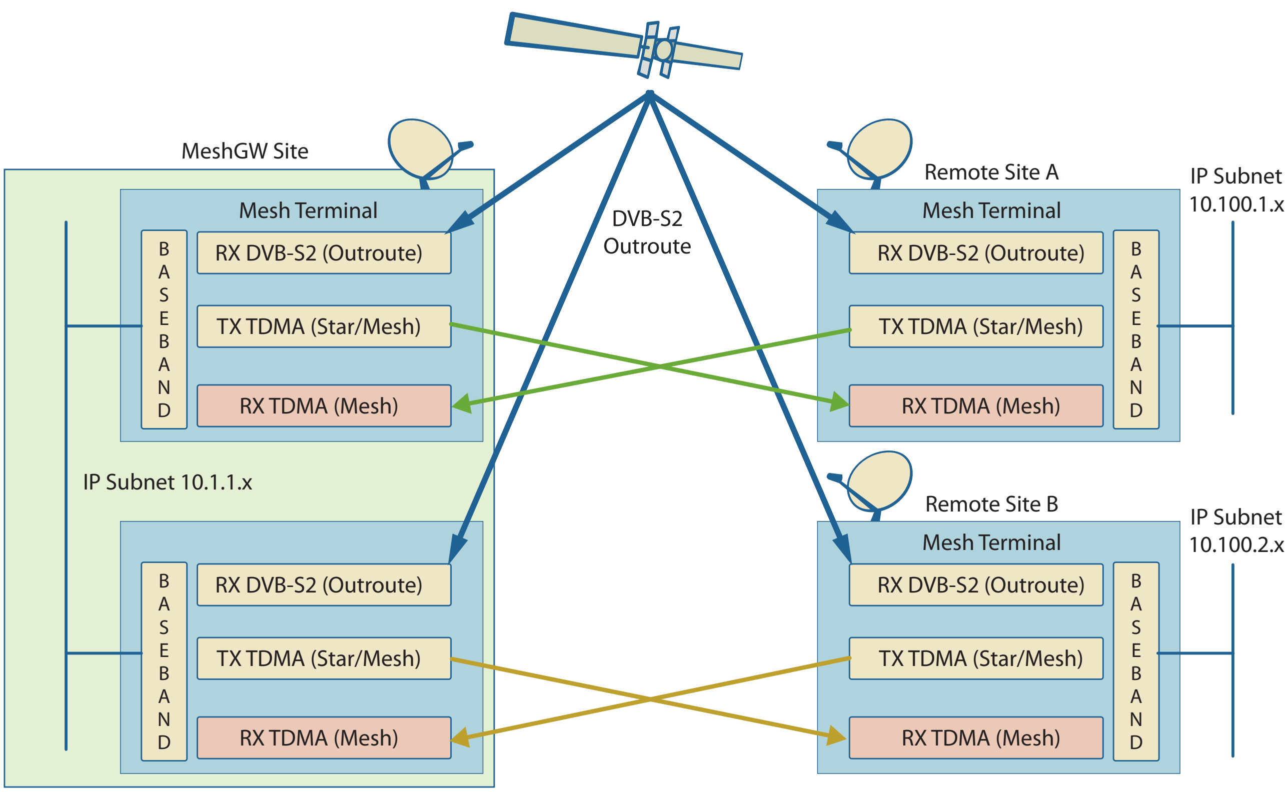

Figure 9. MeshGW and Mesh Terminal Connectivity

Communities of Interest and Supernets

The system operator needs to define rules indicating which mesh terminals may communicate with other mesh terminals. The mechanism for defining the desired connectivity is to segment the mesh terminals in the network into Community of Interest (COI) groups and subgroups. This chapter describes the purpose and design of Communities of Interest and Supernets as they pertain to the Multi-Star Mesh feature. Figure 10 illustrates the connectivity requirements for a simple Multi-Star mesh network and is used to provide examples for the concepts discussed.

Figure 10 shows a network shared by two customers. The first customer has two regions, each with a MeshGW site. In the first region (Region A), the mesh terminals are only allowed to connect to the regional MeshGW site. They are not allowed to connect to each other or to other mesh terminals outside of the region. In the second region (Region B), the remote site mesh terminals are allowed to connect to each other as well as to their MeshGW site. They are not allowed to connect to mesh terminals outside of the region. However, the two MeshGW sites are allowed to connect to each other. The second customer has a single region with no MeshGW site. Any-to-any connectivity is supported within this region. The mesh terminals of each customer are not allowed to connect to the mesh terminals of the other customer.

