HUGHES®

HX System

System Overview
Release 1.2.7

Revision record

Revision	Date of issue	Scope
A	September 4, 2008	Initial Release

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Chapter 1
Overview

The chapter provides a general overview of the HX System. It contains the following sections:

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Scope

This document provides a high-level overview of the HX broadband satellite system, including discussions of system concepts, features, and components.

Audience The primary audience for this document is enterprise customers who are responsible for operating and managing their own HX System gateway. The secondary audience is customers at any level who need to understand the operation of the HX System. This manual assumes that the reader understands:

- Telecommunications and computer networking technology
- Transmission Control Protocol/Internet Protocol (TCP/IP)
- Common computer networking services and protocols
- Satellite communications principles
- Satellite orbit characteristics
- Time and frequency division multiplexing
- Phase-shift keying
- Forward error correction
- Conditions that affect satellite communications

Target Markets The following is a list of potential markets for the current HX system:

- Mobility
- SCPC/MCPC replacement links
- GSM backhaul
- MPLS extension services
- Embassy and government networks
- Private leased-line services

Related publications The following documents provide more detailed information about HX system and gateway components.

- *Guide to Gateway Customer Documentation* (1037851-0001)
- *Gateway Installation Manual, Volume 1: Overview and Hardware Installation* (1037853-0001)
- *Gateway Installation Manual, Volume 2: Component Configuration* (1037854-0001)
- *Gateway Operations and Troubleshooting Manual, Volume 1: Satellite Router Operations* (1037855-0001)
- *Gateway Operations and Troubleshooting Manual, Volume 2: Gateway Operations* (1037856-0001)
- *Gateway Reference Manual, Volume 1: Vision Interface* (1037857-0001)
- *Gateway Reference Manual, Volume 2: NOC Forms and Local Interfaces* (1037858-0001)
- *Remote Terminal Installation Guide, Models: HX50, HX100* (1037106-0001)
- *Remote Terminal User Guide, Models: HX50, HX100* (1036942-0001)
- *Remote Terminal User Guide, Model HX150* (1037194-0001)
- *Remote Terminal Installation Guide, Model HX150,* (1037125-0001)

What's new in this release

Multiple Outroutes The Multiple Outroute (MORT) feature, in a mobile setting, allows a very small aperture terminal (VSAT) to seamlessly operate on multiple outroutes that are managed by a single Network Management System. The VSAT can be commanded by a third party component to switch outroutes when moving from one satellite footprint to another.

Inroute Management by NMSS The HX System Release 1.2.7 now provides for the full management of DNCCs, Aurora CPs, and the Configurable Demodulation System (CDS) (next generation CP) through Vision. Inroutes and Inroute Groups are configured through the NMSS GUI or using the NMSS spreadsheet load facility. The NMSS provides capacity validation checks when adding inroutes. The NMSS further provides the operator the ability to view status and statistics for the DNCC, Aurora CP and CDS. Control commands (reboot, force reload, etc.) are also provided by the NMSS. Capacity validation checks are performed when the logical inroute resources are modified (including changes to Downconverters, Inroute Groups, IQoS Plans, and Inroutes). Hub views are now organized by outroute number instead of outroute group.

Inroute CIR with Min, Guaranteed and Max bandwidth CIR is the rate that has been committed to a particular remote. Satellite routers are allocated bandwidth based on the following parameters:

1. Minimum CIR Rate
2. Guaranteed CIR Rate
3. Maximum CIR Rate

At the very least, the network operating center (NOC) will try to satisfy the minimum configured rate. In the event that additional bandwidth over the minimum is available it is up to the NOC's discretion to provide bandwidth for a particular remote. This excess bandwidth is not guaranteed and when available will be capped at the maximum rate.

Configurable Demodulation System (CDS) This release is the first release of the next generation return channel (inroute) Configurable Demodulation System (CDS).

Advantages of the CDS over its predecessor (IFSS-TC) include:

- Improved configuration flexibility
- Expands the number of inroute channels per demodulator

- Increased inroute capacity per rack space (up to 9 inroutes for 1U of rack)
- Supports higher symbol and user data rates
- Fully managed by NMSS

While the introduction of CDS is an upgrade, HX systems continue to support IFSS-TC, as well.

CACTI Network Manager CACTI Network Manager (new installations only) provides for network monitoring, event logging, and graphing SNMP statistics. Templates for network devices are included with this feature.

Expansion rack option An expansion rack option has been added to the HX System fixed rack model.

The HX System

The HX System is an innovative IP broadband very small aperture terminal (VSAT) system created by Hughes. The system is designed and optimized for smaller networks that require high-bandwidth, high-quality of service (QoS) links. The HX System leverages the best features and capabilities of the proven Hughes HN broadband VSAT system - with over one million terminals deployed - while providing new features that support high-bandwidth, real-time applications such as telephony trunking, video conferencing, and much more.

The most significant upgrade with the HX 1.2.7 over previous models is the inclusion of the mobility feature. While mobile satellite services at lower satellite frequencies (L-band, in particular) have been available for some time, these services tend to provide lower rates of speed (up to 400 kbps) and tend to be very expensive. With the HX 1.2.7, mobile satellite broadband using higher frequency services, such as Ku-band, now provides more bandwidth at a much lower cost.

The HX System's advanced bandwidth-management features enable operators to customize fine-grained QoS and SLAs (service level agreements) on a per-satellite router basis. For example, HX System operators can guarantee both inbound and outbound bandwidth per satellite router. In addition, the HX System can provide dynamic bandwidth allocation for time-division multiple access (TDMA) channels based on usage and need, allowing development of a wide range of service plans fine-tuned to meet individual needs. By leveraging the DVB-S2 transmission standard for the outbound channel, the HX System

achieves the best spectral efficiency of any TDM/TDMA network available today.

> Note: Although the term *satellite router* technically refers to all of the equipment at the remote site, it is often used to refer only to the VSAT.

The HX network architecture is based on the TDM/TDMA star topology. As shown in Figure 1, the system can provide high-speed Internet protocol satellite connectivity between the corporate headquarters and multiple remote sites. The HX System operates in the Ku, Ka, and C frequency bands.
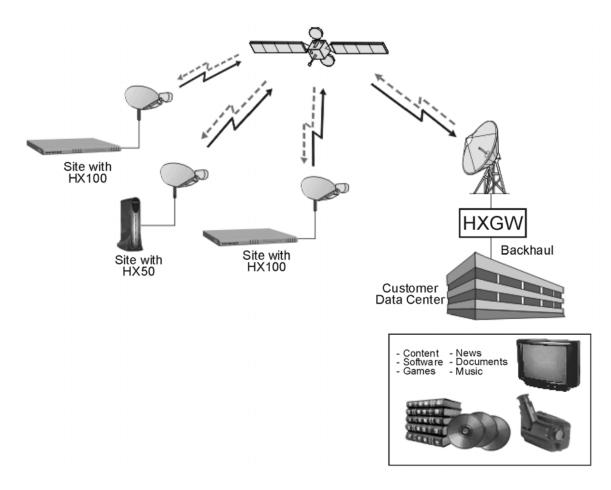
Figure 1: HX System

Innovative features

The HX System provides many state-of-the-art features including:

- **Advanced bandwidth management capabilities** – The HX System allows operators to easily provision services like constant bit rate (similar to *single channel per carrier* or SCPC), minimum *committed information rate* (CIR) with maximum limits, and *best effort* services. Plus, the HX System can tailor these service offerings for each satellite router.

- **DVB-S2** – The HX System uses DVB-S2—the latest generation satellite transmission standard. In its most basic form, DVB-S2 incorporates 8PSK or QPSK modulation together with low-density parity checking (LDPC). The combination of 8PSK with LDPC produces approximately 30% more bandwidth than DVB-S for the same amount of satellite power/bandwidth.

- **Adaptive coding and modulation** – The HX System implementation of DVB-S2 supports adaptive coding and modulation (ACM) in the outbound channel, allowing operators to optimize the outbound channel for each satellite router. For example, satellite routers in low EiRP regions can be assigned robust coding and modulation combinations (QPSK, Rate ½), while satellite routers in beam center can be assigned bandwidth-efficient coding and modulation combinations (8PSK, Rate 9/10). The application of ACM produces up to 30% more bandwidth than DVB-S2, for a total improvement of up to 60% over DVB-S.

- **Most efficient TDMA return channel** – Because HX System TDMA return channels use *Aloha* for initial assignment request, operators can optionally utilize the bandwidth of satellite routers that are idle for some period of time while maintaining the QoS commitment to a customer. The HX System TDMA inbound channel also uses variable length bursts, allowing up to 85% efficiency on the return channel.

- **Robust rain fade mitigation techniques** – Recognizing that high availability is a crucial element of enterprise SLAs, the HX System provides the industry's most extensive set of features for increasing overall system availability. These features include dynamic ACM on the DVB-S2 outbound carrier, dynamic coding of the TDMA return channel, and dynamic uplink power control for the satellite router.

- **Advanced IP features** – HX satellite routers support a number of built-in router functions, which are configured remotely at the HX System gateway. These functions

generally eliminate the need for an external router at remote sites. Router functions include flexible addressing with support for routing information protocol (RIP), network address and port translation (NAPT), port forwarding, DHCP service and DHCP relay, DNS caching, and firewall capability.

- **PEP Data acceleration** – All HX satellite routers implement the Hughes PEP (performance enhancement proxy for TCP) feature, which includes bidirectional TCP spoofing, data and header compression, IP priority levels, ACK reduction, and message multiplexing.
- **Built-in network security** – The HX System offers built-in network security as a standard feature. All data transmissions to satellite routers are encrypted to ensure that only authorized modems access the transmission. Bidirectional encryption is available as an option.
- **Adaptive inroute selection (AIS)** - A satellite router can select an optimal symbol and coding rate for its inroute transmission as a function of a configured trajectory table and through information it learns about its transmission from a closed loop power control algorithm. See the bulleted description above for *Robust rain fade mitigation techniques*.
- **Cost-effective gateway** – The HX gateway is optimized to support small networks. It occupies a small physical space and provides a very cost-effective solution for small networks.

Broadband applications

HX Systems support the following services:

- **Mobility** - HX systems support the use of mobile satellite routers through the use of the following primary enabling technologies:
  – Closed Loop Timing
  – Spreading
  – Doppler

- **Broadband IP connectivity** – The HX System offers a completely private high-speed network with performance-enhancing features that maximize performance and network efficiency. The performance of individual applications (interactive and file transfer) can be independently managed with Hughes performance-enhancing proxy parameters.
- **GSM backhaul** – The HX system can be configured as an IP pipe and used as a global system for mobile communication

(GSM) backhaul to replace T1/E1 and other ground-based base transceiver station-to-base station controller (BTS-to-BSC) network elements.

- **IP multicasts** – The HX gateway supports IP multicasts to send multimedia or other traffic to multiple remote sites simultaneously, and HX satellite routers include IGMP support to route IP multicast traffic to attached workstations.
- **Border Gateway Protocol** - BGP is a routing protocol frequently used with MPLS networks. Utilizing BGP, the HX now offers a more seamless interface to the networks.

HX System architecture

The HX system provides star TDM/TDMA connectivity consisting of a central gateway connecting to multiple HX remote terminals. With a DVB-S/DVB-S2 outbound carrier supporting rates up to 121 Mbps and multiple inbound carriers supporting rates up to 3.2 Mbps, the HX system provides the high throughput needed for high QoS networking.

HX System star topology

The HX system star-topology network has the following major elements, the HX gateway and the HX satellite routers.

HX gateway

The HX gateway is the central processing center of the network. The gateway provides connectivity between HX satellite routers and customer data centers and/or the Internet.

The HX System supports two types of gateways:

- Fixed gateway
- Transportable gateway

Fixed gateway (GW)

The fixed gateway equipment is contained in one or more racks that are in a fixed location.