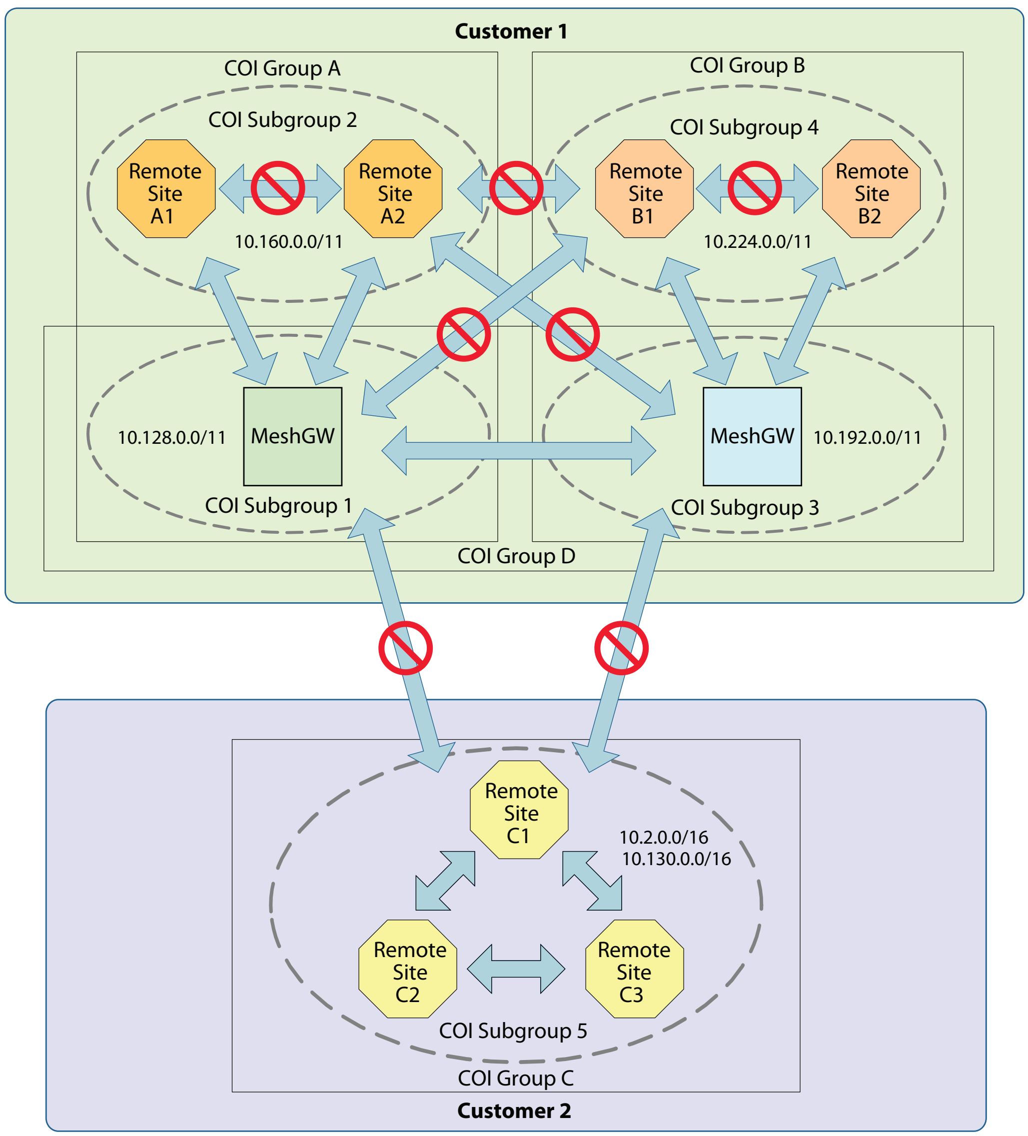

Figure 10. Simple Multi-Star Mesh Network Connectivity Example

Satellite Access Architecture

Outbound Transmission Overview

The outbound transmission of the HX System can be configured for either DVB-S or DVB-S2 operation. With the DVB-S2 mode of operation of the HX System, an operator is able to realize several key features that provide not only bandwidth efficiencies but also result in higher overall availability.

DVB-S2 is the most advanced satellite transmission standard that provides significant performance gains over DVB-S. DVB-S2 supports both QPSK and 8PSK modulation and uses the very efficient LDPC coding technique. Constant Coding and Modulation (CCM) is a standard feature of DVB-S2. However, the optional Adaptive Coding and Modulation (ACM) feature defined in the standard provides additional operating efficiencies. The Hughes HX System supports both CCM and ACM along with backward compatibility with DVB-S systems.

The table below details the significant advantages gained by DVB-S2 over the DVB-S standard. Where DVB-S using QPSK at an E_s/N_o of 6.31 dB produces 41.5 mbps information rate, the DVB-S2 using 8PSK at a lower E_s/N_o of 5.7 dB produces a 54 mbps information rate. In general the DVB-S2 transmission scheme can increase the outbound channel efficiency by 30% or more over that of DVB-S.

Inner Code Rate	QPSK						8PSK		
	DVB-S			DVB-S2			DVB-S2		
	Overall Code Rate	User Data Rate in 36 MHz (Mbit/s)	E_S/N_O (dB)	Overall Code Rate	User Data Rate in 36 MHz (Mbit/s)	E_S/N_O (dB)	Overall Code Rate	User Data Rate in 36 MHz (Mbit/s)	E_S/N_O (dB)
1/2	0.46	27.6	3.75	0.50	30.00	1.2			
3/5				0.60	36.00	2.4	0.60	54.00	5.7
2/3	0.61	36.9	5.39	0.67	40.00	3.3	0.67	60.00	6.8
3/4	0.69	41.5	6.31	0.75	45.00	4.2	0.75	67.50	8.1
5/6	0.77	46.1	7.26	0.83	50.00	5.4	0.83	75.00	9.6
7/8	0.81	48.4	7.88						
8/9				0.89	53.40	6.4	0.89	80.10	10.9
9/10				0.90	54.00	6.6	0.90	81.00	11.2

DVB-S2 LDPC

The LDPC code of DVB-S2 achieves turbo-like performance without the associated limitations at high code rates or modulation rates. In fact, it was Hughes' LDPC-based submission that was selected as the DVB-S2 standard over several other turbo code-based candidates. LDPC coding in the DVB-S2 standard today can get to within 0.7 dB of the Shannon limit. LDPC coding today is so advanced that experts in the field do not expect further performance improvements for decades to come.

DVB-S2 ACM

The Hughes HX system offers the optional ACM feature defined in the DVB-S2 standard that allows the Hughes HX Gateway to dynamically adjust FEC coding and modulation based on signal quality feedback from the Hughes HX remote terminals. This feature is very useful in optimizing transponder resources in varying link margin conditions caused by rain fade or geographically diverse site locations.

TDMA Transmission Overview

The TDMA channel of the HX System employs a unique access scheme utilizing not only Frequency and Time Division Multiple Access (FDMA/TDMA) but also "Diversity Aloha" and a comprehensive set of bandwidth allocation schemes that provides efficient access for multiple users.

A key feature of the HX System is that by virtue of the TDMA channel architecture an operator can configure QoS per remote as opposed to that of other competitors systems that require that all remotes on a single inbound channel share the same QoS profile. In practice this means that with the HX System and operator could, with a single TDMA channel on the system, support some terminals with a Min CIR of 20 kbps, other terminals with a Min CIR of 50 kbps, some terminals with fixed CBR of 40 kbps, and, on top of that, other terminals operating in best effort mode. The HX System is able to develop these QoS services on a per remote basis directly because the TDMA channels are Aloha-capable, are frequency agile, and use variable burst lengths to construct return channel bursts. Figure 11 illustrates some of the key features of the inbound channel.