The majority of this manual refers, by default, to the fixed gateway system.

Transportable gateway (TGW)

The transportable gateway equipment is contained in a single rack that can easily be packed, moved and reassembled.

The system is well suited for applications where network transportability is critical - including homeland security, continuity of operations, tactical military, and remote news gathering. At only two feet in height, the system is a size and

cost-efficient solution to support the rapid deployment of smaller satellite networks in difficult operating conditions.

A TGW overview with a description, list of features, services supported, advantages and technical specifications is included in Appendix B.

HX satellite routers HX satellite routers reside at the end user location and communicate with the HX gateway via satellite link.

Network segments The HX network is divided into *segments,* each of which represents a portion of the communications link. These segments include:

- Gateway segment
- Satellite router segment
- Space segment
- Wide area network segment

Gateway segment The gateway is the centralized earth station through which the entire network is controlled. The gateway is normally located at the customer's Network Operations Center (NOC). It contains transmit and receive communications equipment, a radio frequency terminal (RFT) consisting of RF equipment and a large antenna, and network management subsystems and infrastructure.

The gateway segment manages the entire HX System and any backend systems used for handling tasks such as billing, customer care, and provisioning. See Chapter 2 – *Subsystems* for more information.

Satellite router segment Satellite routers provide broadband TCP/IP communications to remote sites. The satellite router segment is the network segment located at the end-user modems. Each satellite router has an indoor unit (IDU), which contains the receive and transmit units; and an outdoor unit (ODU), which consists of RF equipment and an antenna.

A remote local area network (LAN) host is a device at the remote site that communicates across the HX System via TCP/IP.

See Chapter 9 – *Satellite routers,* on page 69 for more information.

Space segment The space segment is the satellite portion of the link, and connects all of the satellite routers in the network to the gateway.

Wide area network segment The wide area network (WAN) segment includes the Internet and various private independent IP networks with which HX satellite

routers communicate using TCP/IP protocol, including their host computers.

The WAN segment also includes the commercial, off-the-shelf (COTS) switches, routers, and other networking equipment within the gateway that connect the gateway to the independent IP networks.

System management   The network management system server (NMSS), also known as Vision UEM, contains the set of management tools for HX gateway primary components and interface equipment, including:

- IP gateway(s)
- Satellite gateway(s)
- DVB-S2 modulator
- Timing subsystem
- Inroute components:
    – DNCC
    – CDS
    – Aurora CP

Minor components and equipment are managed through their own interfaces. These components within the NMSS are:

- Element-management server
- Graphical user interface
- Backend database
- CACTI

For more information, see *Network Management Support Services (NMSS) subsystem* on page 22.

See Chapter 3 – *Network management* for more information about managing the HX System network.

Information flow

Figure 2 illustrates how information flows through the HX System gateway equipment. Note the difference between the arrows used to represent inroutes and those used to represent outroutes. The differing widths of these arrows signify the different bandwidths for data traveling from the HX gateway to (outroutes or uplinks) and from (inroutes or downlinks) the satellite modems.
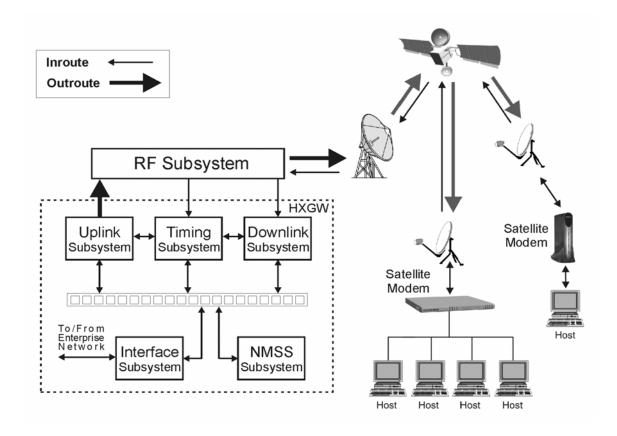
Figure 2: HX System equipment data flow

Chapter 2
Subsystems

This chapter describes the subsystems that comprise the HX system. These subsystems are standard with all Hughes systems and are required for network operation.

This chapter includes:

The subsystems and the network connection are illustrated in Figure 3 on page 14.

See Chapter 3 – *Network management,* on page 27 for a more detailed discussion on Network Management.
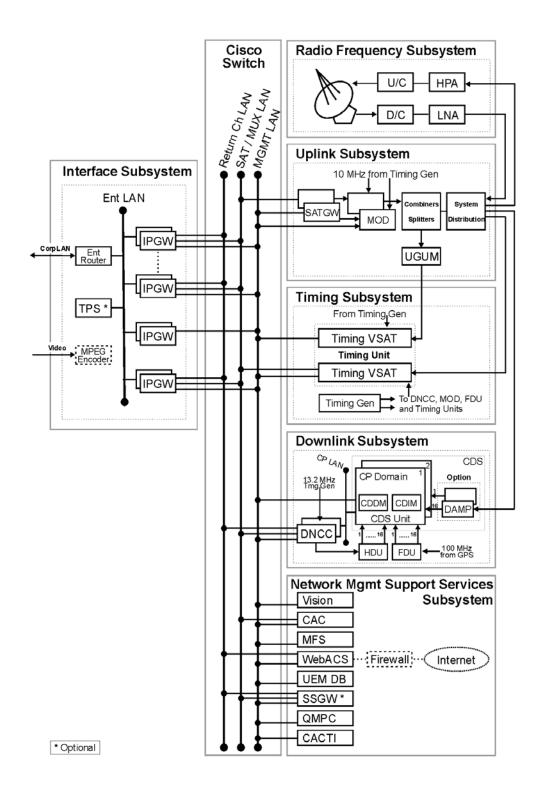
Figure 3: HX Subsystems and LAN Connections

Interface subsystem

The interface subsystem includes the IP gateway (core component) and special services gateway (optional component; described in *Special Services Gateway (SSGW) Installation, Operation, and Maintenance Manual* (1032030-0001).

IP gateways

The IP gateways provides the interface between the HX gateway and the enterprise intranet terrestrial data connections. The IP gateway performs the IP address mapping, packet transmission, compression, and other functions needed to support the HX satellite routers. Traffic between the IP gateway and the intranet host uses a standard IP packet format. However, the IP gateway implements an Hughes-proprietary protocol between itself and the satellite routers that is optimized for efficient, yet reliable communication over the satellite link.

To facilitate data transfer from the IP gateway to the satellite gateway, the IP gateway encapsulates unicast and multicast frames containing traffic destined for satellite routers within User Datagram Protocol (UDP) packets. The IP gateway obtains the encryption information from the CAC, then encapsulates and sends the appropriate unicast data and keys information to the satellite gateway where the traffic stream is encrypted.

IP gateways forward the encapsulated unicast and multicast IP traffic from the customer network to the satellite gateway over the satellite LAN for further outroute processing. Unicast traffic is addressed to a specific satellite router; multicast traffic is sent to satellite routers in a pre-defined group and can include management traffic or user traffic.

The IP gateways record statistics files that contain the amount of traffic that has been processed for each IP subnet. IP gateways are designed as a warm redundant pair with *online* and *standby* modes of operation. IP gateways are SNMP-enabled and are configured, controlled, and monitored by Vision UEM running on the NMSS.

For TCP traffic, the IP gateway implements performance-enhancing proxy (PEP) features. See *Performance Enhancing Proxy (PEP V3)* on page 52 for a description of the PEP feature.

The IP gateway functionality also includes support for multicasting services. In this mode of operation, the IP gateway forwards multicast data (such as multimedia and advertising content) through the satellite gateway to the remote sites that are enabled (using the conditional access system) to receive the multicast stream. Additionally, each IP gateway can also be

configured with a maximum total CIR to limit the IP traffic to the customer's contracted grade of service.

Depending on the size of the network, there may be many IP gateways within a single HX System gateway. Typically, the HX gateway contains at least one IP gateway for each inroute subsystem.

Radio frequency (RF) subsystem

The RF subsystem performs the actual transmission and reception of satellite signals. The RF subsystem delivers received satellite signals to the inroute subsystems at RF. It takes outroute signals in the DVB asynchronous serial interface (ASI) format and modulates and transmits those signals. The RF subsystem is managed via SNMP using the management LAN and is internally redundant. The RF subsystem consists of the radio frequency terminal (RFT) and the system IF distribution module, which use commercial, off-the-shelf equipment.

Radio frequency terminal

The RFT takes the uplink intermediate frequency (IF) output of the system IF distribution module, upconverts it to radio frequency (RF) and transmits it to the satellite. The RFT also receives from the satellite the RF echo of the transmitted signal, along with the RF input for the inroutes, downconverts the signals to IF and forwards the downconverted signals to the system IF distribution module and then to the downlink subsystem. The RFT is made up of commercial off-the-shelf products.

Uplink subsystem

The uplink (or outroute) subsystem performs the multiplexing and transmission of all outbound IP traffic. All outbound traffic is formatted to conform to the DVB-S or DVB-S2 standard.

The outroute subsystem is made up of satellite gateways, DVB modulators, and outroute redundancy equipment.

Satellite gateway

The satellite gateway (SATGW) receives bundled satellite traffic from the other NOC components over a LAN segment, formats the information into individual packets, and forwards them to the DVB modulator for transmission over the satellite.

The satellite gateway receives bundled satellite traffic over the satellite LAN from the following components:

- IP gateways (including management gateways)
- DNCCs
- Special services gateways (SSGW)

- Timing unit (TU)
- Conditional access controller (CAC) server

Satellite gateways can receive encapsulated traffic using multicast addressing.

The maximum length of the packets is configurable for each IP gateway. A maximum expected frame length is also configured into each satellite gateway and must be at least as large as the largest corresponding value configured in the IP gateways feeding that satellite gateway. The UDP frames are all destined to a single IP multicast address. The frames contain sequence numbers and other header information and one or more user traffic frames.

Multicast traffic is received over the satellite gateway multicast address. This multicast address is unique across transponders. The conditional access (CA) key traffic is received over the CAC multicast address. This address is common to all satellite gateways configured in the NOC. The common CAC address and the unique satellite gateway address allow a single LAN configuration to support multiple transponders. All traffic to the satellite gateway is sent via multicast. The satellite gateway can receive traffic on multiple (a maximum of 8) multicast addresses.

DVB and DVB-S2 modulators

Each satellite gateway connects to a DVB or DVB-S2 modulator. The modulators are paired to satellite gateways and are designed to switch together as a chain in the event of a failure. The DVB modulators provide a 70 MHz IF output that is fed into an outroute redundancy module and then onto the uplink system of the RF terminal.

Two standards are supported, DVB-S and DVB-S2. Modulators can be configured to support DVB-S only or both standards.

- DVB-S supports Reed-Solomon coding and QPSK modulation
- DVB-S2 supports LDPC coding in both QPSK and 8PSK modulation.

The modulator supports the following symbol rates:

- In DVB-S mode, the DVB modulator supports the following symbol rates: 1.25, 2.5, 5, and 10 - 45 Msps, using FEC rates up to 7/8.
- In DVB-S2 mode, the DVB modulator supports symbol rates of 1–45 Msps in 1 Msps increments. The supported FEC rates depend upon the frame length (short codeblock or normal codeblock) and type of modulation:

  – Short, QPSK modulation: 1/2, 3/5, 2/3, 3/4, 4/5, 5/6, 8/9
  – Short, 8PSK modulation: 3/5, 2/3, 3/4, 5/6, 8/9

- Normal, QPSK modulation: 1/2, 3/5, 2/3, 3/4, 4/5, 5/6, 8/9, 9/10
- Normal, 8PSK modulation: 3/5, 2/3, 3/4, 5/6, 8/9, 9/10

DVB-S2 supports either CCM or ACM mode:

- In CCM mode, all satellite routers in the network operate at the configured modulation rate, symbol rate, and FEC rate.
- With DVB-S2 operating in ACM mode, satellite routers can adapt their FEC coding rate and modulation type (QPSK or 8PSK) to maximize the downlink speeds for the current operating environment.

The DVB modulators are commercial off the shelf (COTS) products.

Outroute redundancy

For the redundant configuration, outroute redundancy is implemented to switch the SATGW/DVB modulator chain. The functionality of monitoring the outroute and commanding a switchover is implemented by the quality monitor PC (QMPC) software component.

Timing subsystem

The timing subsystem provides the master timing for the entire system. It also maintains the timing synchronization between the NOC and the satellite routers. This subsystem consists of the timing generator, the timing unit and the closed loop timing (CLT) feature.

Timing generator

The timing generator provides the reference clock frequencies to several NOC components, including both outroute modulators, the timing unit, the optional automatic cross-polarization (ACP) spectrum analyzers, and the DNCCs. It also generates a superframe pulse for the DNCCs, the RCDs (older systems), the timing unit, and the radio frequency terminal (RFT).

Timing unit

The timing unit provides return channel timing support for a specific outroute. The timing unit consists of a pair of timing satellite routers, one of which is configured as a superframe numbering packet (SFNP) transmitter. The timing unit also provides timing information for the optional ACP subsystem.

A timing unit measures the difference in time between the L-band looped back signal and the signal looped back from the satellite and provides TDMA timing information to the satellite return channel terminals and the DNCCs within the downlink subsystems accessible from terminals receiving this outroute.

Closed loop timing The CLT feature provides timing adjustment feedback to enable the satellite router to transmit as close as possible to the middle of the burst aperture.

For more information see *Closed loop control* on page 65.

Timing subsystem physical constraints A timing generator supports:

- Ten 10 MHz coaxial connectors thereby supporting up to 8 DVB modulators or ACP systems. Two per outroute and one per ACP system (if added) are required.
- Eight DNCCs.
- Six timing VSATs.

Downlink subsystem

The HX gateway can be configured with one or more inroutes. Each inroute is a time-division multiple access (TDMA) return channel. The inroute subsystem manages the return channels associated with a group of satellite routers.

This system release features the introduction of the CDS, which replaces the IFSS-TC in newer systems.

Configurable Demodulation Subsystem The CDS is a powerful digital signal processor that demodulates one or more carriers, performs error corrections, and forwards the resultant bursts to a NOC component.

A CDS consists of a single cardset, configurable demodulation decoder module (CDDM) and configurable demodulation interface module (CDIM). The CDS is hosted on a CompactPCI (cPCI) chassis, along with a host control processor (CP) that is connected to the dynamic network control cluster (DNCC) through a LAN interface. The DNCC interfaces with the NOC components via multiple LANs. The CDS receives inroutes from the RF equipment and timing from the timing components. The inroute bursts are processed by the CDS (demodulated and decoded) and passed on to the DNCC. After converting inroute bursts into IP packets, the DNCC passes the inroute traffic onto the final destination, such as the corporate LAN or the Internet via the internet protocol gateway (IPGW).

The CDS is completely compatible with DNCCs that interface with Aurora return channel CPs.

One CDS platform can handle up to 9 inroutes, which can vary based on whether a type 1 or type 4 board is used, across a frequency band up to 36MHz wide, in a single 1U chassis.

The term CDS can refer to one or more instances of the CDS platform.

CDS replaces the IFSS-TC, which shipped with older systems. Furthermore, while the introduction of CDS is an upgrade, HX systems continue to support both CDS and IFSS-TC.

CDDM The CDDM is a 6U wide module that plugs into one of the I/O slots in the front of a cPCI chassis.

CDIM The CDIM is a 6U wide module that plugs into one of the I/O slots in the rear of a cPCI chassis. The CDIM card accepts a wideband IF input signal containing one or more inroutes, centered at 70 MHz with a bandwidth of 36 MHz from the external NOC equipment.

IF Subsystem-Turbo Code system

In place of the CDS, most older systems have the IFSS-TC.

The IF Subsystem-Turbo Code (IFSS-TC) is a modular system that:

- Acts as the HX gateway satellite radio receiver.
- Demodulates and decodes inroute signals received from remote user modems via the satellite.

A typical redundant configuration includes:

- Up to two compact peripheral component interconnect (cPCI) chassis, that contain storage media, power supplies, control processors (CPs), CP transition boards, and RCDs that contain software radio modules (SRMs) and receive control modules (RCMs)
- One optional frequency distribution unit (FDU)
- Up to two intermediate frequency distribution units (IFDUs)
- One optional HNS timing control (HNSTC) distribution unit (HDU)'

A nonredundant system contains one cPCI chassis.

Return channel components The NOC can be configured with one or more TDMA return channel subsystems (TRCSs). The TRCS manages the return channels associated with a group of satellite modems.

Return channel demodulator

The RCDs provide the demodulation of the TDMA burst return channels. The RCD accepts the inroute data, extracts the traffic data, and gives the traffic data to the DNCC. The RCD consists of the SRM and RCM.

Return channel control processor

The return channel CP is a Pentium III single-board computer in the cPCI chassis that manages the RCDs. Depending on the NOC rack configuration, there may be 1, 2, or 4 CPs in a system.

Return channel IF distribution

The return channel IF distribution module receives the IF output from the system IF distribution module and forwards it to the RCDs.

Dynamic network control cluster (DNCC)

The dynamic network control cluster (DNCC) performs all the processing and control functions of the inroute subsystem. The DNCC manages return channel bandwidth. The DNCC receives traffic bursts and control bursts. The traffic bursts contain modem IP traffic as well as "piggybacked" bandwidth requests. The control bursts can contain modem status, bandwidth requests, or *ranging* information. Ranging is used to adjust the operational parameters of a site and to fine-tune the satellite router's timing and transmit power without the need for user intervention. If the DNCC requests that the satellite router enter ranging mode, the satellite router uses its assigned ranging burst. Based upon these measurements, the site chooses the proper settings to transmit traffic to the DNCC.

The DNCC processes each type of burst and constructs IP packets, which are forwarded to the IP gateways. Different bandwidth allocation algorithms are implemented on the DNCC. Additionally, the DNCC generates the frame timing messages and forwards them to the timing components.

The DNCC is simple network management protocol (SNMP)-enabled and is configured, controlled and monitored by Vision UEM running on the NMSS.

The DNCC maintains detailed logs on all events pertaining to the downlink subsystem. These include ranging/commissioning information, inroute packet statistics, and other relevant data. Redundant HX gateways contain two DNCCs configured as a warm redundant pair with primary (online) and secondary (standby) modes of operation.

Control Processor

To maximize efficiency when processing traffic, each inroute defined at the DNCC is assigned an inroute group. All inroutes in the same group are managed by the same CP. The number of inroutes differs between CDS and IFSS-TC (older systems).

Systems with CDS

In newer systems with CDS and one BPE FPGA on the CDDM board, each CP can support the following:

Table 1: CP support for systems with CDS

Symbol Rate (for all active inroutes)	CDDM Board Type (Number of BPE FPGA's)	Maximum active inroutes
256 KSPS	1	9
256 KSPS	4	9
512 KSPS	1	4
512 KSPS	4	9
1024 KSPS	1	2
1024 KSPS	4	9
2048 KSPS	1	1
2048 KSPS	4	4

Systems with IFSS-TC

In older systems with IFSS-TC, each CP can support the following:

- 12 inroutes, 256/512 ksps Turbo BCH at 1/2, 2/3, and 4/5 forward error correction (FEC) rate
- 6 inroutes, 1024 ksps Turbo BCH at 1/2 and 4/5 FEC rate
- 3 inroutes, 2048 ksps Turbo BCH at 1/2, 2/3, and 4/5 FEC rate

RCDs are housed in a cPCI chassis. The HX gateway rack can support either one or two cPCI chassis, with three RCDs per chassis. Each RCD can support a single inroute type (combination of symbol rate, FEC rate, and coding type).

Network Management Support Services (NMSS) subsystem

The NMSS is the name given to the functional elements running in the NMSS (network management and support services) server.

These elements are:

- Vision - provides configuration and control interface for many of the NOC components
- Conditional Access Controller - provides access control for information transmitted through the HughesNet service
- Management file server (MFS) - provides a repository for software and configuration parameters to be downloaded to NOC components

- Web-based auto-commissioning - provides commissioning services for satellite routers
- UEM database - stores all network configuration data
- Special services gateway - (optional) acts as an IP gateway for satellite routers before they are commissioned, and provides bandwidth broker services for the downlink
- Quality Monitor PC - receives satellite output and monitors the quality
- CACTI - network monitoring and event logging

Vision

Vision provides a software interface to monitor, configure, and control network components, including satellite routers and NOC components.

Conditional access controller

The conditional access scheme prevents the reception of traffic belonging to a different customer. The CAC uses encryption technology to protect the user against unauthorized access. The CAC components perform the key management for the unicast TCP/IP encryption and IP multicast conditional access. Typically a single multicast IP address is used; however, a scaling feature that uses multiple multicast addresses is also available for large networks.

Management file server

The management file server (MFS) is both a repository and a component controller. It is a repository for software downloads and parameter files for managed NOC components. It also controls the enable/disable functions of NOC components and notifies those components of the file and version information and updates.

MFS relies on the management gateway client (MGC) service that is installed on each managed component. The MFS sends periodic heartbeat messages to the MGCs on these components using broadcast or multicast. If the MGC on a particular components determines that new software or configuration files are needed, it downloads these files from the MFS using FTP.

Vision copies files into MFS using FTP/Windows file sharing and notifies the MFS of any newly uploaded files using SNMP.

Web-based auto-commissioning

When a satellite router is installed, certain information must be provided to the NOC operator to ensure the site is commissioned properly. Auto-commissioning automates the commissioning process with no intervention by the NOC operator to provide fast turnaround on satellite router installations and prevent configuration mistakes. WebACS also configures components necessary for older generation equipment.

Auto-commissioning can take place over the Internet or the satellite link using the web-based auto-commissioning server (WebACS).

Satellite-based commissioning   Satellite-based commissioning (SBC) is a optional feature that allows an operator to commission the installation without using a phone line to contact the WebACS. This method automatically establishes TCP connectivity between the client and NOC components.

SBC implements various approaches to enable this to occur. Some of the important techniques used to enable this are as follows:

- The source IP address configured in the TCP/IP stack can be the same for multiple PC's that are commissioning simultaneously
- The default gateway IP address for all commissioning PC's will be the same
- The DNS server IP address can be any private address reserved by HNS since DNS lookups are proxied in the NOC during SBC

The SSGW is the major NOC component of the SBC process.

SBC is not available with the TGW-100.

UEM database   The unified element management (UEM) database contains configuration information for these services, maintained under a separate schema for each. The NOC Forms application provides a configuration interface for CAC, WebACS, while Vision contains its own interface. The MFS is configured using an ASCII text file.

Special services gateway   The special services gateway acts as the IP gateway for satellite routers that are not yet commissioned. The special services gateway is optional, but required for using the WebACS feature.

The SSGW is not an option on the Transportable Gateway (TGW) model.

Quality monitor PC   The QMPC, with help from the SNMP interface, receives the satellite gateways modulated output and monitors its quality, posting alarms and initiating satellite gateway switchover as appropriate.

Used in redundant systems only, the QMPC ensures that only one SATGW-DVB modulator chain passes traffic at any given time. The SATGW-DVB modulator chain to pass traffic can also be selected manually by the HX gateway operator.

The QMPC resides on the NMSS server and has the ability of supporting multiple transponders (up to eight outroutes).

Note: The nonredundant HX system configuration does not contain a QMPC.

CACTI Network Manager CACTI Network Manager (new installations only) provides for network monitoring, event logging, and graphing SNMP statistics. Templates for network devices are included with this feature.

Local area networks

The HX systems use LANs and VLANs to simplify connections and reduce cable clutter. The following list indicates the functions of the individual LANs/VLANs within the system.