Aloha-Based TDMA Channel

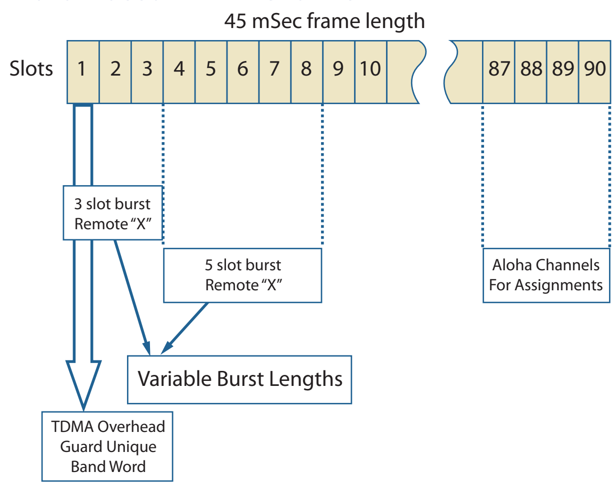

Figure 11. Inbound Channel Features

Aloha is a contention-based access scheme for TDMA whereby remote terminals randomly transmit messages into predefined Aloha channels—if a collision occurs, the sending remote terminal will retransmit the message. The important point about an Aloha-based scheme is that remote terminals can be configured to occupy no bandwidth if they are idle. Thus, when a remote has no traffic to send across the satellite link, it is categorized as inactive and is not assigned any TDMA bandwidth. Upon having data to transmit, the remote will randomly select one of the TDMA Aloha channels to transmit a burst requesting a capacity assignment.

Once the request is received by the HX Gateway the remote is assigned capacity based on its traffic profile. If the traffic profile is for Min CIR, the remote is provided with dedicated capacity based on its Min CIR profile. Alternatively, if the remote is configured to utilize the best effort scheme, it is provided a dynamic stream capacity, which varies based on the remotes backlog queue as well overall TDMA group traffic load.

Even for those remotes that are provided dedicated capacity the HX System allows the capacity to released after a configurable period of time. Thus, if the remote has been idle 10 minutes, the system could be configured to declare the remote idle and free up the capacity for other terminals to utilize.

As with any contention based system, the Aloha scheme introduces a small probability of collision (typically this is designed for less than 15%). Unique to the HX System is the capability to use Diversity Aloha whereby each Aloha message is sent twice thus ensuring that over 95% of the messages are transmitted in the first try.

Dynamic TDMA Frequency Assignment

An important feature of the HX System inbound architecture is the fact that remotes are not permanently assigned into any particular TDMA channel. Instead the HX System treats the inbound channels as a "pool" of inbound capacity against which remotes can draw their TDMA bandwidth. If a remote is allocated inbound capacity under the best effort mode then the bandwidth manager will dynamically change TDMA assignments based on traffic loading across the channels.

When a remote has no traffic to send across the satellite link it is categorized as inactive and is not assigned any TDMA bandwidth. Upon having data to transmit the remote will randomly select one of the Request TDMA Aloha channels and transmit a first burst that contains a configurable amount of user data plus some control information.

Once the request is received by the HX Gateway the remote is assigned capacity based on its traffic profile. As part of the traffic profile, the operator can configure the period of idle time after which the capacity assignment for the remote terminal is deallocated.

Variable Packet Sizes

Rather then trying to fit all inbound transmissions into predefined fixed length bursts (as done by other systems), the Hughes HX system uses a variable burst length scheme. This allows the system to efficiently fill the TDMA channels as the channel assignment does not need to be a fixed length.

HX260 Remote Terminal

The HX260 is a high performance satellite router designed to support dynamically assigned high-bandwidth IP connectivity in simultaneous mesh and star operation. The HX260 satellite router provides for high QoS features including Adaptive Constant Bit Rate (CBR) capacity assignment that delivers high quality low jitter bandwidth for real time traffic such as VoIP or videoconferencing. With the ability to support simultaneous mesh and star operation the HX260 is the ideal platform to for such applications as VoIP services where simultaneous mesh connections are required on a per-call basis and at the same time continuous Internet access is demanded. The HX260 also has advanced integrated IP features including RIPv1, RIPv2, BGP, DHCP, NAT/PAT, and DNS Server/Relay functionality together with a high performance satellite modem. Figure 6-1 illustrates the front panel of the HX260 and Figure 6-2 illustrates the rear panel of the HX260.