- Gateway LAN
  - Management VLAN
  - Satellite or MUX VLAN
  - Return channel VLAN
  - Control processor (CP) VLAN

- Enterprise LAN/VLAN

Gateway LAN The gateway LAN is used for internal communications and consists of four VLANs.

Management VLAN The management LAN connects the network management subsystem to other subsystems.

The management LAN carries all NOC administrative messages, including managed NOC component software and configuration information.

Satellite VLAN The satellite LAN connects the multicast broadcasters to the multiplex (MUX) subsystem.

The satellite LAN carries outroute traffic destined for satellite routers from the IP gateway, management gateway, dynamic network control cluster (DNCC), timing unit, and conditional access controller (CAC).

The satellite gateway receives the traffic on the satellite LAN and sends it on the outroute. The satellite also sends flow control information to all the IP gateways on the satellite LAN.

The satellite LAN is a dedicated LAN, which makes it easier to troubleshoot in cases of packet loss.

The Satellite LAN is also referred to as the Multicast or MUX LAN.

Return Channel LAN The return channel LAN allows the DNCC to forward received inroute packets to the IP gateways in the uplink subsystem. The DNCC transmits these packets into the return channel LAN.

CP VLAN The CP LAN carries inroute control messages, such as burst time plans, from the DNCC to the CDS (or the IFSS-TC). It also carries user traffic from the CDS (or the IFSS-TC) to the DNCC.

Enterprise LAN/VLAN The enterprise LAN carries user and management traffic from the IP gateways to the customer's enterprise router or the internet.

The enterprise LANs connect an uplink subsystem to the independent IP network accessible by terminals receiving the subsystem's uplink in such a way that the traffic from one independent IP network is accessible only by a terminal authorized to access that network. The downlink subsystem also requires access to these enterprise LANs so that it can forward inroute packets to the associated equipment within the appropriate uplink subsystem.

The enterprise LAN is also referred to as the INET LAN.

Chapter 3

Network management

This chapter describes the network management functions.

- *Overview* on page 27
- *Configuration management* on page 29
- *Fault management* on page 31
- *Performance management* on page 32
- *Security management* on page 32
- *Component control* on page 34

Overview

Network management provides management tools for HX System gateway components and interface equipment, including:

- IP gateway
- Timing unit(s)
- Satellite gateway
- DVB modulator
- DNCC
- CP
- CDS (or IFSS-TC in older systems)

All other network components and equipment are managed through their own interfaces.

Figure 4 illustrates the network management system architecture and how it connects to other HX gateway components.
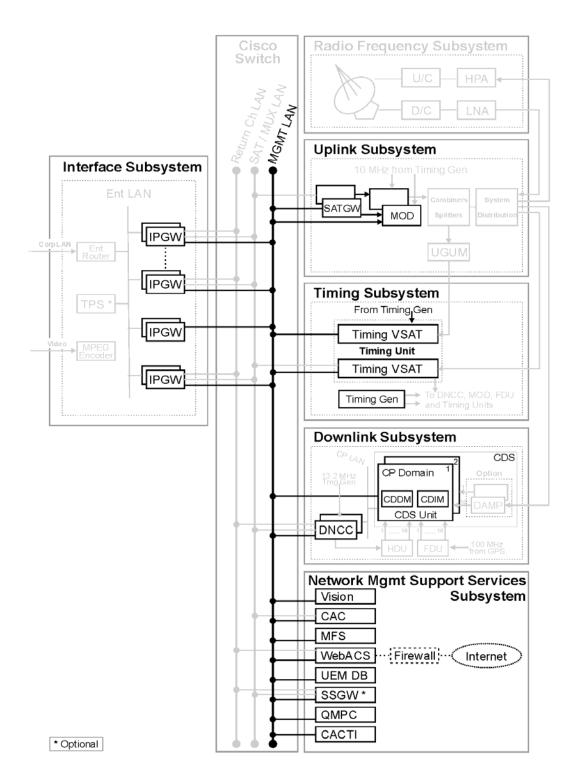
Figure 4: Network management system and LAN connections

NMSS server components The HX gateway incorporates four major network-management components within a single high-performance server:

- Element-management server
- Graphical user interface (GUI)
- Back end database
- CACTI

These components enable the HX gateway operator to perform both network operations (such as monitoring network status and statistics) and overall network management activities (such as configuration and control).

Configuration management

NMSS configures satellite routers and some of the HX gateway components. The network configuration is stored in the UEM database, and operators can maintain it either through the Vision graphical user interface (GUI) or provision components using a batch mode facility. In addition, Vision provides a commissioning interface to the Web-based auto commissioning system (WebACS) to support the auto-commissioning of satellite routers.

Gateway component configuration NMSS generates configuration files for each Vision-managed gateway component as needed, and sends them to the MFS component of the NMSS server. The MFS acts as a central repository for all configuration and software files for Vision-managed gateway components. Each gateway component managed by Vision contains a *management gateway client* (MGC). MGC is in constant communication with MFS using a proprietary protocol. the MGC downloads configuration files from MFS.

Remote site component configuration NMSS also generates configuration files for remote site components. It communicates with remote components through a specialized mechanism called software download (SDL), which informs the components of changes in required files. The SDL protocol permits files to be delivered in both *push* (sent unilaterally by NMSS) and *pull* (requested explicitly by the modem component) modes. In addition, NMSS uses a multicast delivery mechanism to transmit shared files simultaneously to all modem components that need them, thereby conserving outroute bandwidth. Files that are not shared between components are sent via unicast delivery.

Profiles and profile groups To simplify the task of managing the many different configuration parameters available in the HX System, NMSS provides conceptual groupings of related parameters called

profiles. Profiles are generally organized by function or feature, and can be of two types: shared and unique.

- Shared profiles can contain such parameters as resource allocations and tuning parameters, which are often shareable. Operators can create shared profiles and manage them independently of any particular network component.
- Unique profiles contain parameters, such as interface addresses, whose values cannot be shared because they must be specific to a component.

Most shared profiles are *optional* profiles. Profiles containing parameters that must be configured on a device are considered *mandatory* profiles. Profiles containing critical values that should be changed only by a network administrator are considered *restricted* profiles. A network administrator can determine which profile types are considered restricted.

Because the large number of optional features can make even the management of profiles tedious, NMSS provides an even higher level of conceptual grouping called the *profile group*. A profile group is simply a collection of shared profiles that can be associated with a component as a set. A remote site component can be associated with one core profile group, which is assigned by a network administrator, and optional customer profile groups, which can contain profiles that are not restricted.

Software configuration management

NMSS supports the ability to remotely install and upgrade software images on both gateway and remote site components. Software profiles are used to manage software versions. Vision distributes software files to gateway and modem components using the same mechanisms used to distribute configuration files. Software images for modem components are multicast via SDL.

Configuration interfaces

NMSS provides a number of interfaces through which network configuration can be defined and maintained.

The NMSS graphical user interface (GUI) is the interactive interface that operators use to perform initial network definition and the creation of profiles, users, and hub components, as well as other administrative tasks. The GUI provides full manual control of all configuration parameters and system settings, subject to configured operator access policies and restrictions. HX gateway personnel can use the GUI, as can customers at remote sites and customer support agents.

NMSS also has a provisioning interface intended for batch-mode definitions of remote site components. The provisioning tool extracts a list of sites to be provisioned from an extensible

markup language (XML) formatted file and updates the Vision UEM database with the site definitions and configurations. A typical use of this tool is the integration of a service provider's order-entry system. For better integration with desktop tools, there is also a utility to convert comma-separated value (CSV)-formatted files into XML.

Finally, NMSS provides a commissioning interface that is used by the WebACS during the auto-commissioning process.

Fault management

Fault management functions provided by NMSS include status monitoring, reporting, and alarms.

Status monitoring

Vision monitors the status of gateway and remote site network components through simple network management protocol (SNMP) and proprietary Hughes protocols. All managed HX network components have embedded SNMP agents that can report status and statistics information to a suitably configured SNMP manager.

Vision uses SNMP to periodically obtain key status information from gateway components. It can also query remote site components periodically for key status information, although this capability can be disabled to conserve network resources. Vision can use an alternate mechanism–the VSAT information protocol (VIP)–when available, to get status information from remote sites more efficiently.

Current status information is displayed on the Vision UEM GUI through color-coded icons. The GUI also provides fault-isolation capabilities that operators and customer support agents can use to troubleshoot and diagnose faults. The diagnosis functions use real-time SNMP queries to report up-to-date information from network components.

Alarms

HX network components with SNMP agents generate SNMP traps when certain error conditions occur, and send them to a configurable trap IP address. The traps generated by network components are documented in the SNMP management information base (MIB) definitions for those components.

To assist in the detection of failed sites or specific patterns of network failures, NMSS can generate certain alarms in the form of SNMP traps. For example, a component alarm can be generated when a remote site has been down for a configured period of time, and an aggregate alarm can be generated when the number or rate of failures of components in a specific group exceeds a configured threshold.

Performance management

NMSS provides both real-time and historical statistics on network components and traffic. These statistics are obtained by querying components through SNMP.

Real-time statistics

Real-time performance reports are shown through the Vision UEM GUI. Detailed statistics, which are updated periodically, can be displayed on every managed network component. The display formats can be changed dynamically to show absolute values, relative values, deltas, or rates. NMSS also has an integrated graphing tool called FlexGraph that can be used to build an ad hoc graph of selected statistics to display trends in real time.

Historical statistics

The historical statistics collection feature enables users to define ad hoc sets of statistics to be sampled periodically and saved in a disk file. NMSS can run the sampling operations between a specific range of times, and save the results in a comma-separated variables (CSV) formatted file. This facility can be used for long-term trend analysis.

Security management

NMSS provides mechanisms for operator security, network component security, and encryption key management.

Operator security

NMSS controls all access to network management features by user-level authentication. All interfaces, whether interactive, batch-mode or programmatic, are protected by a user id/password login sequence.

There are two classes of users defined. *Privileged* users have unrestricted rights. They can define other users, assign access rights for those users, and perform other supervisory and administrative functions. *Unprivileged* users can only perform actions for which access rights have been granted to them.

Network component security

The network is logically partitioned into network management domains (NMDs):

- Configuration NMDs
- Management NMDs

Each operator can be associated with one or more NMDs, thus restricting that operator's access to network devices only in the assigned NMDs.

Configuration NMDs

Vision supports logical partitioning of the network into non-overlapping domains called configuration NMDs.

Partitioning is performed at the network device (satellite router or HX gateway component) level.

When a network is installed, one NMD, called the default NMD, is automatically provided. Each device belongs to exactly one NMD.

Management NMDs To limit the number of service offerings that must be managed and maintained, all value-added resellers (VARs) are presented with the same set of service offerings (and therefore, profile groups). Because profile groups are linked to NMDs, all satellite routers belonging to VARs must reside in the same NMD in the NMSS.

To allow each individual VAR to monitor and control its own satellite routers, yet prevent them from accessing other VAR's satellite routers, NMSS provides a management NMD that may be assigned to each satellite router. Operators can then be assigned to a management NMD.

Management NMDs differ from configuration NMDs in three important aspects:

- A management NMD is optional for a satellite router.
- Any operator assigned to a management NMD may ONLY be granted monitor and control privileges to those satellite routers within the management NMD.
- No configuration privileges may be granted to any operator within a management NMD.

Encryption key management The management of traffic encryption keys is performed by the UEM/CAC. See For more information, see Chapter 4 – *Network security*.

Component control

NMSS can send commands to network components using SNMP for actions such as resets, reboots, and forced reloads of software configuration.

HX gateway control

You can send commands to the following HX gateway components:

- IP gateway (IPGW) / satellite gateway (SATGW)
- MFS (resides on the NMSS server)
- DNCC
- CP
- CDS

Remote site control

You can send commands to the satellite routers at remote sites.

Chapter 4

Network security

This chapter describes the data security features in the HX System. These features guarantee data integrity and confidentiality, and protect the network from intrusion and external exploits. The following topics are presented:

- *Data encryption* on page 35
- *Network security features* on page 36

Data encryption

The HX System can employ several information assurance techniques to safeguard the integrity and confidentiality of data transported through the system. These techniques include:

- DES-encrypted outbound channel
- Two-way IPSec encryption

DES-encrypted outbound channel

The outbound channel is encrypted using the data encryption standard (DES) by the HX CAS (conditional access system) feature. This CAS feature:

- Is hardware-based
- Ensures that traffic is received by satellite routers legally
- Prevents unauthorized eavesdropping

The HX CAS feature assigns a unique key to each satellite router. It is responsible for key management and for encrypting outbound data to satellite routers to ensure that satellite routers can only decrypt the data intended for them.

When a satellite router is commissioned, it requests its encrypted effective master key (EEMK) from the HX gateway. This key is sent to the satellite router, and then:

- Used at the HX gateway to encrypt all data sent to the satellite router
- Used by the satellite router to decrypt all data received from the HX gateway

Because all data transmissions to satellite routers are uniquely keyed, a satellite router can decrypt only the data sent to it. The EEMK is also used by satellite routers to authenticate themselves to the HX gateway.

Two-way IPSec encryption

IPSec in the HX System is NIST for FIPS 140-2 level 1 certified and has these characteristics:

- End-to-end encryption from satellite router to the endpoint on the enterprise network using IPSec, Advanced encryption standard (AES), and Internet key exchange (IKE) protocols
- Rides over top of the encrypted outroute and clear inroutes
- AES implemented in software
- TCP proxy is outside of the IPSec tunnel, preserving satellite acceleration in a secure configuration

The HX System provides standards-based IPSec/IKE support for encrypting user data traffic and managing encryption keys. The IKE protocol is used to automatically generate and maintain 128-bit session keys and to set up an IPSec tunnel between a satellite router and an IP gateway in the enterprise network. This ensures that the data is encrypted end-to-end between the customer's remote site and the enterprise network.

The HX System IPSec feature provides encryption without affecting the TCP acceleration and prioritization features. (See *Network layer features* on page 51 for information about the TCP acceleration and prioritization features.) The Hughes IPSec Kernel is NIST certified.

Network security features

The HX System provides the following network safeguards to protect the HX gateway and the LANs connected to satellite routers:

- Firewalling – A packet filtering firewall to protect LANs connected to satellite routers
- Fenced Internet – URL *white lists* can be defined to restrict web browsing from remote LANs to only permitted sites, IP addresses, and domains.

Note: The HX system supports network address translation (NAT) and port address translation (PAT)—features that can hide the topology of LANs behind a satellite router to prevent computers on those LANs from being directly addressed from the Internet. See *NAT/PAT* on page 53 for information about this feature

Firewalling Satellite routers have an embedded firewall. Firewall rules can be defined in satellite router profiles at the HX gateway and forwarded to satellite routers. There are also firewall configuration and statistics web pages on the HX satellite router System Control Center which, when enabled in HX gateway profiles, can be used to create firewall rules at the satellite router, and view firewall statistics. The HX satellite router firewall works on inbound (outroute) traffic only.

Fenced Internet The fenced Internet access (FIA) service is an option that requires a TurboPage server. The FIA service provides a mechanism for enterprise customers to restrict remote site access to a limited number of specifically approved Internet sites. Different lists of approved sites can also be supported for multiple subsets of a customer's remote sites.

Bandwidth management

Bandwidth management is the collection of techniques used in the HX system to manage available bandwidth to the greatest advantage. The HX system uses a variety of techniques to manage bandwidth to maximize flexibility and adapt to environmental conditions while providing guaranteed levels of throughput to meet service level agreements (SLAs) or demanding real-time media transport requirements.

The following sections describe the bandwidth management techniques used in the HX system:

Bandwidth management overview

The HX System allows operators to customize bandwidth assignments for each satellite router to meet individual QoS and SLA requirements (as compared with the HN System that is designed to provide a fair distribution of bandwidth across a broad set of satellite routers within a collective system).

Additionally, the HX System uses *variable burst length* transmissions for the inbound route. This is an advantage over systems that use *fixed burst length* sizes. Such systems waste a significant amount of bandwidth because every inbound burst must be the same size, regardless of actual payload demands. The Hughes HX System allows the return channel burst size to be built optimally per satellite router, based on demand.

Extensive and repeated tests on the throughput of the Hughes inbound system demonstrate inbound efficiency up to 85 percent. In practical application, this means that the aggregate upstream performance for a typical inroute easily reaches 85 percent of the inbound channel rate; for example 1.3 Mbps aggregate upstream throughput for a 1.6 Mbps return channel.

Bandwidth assignments

The HX System has the flexibility to provide two types of bandwidth assignments:

- **Nailed-up bandwidth** - ensures that the bandwidth is guaranteed and has low latency on start-up, but inefficient use of the bandwidth may be experienced if the satellite router is idle for long periods of time.
- **Activity-based bandwidth** - provides a more efficient use of the overall bandwidth, but causes delay at the initial start-up of traffic.

The system can operate in a mixed mode, for example, it can provide some sites nailed-up bandwidth assignment while providing other sites with bandwidth based on activity. In both cases, there is the capability to dynamically adjust the assigned bandwidth based on real-time traffic requirements.

Inroute bandwidth pooling

To leverage the fact that all satellite routers within the HX System are fully frequency-agile across all inbound channels, the HX System *bundles* the inbound channels into a single large pool of resources. At any point, a satellite router may be instructed to access virtually any inbound channel. The channel accessed is determined by the HX gateway dynamic network control cluster (DNCC), which considers multiple factors, including the QoS commitments of each satellite router.
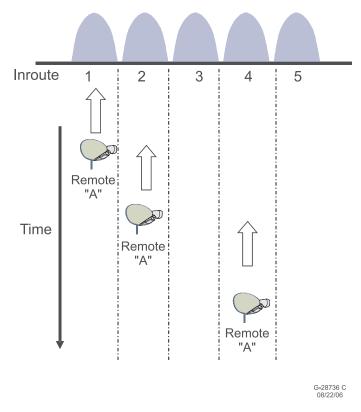
Figure 5: Multi-frequency inbound access

To achieve the efficiencies of pooling (that is, to realize the effects of the law of large numbers) while, at the same, providing the quality of service committed for each satellite router, the HX System uses a number of techniques. One important element is the concept of *inroute quality of service* (IQoS) plans. An IQoS plan is simply the logical partition of inroute bandwidth together with the satellite routers that can access the logical bandwidth. The assigned logical inroute bandwidth is designated as *Open* and is typically used by satellite routers configured for *dynamic stream* (otherwise known as *best effort* access). Figure 6 illustrates the structuring of the inroute bandwidth.
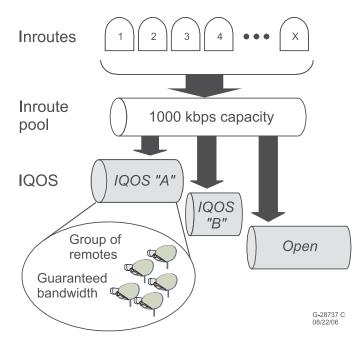
Figure 6: Inbound pooling

An important element in the inbound allocation scheme is that bandwidth need not be dedicated (that is, assigned to a specific satellite router or group of satellite routers) but can instead be *guaranteed*. The advantage of guaranteeing bandwidth is that when an IQoS plan does not fully utilize its assigned bandwidth, the HX System is free to reallocate this bandwidth to other IQoS plans (allowing over subscription of bandwidth), providing flexibility to an operator.

Dynamic stream services When a satellite router is configured for dynamic stream services, the amount of bandwidth it receives is based on a combination of the following factors:

- Backlog amount – This is the satellite router's estimation of how much bandwidth it needs at any given amount.
- Available IQoS capacity – This is the amount of available network capacity the system is using to allocate the dynamic stream capacity for this IQoS plan.

The IQoS plan defines the maximum amount of bandwidth available to a group of satellite routers as they access the dynamic stream bandwidth. The HX System supports multiple IQoS plans, allowing operators to provide different levels of best-effort services to different groups of customers.

Advanced bandwidth management techniques

The HX System has advanced bandwidth management tools that advise the operator how much outbound and inbound bandwidth has been consumed by various CBR and CIR services, as well as how much bandwidth is available for the best effort services. These tools, which provide a variety of statistical and status information, allow an operator to intelligently load the network and understand to what extent the network is over-subscribed.

The CBR traffic is assigned the highest priority, followed by CIR traffic. CBR and CIR are serviced before assignment of bandwidth for best effort services.

Preassigned CBR services

With this bandwidth management scheme, satellite routers can be configured (preassigned) to consume a fixed amount *constant bit rate* (CBR), and this bit rate can be configured independently for the outbound and inbound directions. For example, a satellite router can be configured with a 512 kbps inbound CIR and a 256 kbps outbound CBR. Additionally, the satellite router can be configured to deallocate the bandwidth if the channel has been idle for a configurable period of time.

CBR services operate similar to *single channel per carrier* (SCPC) links, as the assigned bandwidth per channel is fixed, based on the configuration of the link.

> Note: The idle timeout feature can be disabled in order to configure nailed-up bandwidth assignment.

Outroute CBR

Statically configured Constant Bit Rate requirements (Hard QoS configuration per VSAT):

- CBR traffic is assigned the highest priority, ahead of CIR and Best Effort.
- The CBR bit rates values range from 32 Kbps to the IP gateway CIR
- CBR users are not allowed to pass traffic in excess of the CBR bit rate.
- CBR configuration specifies the bit rate on a per-remote basis.
- The IP gateway supports remotes with different outroute CBR requirements.

Adaptive CBR with step increments

In this bandwidth assignment service, satellite routers are allocated bandwidth based on the following parameters:

- **Minimum CBR** – The amount of bandwidth that will be immediately allocated to a satellite router at the initiation of a

data session. This minimum CBR is low jitter, as the bandwidth is assigned to the satellite router until the CBR session terminates. Termination of the CBR session is based on idle period. Figure 7 illustrates the CBR feature of the HX System.

- **Maximum rate** – The maximum amount of bandwidth that the modem will be allocated.
- **Threshold level** – The level of usage at which the satellite router will be allocated an additional fixed amount of bandwidth (described in the *Step increment* bullet item).

  The **step-up threshold** is a percentage of the currently assigned bandwidth that, once reached, creates an *increase* in the allocated bandwidth. The *increase* amount is dictated by step-size.

  The **step-down threshold** is a percentage of the currently assigned bandwidth that, once reached, creates a *decrease* in the allocated bandwidth. The *decrease* amount is dictated by step-size.

The threshold level is defined as the following ratio:

$$\frac{\text{Bandwidth Used by the Satellite Router}}{\text{Bandwidth Assigned or Allocated}}$$

For example, if the threshold level is 80%, when the utilization level exceeds 80%, an additional *step increment* of bandwidth is allocated to the satellite router. The utilization or load of the channel is evaluated every 500 ms.

- **Step increment** – The fixed amount of bandwidth, in kbps, that will be allocated to a satellite router as it requires more than the minimum CBR amount. 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 modem or until the bandwidth of the inroute is exhausted.

  The **step-up threshold** is a percentage of the currently assigned bandwidth that, once reached, creates an *increase* in the allocated bandwidth. The *increase* amount is dictated by step-size.
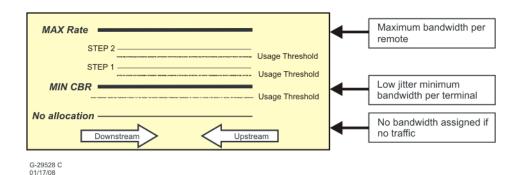
  The **step-down threshold** is a percentage of the currently assigned bandwidth that, once reached, creates a *decrease*

in the allocated bandwidth. The *decrease* amount is dictated by step-size.