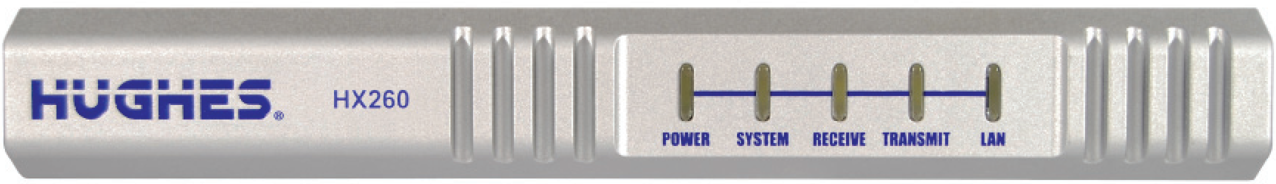

Figure 12. HX 260 Front Panel

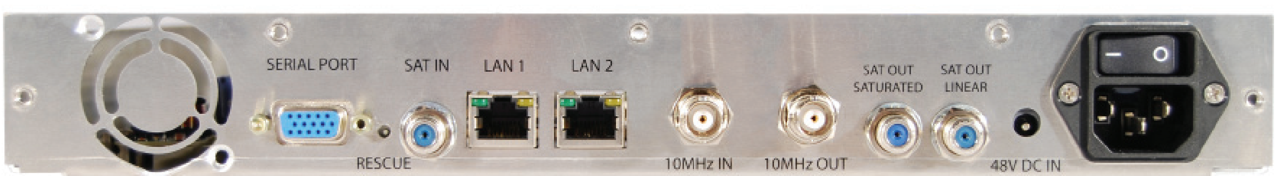

Figure 13. HX260 Rear Panel

HX260 Features Supported

- QoS features include:
  - On-demand constant bit rate (CBR) services
  - Adaptive CBR with Min CIR (committed information rate) with Max rate
  - Backlog-based dynamic stream with weighted fair queuing
  - Class-based weighted prioritization
  - Multicast data delivery
  - Four levels of IP traffic prioritization
- Capacity allocation
  - Support both preassigned (static) traffic assignment and dynamic traffic assignment
  - Idle remotes can be configured to release all network resources
- Acts as a local router providing:
  - Static and dynamic addressing
  - DHCP server or relay
  - DNS Caching
  - RIPV1, RIPV2, BGP routing support
  - Multicasts to the LAN by using IGMP
  - NAT/PAT
  - VRRP
  - VLAN tagging
  - Firewall support through integrated access control lists
- Supports unicast and multicast IP traffic
- Software and configuration updates via download from the HX Gateway
- Implements dynamic, self-tuning Performance Enhancement Proxy (PEP) software to accelerate the throughput performance by optimizing the TCP transmission over the satellite, delivering superior user experience and link efficiency (Star operation only)
- Mesh connections are supported for TCP and UDP traffic without PEP
- Bidirectional data compression (Star only)
- Configuration, status monitoring, and commissioning via the NOC
- Embedded Web interface for local status and troubleshooting
- Remote terminal management via the Hughes Unified Element Manager and SNMP agent
- User-friendly LED display indicating terminal operational status

Technical Specifications

Physical Interfaces

Two 10/100BaseT Ethernet LAN RJ45 ports

Satellite Specifications

Downstream Channel	DVB-S2 with Adaptive Coding and Modulation or DVB-S
Downstream Rate	1-45 Msps (in 1 Msps steps)
Downstream Modulation	QPSK, 8PSK (Adaptive Modulation)
Downstream Coding	BCH with LDPC 3/5, 1/2, 2/3, 3/4, 5/6, 8/9, 9/10 (Adaptive Coding)
TDMA Channel Rate	256, 512, 1024, 2048 ksps
TDMA Channel Coding	Rate 1/2, 2/3, 4/5 with TurboCode (Adaptive Coding)
TDMA Receiver(s)	1 standard, multiple as an option
Bit Error Rate (Receive)	10^{-10} or better
Bit Error Rate (Transmit)	10^{-7} or better
Interface to ODU	Industry standard BUC (L-band) or Hughes proprietary BUC

HX260 Mechanical and Environmental

1U enclosure for 19" rack

Weight (IDU)	5.5 lbs (2.5 kg)
Dimensions	19"W x 1.75"H x 18"D (48.26 cm W x 4.45 cm H x 45.72 cm D)
Operating Temperature:	+32 F (0° C) to 122 F (+50° C)

Proprietary Statement