- **Session activity timeout** – The period of IP inactivity after which the session will be disconnected and the bandwidth freed for use by other satellite routers.

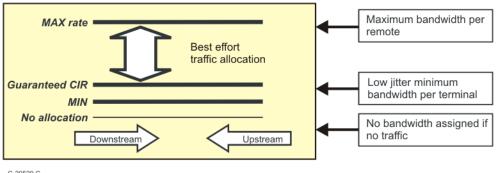Note: The idle timeout feature can be disabled in order to configure nailed-up bandwidth assignment.

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Figure 7: CBR services

CIR In this bandwidth assignment service, satellite routers are allocated bandwidth based on the following parameters:

- **Minimum CIR rate** – The amount of bandwidth that will be immediately allocated to a satellite router at the initiation of a data session. This minimum CIR is low jitter, as the bandwidth is assigned to the satellite router until the CIR session terminates. Minimum CIR bandwidth is prioritized after configured CBR bandwidth. Termination of the CIR session is based on idle period.
- **Guaranteed CIR rate** – The amount of bandwidth to be allocated to a satellite modem when the satellite modem's bandwidth utilization exceeds the configured threshold percentage of the minimum CIR value. When this occurs, bandwidth allocation to the satellite modem is increased to the configured guaranteed value.

  Guaranteed CIR value is available only in the inbound direction.
- **Maximum CIR rate** – The maximum amount of bandwidth to be allocated to a satellite router when the advertised backlog exceeds the configured guaranteed.

Figure 8: CIR services with best effort

Figure 8 illustrates the CIR with best effort service. In this access mode, the satellite router is provided the guaranteed CIR the moment traffic activity is detected. A satellite router is eligible to receive bandwidth in excess of its guaranteed CIR up to its maximum CIR based upon its advertised backlog, periodic, and left-over bandwidth. The DNCC (the bandwidth manager element in the HX gateway) provides the requested (or excess) bandwidth in a best effort manner. If the bandwidth is available, it is granted up to the maximum rate defined for the satellite router.

Outroute CIR Statically configured CIR service requirements (Hard QoS configuration per VSAT):

- CIR traffic is assigned a lower priority than CBR traffic and a higher priority than best effort traffic.
- The CIR configuration specifies a minimum CIR (minCIR) and maximum CIR (maxCIR) bit rates on a per-remote basis.
- The IP gateway supports remotes with different outroute CIR requirements.
- The CIR bit rates values range from 32 Kbps to the IP gateway CIR.
- CIR users are not allowed to pass traffic in excess of maxCIR bit rate.
- CIR users with a CIR level between the minCIR and the maxCIR bit rate are serviced as best effort users, but the traffic is sent at CIR users traffic priority.

- Servicing of CIR users with CIR level between the minCIR and the maxCIR bit rate should not be at the expense of CIR users with CIR level below their respective minCIR.
- Outroute multicast traffic is not included in the computation of users' CIR levels.

Best effort services

A satellite router that is configured for best effort services is eligible to receive backlog, periodic, and left-over bandwidth. When a satellite router is configured for best effort services, the amount of bandwidth it receives is based on the backlog amount. This is the satellite router's estimation of how much bandwidth it needs at any given amount.

Best effort users can be assigned (optionally) to an IQoS plan. The IQoS plan defines the maximum amount of bandwidth available to a group of satellite routers as they access the dynamic stream bandwidth. The HX System supports multiple IQoS plans, allowing operators to provide different levels of best effort services to different groups of customers.

Best effort utilizes the remaining bandwidth after meeting the requirements for guaranteed CBR and CIR bit rate services.

Bandwidth terminology

Operators need to be familiar with the following bandwidth related terms:

- Backlog - the estimated amount of data queued in a satellite router that is awaiting to be sent to the hub.
- Periodic - bandwidth that is periodically assigned to satellite routers based upon configuration.
- Left-over - bandwidth that has not yet been assigned and is distributed evenly to active satellite routers.
- Nailed-up - bandwidth that is assigned by the DNCC to a satellite router regardless of usage.
- Activity - bandwidth assigned solely on usage.

Traffic prioritization

Networks must be able to prioritize traffic to ensure that business-critical applications do not suffer due to bandwidth contention with less important applications. Traffic prioritization comprises the following:

- Soft QoS (or Application Level Quality of Service) - Traffic prioritization is based on the application.

  In the outroute direction, the IPv4 traffic destined for a terminal is prioritized based on the application type in the queued IP packets.

The QoS class for different applications can be marked based on the following:

- IP address
- DSCP value
- TCP port number
- UDP port number

- Hard QoS (or Terminal Level Quality of Service) - Traffic prioritization is based on the Hard QoS subscription. For example, Hard QoS gives preference to a constant bit rate terminal over a best effort terminal.

In the outroute direction, traffic prioritization occurs in the soft QoS before the hard QoS.

The HX System can prioritize both inbound and outbound traffic (Figure 9) based on IP parameters. This prioritization can be based on either source or destination IP address and/or IP port numbers and Diffserv code point bits. This allows prioritization based on machine identity or application traffic.

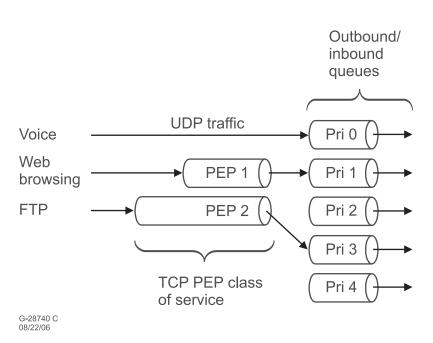For an explanation of PEP, please see *Performance Enhancing Proxy (PEPV3)* on page 59.

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Figure 9: HX System traffic prioritization

Unlimited combination of service plans

Because the HX System treats the inbound channels as a pool, and given that inbound TDMA bursts are of variable lengths, the HX System can efficiently provision a virtually unlimited combination of service plans. This contrasts significantly with some vendor solutions in which all the satellite routers on an inroute must have essentially the same (or similar) service plans with regard to minimum committed information rate (which is always consumed) and maximum rate. Figure 10 illustrates how an operator using the HX System can customize the service plan per satellite router, based on customer requirements rather than on limitations of the satellite system.
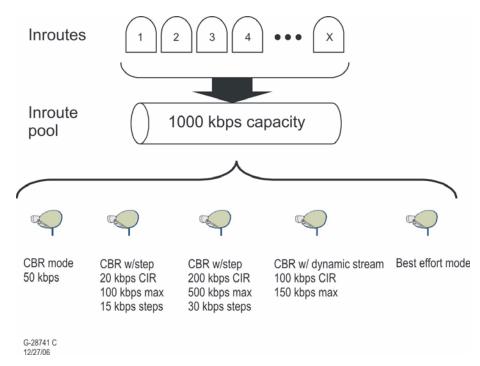

Figure 10: Multiple service plans

The HX System provides a variety of standard and specialized IP features designed to minimize space segment latencies and support standard and advanced IP networking protocols and services.

For the purpose of this discussion, the HX System IP features are broken down into the following two groups.

- *Network layer features* on page 51
- *Application layer network services* on page 55

Network layer features

The network layer IP features provided in the HX system include:

- Bandwidth conservation features:
  – IP header compression
  – Payload compression
  – PEP protocol implementation

- IP packet delivery prioritization
- NAT/PAT
- Port Mapping
- VLAN tagging

Each of these features is described in the following sections.

Note: The HX system also supports IPSec encryption. See *Two-way IPSec encryption* on page 35 for a discussion of IPSec support.

Bandwidth conservation features

The HX System implements a variety of mechanisms for reducing the amount of data that must be transmitted across the space segment, and for reducing transport latency. These techniques include:

- IP packet payload compression
- Inbound header compression
- The performance enhancement proxy (PEP)
- TurboPage

IP packet payload compression	IP packet payload compression is a feature of the performance enhancing proxy (PEP). It compresses grouped packets to achieve compression ratios of up to 12;1. For more information, see *PEP and TCP payload compression* on page 60.

Inbound header compression	A standard TCP/IP header is 40 bytes per packet, and most of that information is redundant for a given session. Header compression suppresses any redundant information, reducing the bandwidth required for the header. This compression capability requires that a large number of the fields either do not change, or change only in expected ways. Inbound header compression:

- Compresses TCP/IP headers from 40 bytes to 10-12 bytes
- Reduces bandwidth by 15-20%

Multiple types of IP headers can be compressed, including:

- IP headers
- UDP headers
- RTP headers
- PBP headers

Performance Enhancing Proxy (PEP V3)	The performance-enhancing proxy (PEP) feature improves the throughput and response time of Internet applications while minimizing required bandwidth. The HX satellite routers implement the PEP feature, which includes bidirectional TCP spoofing, data and header compression, IP prioritization, acknowledgement reduction, and message multiplexing.

The PEP feature can be disabled if required.

TCP spoofing

TCP spoofing uses local devices in place of devices on the other side of the satellite link to respond to TCP overhead messages. For example, in the PEP TCP spoofing scheme, the HX gateway acknowledges packets from the enterprise network, while satellite routers acknowledge packets sent to the enterprise network from the remote LAN. PEP also spoofs the three-way TCP connection handshake and connection terminations.

The Hughes PBP (PEP backbone protocol) is used in the space segment. It multiplexes multiple TCP connections for transport across the satellite link, thus reducing delays and maximizing bandwidth efficiency.

PEP and TCP payload compression

PEP can compress packet payloads to achieve savings in data transmission time. PEP uses the V.44 lossless compression

algorithm and stateful compression; that is, compression is applied across multiple packets at a time to take advantage of the greater data redundancy available across multiple packets, and consequent greater compression ratios. Compression ratios of up to 12:1 are achieved. PEP compression can be enabled on individual PEP connections.

TurboPage   TurboPage web acceleration uses the HTTP performance enhancing proxy (HPEP) to increase the speed of web page loading. This feature consists of a TurboPage server at the gateway and a TurboPage client in the satellite router. The server and client maintain a persistent TCP connection across the satellite link, and all HTTP/TCP requests are multiplexed across this connection.

The TurboPage feature parses HTML documents and HTTP responses, and fetches a subset of the referenced uniform resource locators (URLs), and forwards the information over the satellite link. The default behavior forwards embedded images, embedded HTML frames, cascading style sheets, and JavaScript URLs of moderate size, with the maximum prefetched size configurable for each kind of URL.

IP packet delivery prioritization   Inroute prioritization uses five queues to which users can map traffic with special handling for constant bit rate (CBR) traffic, such as real-time transport protocol (RTP) and facsimile. One queue is reserved for CBR traffic, and the other four queues carry PEP and non-PEP traffic, based on priority configurations. The packets from the CBR queue are transmitted before packets from any of the priority queues. Users can map PEP classes of service and non-PEP traffic to one of the four priority queues.

Packet delivery prioritization is based on:

- Source IP address range
- Destination IP address range
- TCP /UDP port number
- Diffserv code point (DSCP) bits

NAT/PAT   HX System satellite routers support network address translation (NAT) and port address translation (PAT), allowing translation of IP addresses from the local LAN to global or external addresses.

Note: PAT is sometimes referred to as NAPT, for Network Address Port Translation.

The capability for NAT and PAT is assigned to satellite routers in their profiles, assigned to them at the HX gateway.

The following NAT/PAT modes are supported:

- Port Address Translation (PAT) allows users to send data traffic from multiple IP devices on the satellite router LAN using a single address.
- Simple NAT enables enterprise customers to cut over to the network without changing their existing networks. By using static translation tables, it also makes servers on the satellite router LAN accessible from the WAN side. Simple NAT provides two methods for configuring the translation tables:
  - Auto-Map: The mapping from satellite router LAN addresses to NAT addresses can be auto-generated, based on the address ranges configured.
  - Manual-Map: The mapping table entries can be specified individually. This is especially useful if the satellite router LAN has sparsely addressed IP devices, such as when the satellite router LAN subnet size exceeds the NAT subnet size.

Port mapping If a satellite router is configured for port address translation, it can also be configured for port mapping. Port mapping (or *port forwarding*) is the mapping of traffic received by the satellite router on a given port to a particular IP address/port number on the satellite router LAN. Mappings can be specified as either TCP or UDP. Port mapping can be configured in a remote profile at the HX gateway, or optionally in a Port Mapping configuration page on the satellite router's System Control Center interface. For more information, refer to the User Manual for the type of satellite router you are using.

VLAN Tagging VLAN Tagging is comprised of three features:

- IPGW VLAN tagging
- Remote VLAN tagging
- End to End VLAN tagging

IPGW VLAN tagging The IPGW VLAN Tagging feature allows an operator to define multiple logical IPGW instances on a single IPGW server. Each of these instances is associated with a unique VLAN ID on its enterprise VLAN, which is permanently tied to the VLAN instance. Therefore, any packet traversing from a satellite modem defined on that IPGW instance will always be tagged with the respective enterprise VLAN id.

Remote VLAN tagging The Remote VLAN tagging feature allows the operator to configure up to 8 VLAN tags on a particular satellite modem LAN. However, the VLAN tags are not sent over the spacelink and are inserted and stripped by the satellite modem locally.

End to End VLAN tagging End to End VLAN tagging is a feature that allows the passage of pass the VLAN tags all the way from the satellite modem to the hub server.

This situation can become necessary when a typical satellite modem is connected to a LAN with multiple servers, each with the need to communicate with a different customer intranet host servers. These host servers are spread among multiple VLAN IDs based on their functionality. To accomplish this, it is necessary to use a specific VLAN id for all packets between the satellite modem PC and the enterprise host server. Another satellite modem PC (on the same remote) will connect with a different VLAN ID to a different host server on the customer enterprise network.

Situations can dictate that existing terrestrial network infrastructure be configured to prioritize certain VLAN IDs over others, which is why it is essential to pass the VLAN tags all the way from the satellite modem to the hub server.

Application layer network services

Several HX System IP features relate to satellite routers. These capabilities are configured at the HX gateway using the Vision UEM remote profiles feature and implemented in the satellite router. The satellite router IP features include the following:

- DHCP server
- DHCP relay
- DNS caching
- Access Control List
- Policy Based Routing (PBR)
- VRRP

DHCP server The dynamic host configuration protocol (DHCP) service running in the satellite router manages the automatic assignment of IP addresses to devices on the remote LAN. When enabled, the DHCP service responds to a DHCP request by assigning an IP address, a subnet mask, up to two domain name server (DNS) IP addresses, and a default gateway IP address.

DHCP relay HX satellite routers implement a DHCP relay feature which allows devices on remote LANs to obtain IP addresses and other information, such as an initial bootstrap program and DNS IP

address, from an enterprise DHCP server. DHCP requests received by a satellite router from devices on a connected LAN are forwarded through the spacelink to the HX gateway, which in turn, forwards them to an enterprise DHCP server. The responses are carried over the spacelink to the satellite router and sent out on the LAN port from which the requests were received.

Note that DHCP requests cannot be relayed from one satellite router to another, or from the enterprise network to a satellite router.

The DHCP relay feature allows relaying to multiple DHCP servers in the enterprise network.

Note: The DHCP service and DHCP relay features cannot operate simultaneously. The DHCP server feature is automatically disabled if DHCP relay is enabled.

DNS caching The optional DNS caching feature employs a DNS-caching proxy on the satellite router to cache resolved DNS requests. Requests for previously resolved addresses are provided from the cache, saving the delay and bandwidth required to send the DNS request across the satellite link for resolution.

DNS caching is enabled on satellite routers using satellite router profiles configured in the Vision software.

Access Control List The Access Control List feature controls access from both local and enterprise/internet side via up to fifty rules if configured from UEM and twenty rules if configured locally. The feature is configurable via Vision EMS and, optionally, from the local web based user interface.

PBR PBR is a feature that allows parameters to specify the next hop router to which a packet can be forwarded. A maximum of three PBR next hop routers can be defined for each LAN interface. For each router, the VSAT can be configured to either assume that the router is always available or to periodically check the status of the next hop routers through RIP or Ping. When PBR is enabled, an Access Control List rule is declared unavailable if the configured next hop router is not available.

PBR also allows an alternate router to be specified from the list of next hop routers. Traffic is forwarded to the next hop router whenever the spacelink status goes down. The alternate router functionality is disabled if VADB is enabled on the VSAT.

Next hop routers are meaningful only for "allow" rules.

VRRP VRRP provides redundant internet gateways. Increased availability is achieved by creating a virtual router consisting of a group of cooperating physical routers that share a MAC and IP address. The physical routers elect and monitor a master router to service requests. If the master router fails, another group member assumes its responsibilities. This implementation monitors the spacelink (using SHM) and optionally a remote host (via pings). This implementation also reports the VSAT as being in an *up* or operational state as long as both are functioning properly.

Multicast features

The HX System supports IP multicasting services. In this mode of operation, the Internet protocol gateway (IPGW) forwards multicast data (bandwidth-intensive, timing sensitive rich-media data such as digital audio and video broadcasts) and streams it out to remote sites that are enabled, via the conditional access system (CAS) to receive the multicast stream. Additionally, the IP gateway can be configured with minimum and maximum committed information rate (CIR) thresholds for each application, as well as CIR for the entire gateway (based on the contracted grade of service).

This chapter describes the multicast applications supported by the HX system and the methods used in the HX gateway and satellite routers to implement multicast support, addressed in the following sections:

- *Multicast applications* on page 59
- *HX gateway multicast management* on page 60
- *Satellite router multicast support* on page 60

Multicast applications

The HX System uses multicasts for a number of purposes, such as transmitting control information and configuration files generated by the Vision UEM system, and for transmitting IGMP protocol traffic such as conferencing, streaming media or other multicast media. Network time protocol messages are also multicast. From the end user perspective, the most important of these is IGMP protocol support.

Broadcast applications

Broadcast enterprise file transfers can be sent to all members of an enterprise network, with payloads that can provide piped-in music or advertisements used in retail locations. The Hughes system supports broadcast applications with the addition of an optional enterprise package delivery (EPD) server. You define the content and the package distribution to initiate the broadcast application.

Streaming media applications

Streaming media applications can be served by systems on the enterprise network and reliably received by systems on remote LANS by simply configuring the IP gateway to provide the required constant bandwidth, and the satellite routers to recognize and pass IGMP traffic. No special equipment or software is required to use the HX system as a pipe for video conferences, video and audio streams, and so on.

Remote Site Originated Multicast

The HX System Remote Site Originated Multicast (RSOM) feature adds the capability to carry IP multicast traffic, which originates at a remote site, across an inroute to the NOC. At the NOC, the traffic can be forwarded to a customer's data center and/or back to the outroute to the customer's other remote sites.

HX gateway multicast management

The HX gateway can support up to 10 simultaneous multicast streams. Each IP gateway can be configured with minimum and maximum committed information rate (CIR) thresholds for each application, as well as CIR for the entire gateway (based on the contracted grade of service).

Vision UEM provides a number of features for managing the multicast capability. These include a multicast gateway statistics screen in Vision UEM and SNMP MIBs that provide multicast statistics, including:

- Received multicast bytes
- Transmitted multicast bytes
- Multicast frame collisions

Satellite router multicast support

Satellite routers can be configured, through their profiles, with a variety of multicast-related parameters, including:

- IGMP enabled
- IGMP broadcast advertisement enabled
- LAN interfaces that can route multicasts

The Vision UEM interface also has screens for viewing per-satellite router multicast statistics collected from the satellite routers.

The HX multicast capability works transparently with multicast-enabled PC applications like NetMeeting and others, while minimizing latency and bandwidth required to transmit multicast content.

Multicasts from the HX gateway are also used to prepopulate DNS and web caches in satellite routers.

Transmission features

This chapter introduces HX System transmission function elements and explains the features and advantages of the HX System transmission implementation.

This chapter discusses the following topics:

- *Outbound channel: DVB-S2* on page 61
- *Inbound channel: adaptive coding* on page 64
- *Closed loop control* on page 65
- *Inroutes and inroute groups* on page 66

Outbound channel: DVB-S2

All of the Hughes satellite IP broadband systems use the DVB standards for the outbound transmission channel. The use of DVB for the outbound channel provides the following significant advantage for an operator:

- DVB scales efficiently

The HX System also supports the DVB-S2 standard to provide the following advantages:

- Improved spectral efficiency
- Outbound adaptive coding and modulation (ACM)

These features are described in the following sections.

DVB scaling

DVB channels are designed to scale effectively to large carriers—the HX System can support carriers as large as 45 Msps on the outbound channel. This contrasts sharply with non-DVB systems, in which the maximum outbound channel capacity in some instances is limited to 10 Msps. Uplinking multiple outbound channels incurs an efficiency penalty as each additional carrier requires channel spacing. In addition, the advantage of satellite multicast is reduced as each outbound carrier must replicate every multicast message.

With the Hughes HX system, an operator can use a single outbound channel to support hundreds of satellite routers.

DVB and multiplexing

Another important advantage of DVB systems is their ability to multiplex two or more DVB-S channels together into a single carrier. For operators who already broadcast a DVB video carrier, the addition of data capacity is easily achieved by multiplexing DVB video streams with a Hughes DVB data stream. With larger

multiplexed DVB streams, the operator can take advantage of single carrier mode across the transponder by operating the carrier in saturation. Figure 11 illustrates how two DVB streams can be multiplexed together.
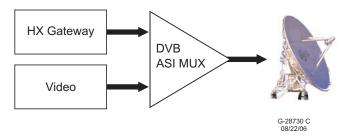
Figure 11: Multiplexing DVB Streams

DVB-S2 spectral efficiency

The most recent enhancement to the DVB standards is DVB-S2, which introduces several important new features that, together, provide significant spectral efficiencies over DVB-S and proprietary, non-DVB, channel formats. DVB-S2 provides for 8PSK and QPSK by using a powerful FEC system based on the concatenation of Bose, Ray-Chaudhuri, Hocquenghem (BCH) codes with LDPC (low-density parity checking) inner coding. The result of the BCH/LDPC coding is only 0.7 dB from the Shannon limit. This is a significantly better performance than any proprietary *turbocode*—most of which operate roughly 2 dB from the Shannon limit.

The bottom line for operators is that the DVB-S2 can provide up to 2.25 bits per Hz or more (depending on the link budget), resulting in better bandwidth economics.

DVB-S2 outbound adaptive coding and modulation

A powerful feature of DVB-S2 is adaptive coding and modulation (ACM), an addition specifically for interactive services such as broadband IP over satellite.

ACM allows an operator to vary the modulation and coding of the outbound channel on a per-satellite router basis. This feature can be applied in two ways—first to optimize the link budget of the outbound channel, and second to make dynamic adjustments to compensate for atmospheric attenuation of the outbound channel.

In the first application of ACM—optimizing the link budget—an operator can predefine the outbound coding/modulation combinations for each satellite router based on the satellite *footprint* or EiRP contour. As shown in Figure 12, the satellite routers that are at beam edge can be configured for the most robust coding/modulation combination (QPSK rate ½), while the

satellite routers at beam center can be configured for the most bandwidth efficient coding/modulation combination (8PSK Rate 9/10). The ability to customize the outbound channel per satellite router allows an operator to realize additional bandwidth efficiencies of up to 30% over and above the 30% gain from 8PSK and BCH/LDPC coding. Thus, DVB-S2 with ACM can provide an operator up to 60% bandwidth gain over DVB-S.
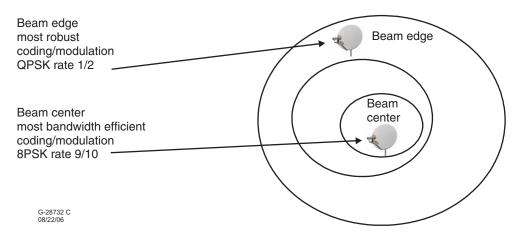
Beam edge
most robust
coding/modulation
QPSK rate 1/2

Beam center
most bandwidth efficient
coding/modulation
8PSK rate 9/10

Beam edge

Beam center

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Figure 12: Using ACM to optimize the link budget

In the second application of the ACM feature, the HX system can dynamically change the coding/modulation combination based on changing received signal conditions, which occurs in the event of a rain fade. In this mode, there is a closed loop control feedback mechanism between the HX gateway and the satellite router, whereby the satellite router can instruct the HX gateway to change the coding/modulation combination to overcome rain fade. The benefit for an operator is the ability to provide higher availability to its customers. The ACM capability of the HX System is shown in Figure 13.
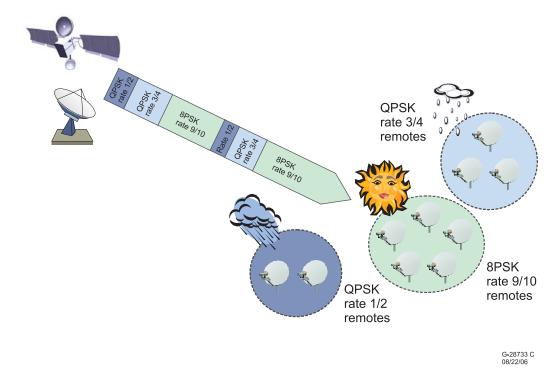
Figure 13: Using ACM to dynamically change coding/modulation

Inbound channel: adaptive coding

The Hughes system can dynamically change the coding rate of the inbound channel. This feature significantly improves link availability. As shown in Figure 14, this feature enables the return channel demodulators (RCD) at the HX gateway to demodulate, decode, and process bursts of varying coding rates within the same TDMA frame. The gateway demodulator does not need to know the coding of each burst in advance. The coding rate is determined spontaneously, allowing the satellite router to dynamically change it based on link conditions, as affected by rain fade.

Figure 14: Multiple FECs within one TDMA frame

Closed loop control

The Hughes HX System has a *closed loop power control* between the HX gateway and satellite routers so that there is a continuous monitoring of the outbound and inbound channels. As shown in Figure 15, the closed loop control provides for the HX gateway to continuously monitor the received signal quality of transmissions from each satellite router while each satellite router continuously monitors the received signal quality of the transmission from the HX gateway. As atmospheric conditions affect the link quality, each component is able to request changes to overcome fade conditions.

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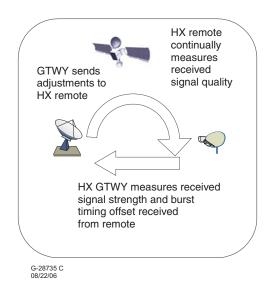
Figure 15: HX System closed loop power control

At the gateway, the outbound channel coding and modulation can be varied dynamically, while at the satellite router the forward error correction (FEC) coding can be varied dynamically to improve link availability. If the satellite router needs a more robust link performance for the inbound transmissions, it has the ability to shift to a different inroute group supporting a lower symbol rate. Note that the latter capability does not exist when operating with CBR IQoS plans. Additionally, the satellite router can dynamically change its local uplink power control to overcome fade conditions.

Closed Loop Timing

As part of the closed loop control implementation, the HX System also supports closed loop timing (CLT) which allows for both mobility of operation as well as *spot beam* satellite operation.

The CLT feature provides timing adjustment feedback to enable the satellite router to transmit as close as possible to the middle of the burst aperture.

Inroutes and inroute groups

This section describes the technical aspects of the Hughes HX System implementation of inroutes and introduces the concepts of inroute groups. Inroute groups are used in the HX System to bundle inroutes and collectively assign them a bandwidth and other properties.

The inroute portion of the space segment transmits data from the satellite routers to the HX gateway.

The inroute transmission has the following parameters:

- Frequency-time division multiple access (F-TDMA). Each inroute is at an assigned frequency on the satellite (FDM), and each satellite router accesses the inroute at its assigned time slot (TDM).
- Offset quadrature phase shift key (OQPSK) modulation
- Convolutional or turbo coding
- Viterbi forward error correction (FEC)

The inroute is divided into units called superframes. Each superframe is divided into frames, and each frame is divided into slots. The slot is the basic unit of inroute capacity. The slot size and number of slots are determined by the inroute data rate.

The satellite router transmits a burst at the assigned time slots. This burst enables the burst channel demodulator to lock onto the incoming signal.

Inroute types and burst types

Inroutes use one of the following access methods to transmit user data to the HX gateway:

- Aloha is immediate, contention-based user data transmission, and is not allocated. The satellite router randomly transmits the bursts on an aloha channel. If another satellite router is transmitting at the same time, a collision occurs. The HX System uses diversity ALOHA, which involves transmitting two copies of the packet, each in a different ALOHA slot. The HX gateway will only use one of the packets received on the ALOHA channel. The satellite router may be assigned to a stream depending on inroute configuration and network congestion.
- Stream allocation is a defined allocation at a defined time. The satellite router is assigned and allocated the stream after the HX gateway detects the ALOHA burst. Stream allocation

provides transmission opportunities of variable sizes based on advertised demand. The HX gateway can be configured to deallocate the stream if there is no demand for bandwidth.

Inroute groups An inroute group is a configured collection of inroutes with the following characteristics:

- Defined as a set of inroutes with the same symbol rate
- Operate at the same information rate
- Includes at lease one aloha BURST
- Bandwidth is assigned as a unit

The maximum number of inroutes in a group depends on the inroute information rate:

- 256 ksps - 32 inroutes
- 512 ksps - 32 inroutes
- 1024 ksps - 16 inroutes
- 2048 ksps - 8 inroutes

This chapter describes the satellite routers for the HX System. It addresses the following topics:

- *Overview* on page 69
- *Features* on page 70
- *Satellite router configuration and commissioning* on page 72
- *IP device support* on page 72

Overview

Hughes high-performance satellite routers are designed to support high-bandwidth links with QoS features such as Min/Max CIR together with dynamic allocation of bandwidth. With integrated IP features including NAT/PAT, DHCP, RIPv1, RIPv2, BGP and DNS server/relay functionality combined with TCP acceleration, Hughes satellite routers are the ideal platform to enable high-performance IP connectivity for a variety of applications including cellular backhaul, MPLS extension services, virtual leased-line services, and other high-bandwidth solutions.
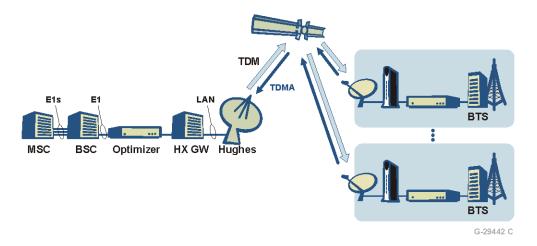
Figure 16: Typical HX100 site configuration

The HX System supports three different satellite routers: the HX50, HX100, or HX150.

HX50, HX100, and HX150 satellite routers are self-hosted, and therefore, do not require a PC to support operations. These routers download their software directly from the HX System gateway. Their configuration parameters are also set by the gateway, or in some cases, optionally at the satellite router through its System Control Center interface.

Antenna   HX satellite routers typically use a 1-meter rectangular linear antenna. The size and shape of the antenna depends on the specific characteristics of the deployed system, particularly the link budget.

Outdoor unit   Mounted on the antenna, the ODU includes the two-way radio, which enables the modem to receive and send signals to the gateway via the satellite.

Indoor unit   The indoor unit, or satellite router, is a standalone platform that communicates with customer devices using Ethernet ports to provide access to HX outroutes and inroutes. HX indoor units include two Ethernet ports.

Features

The HX50, HX100, and HX150 satellite routers route IP traffic from the outroute onto site LANs and transmit data back on the inroute. Table 2 lists the satellite router features.

Table 2: Features list for HX50, HX100, and HX150 satellite routers

Features	HX50	HX100	HX150
Two 10/100BaseT LAN ports to allow configuration of two independent LAN segments (subnets) at the customer site	X	X	
High bandwidth requirements and many simultaneous users	X	X	X
Ku-, Ka-, and C-band transmission (all modems can operate in extended C-band, the HX50 and HX100 can operate in India C-band)	X	X	X
L-band interface			X
Designed for enterprise and government networks	X	X	X
High bandwidth availability	X	X	X
DVB-S2 outroute	X	X	X
Mobility support through doppler compensation			X
Spreading			X
Saturated radio support	X	X	
Rack mounting kit		X	X

Table 2: Features list for HX50, HX100, and HX150 satellite routers (Continued)

Features	HX50	HX100	HX150
Standard and custom IP network protocols and features			
DHCP server and DHCP relay support	X	X	X
IGMP for multicast to LAN	X	X	X
VLAN tagging	X	X	X
ICMP support (pings, etc.)	X	X	X
Embedded web server for modem status query and configuration	X	X	X
NAT/PAT	X	X	X
RIPv2	X	X	X
DNS caching	X	X	X
Static and dynamic addressing	X	X	X
Firewall support through integrated access control lists	X	X	X
Supports unicast and multicast IP traffic	X	X	X
Obtains software and configuration updates via download from the HX gateway	X	X	X
Implements dynamic, self-tuning PEP software to accelerate the throughput performance by optimizing the TCP transmission over the satellite	X	X	X
Provides bidirectional data compression	X	X	X
Provides configuration, status monitoring, and commissioning via the gateway	X	X	X
Incorporates satellite router management via UEM and SNMP	X	X	X
Quality of service features			
Minimum CIR with fixed steps to maximum rate (rate limiting)	X	X	X
Minimum CIR with best effort to maximum rate (rate limiting)	X	X	X
Best effort services-weighed fair queueing	X	X	X
Class-based weighted prioritization	X	X	X
Multicast data delivery	X	X	X
Four levels of IP traffic prioritization	X	X	X
Bandwidth allocation features			
Supports both preassigned (static) and dynamic traffic assignment	X	X	X
Idle satellite routers can be configured to release all network resources	X	X	X
High availability features			
Closed-loop control between hub and satellite router	X	X	X
Dynamic outbound coding and modulation changes based on receive signal	X	X	X
Dynamic inbound coding changes based on received signal	X	X	X
Dynamic satellite router uplink power control	X	X	X

Note: While the HX50 and HX100 share a basic set of features and functionalities, the HX100 offers a rack mounting kit over the HX50. The HX100 is packaged in a thin horizontal enclosure and includes a mounting kit for optional rack installation. The HX50 has a smaller, more portable desktop form and includes an attachable pedestal base for optional vertical mounting.

Satellite router configuration and commissioning

A key advantage of the HX system is the ability to centrally configure and commission satellite routers. Most of the networking features of satellite modems can be configured centrally using the Vision UEM software. NAT, firewall rules, and many other parameters are assigned to satellite routers through preconfigured profiles created at the HX gateway. Configuration of many of these items can be delegated to the satellite routers, allowing, for instance, firewall rules to be defined remotely at the satellite routers through its system control system interface and pushed out to individual or groups of satellite routers This flexibility allows operators to design exactly the right combination of centralized and decentralized network management appropriate to their particular enterprise.

Remote commissioning is another important HX feature. Remote commissioning allows configuration parameters for satellite routers to be automatically uploaded to satellite routers from the WebACS (Web-based auto commissioning) server in the HX gateway. Installers use an embedded web-based wizard served by the satellite router to configure positional and other basic parameters; remaining data is provided by the WebACS system.

WebACS is an optional component and not shipped with a standard rack.

IP device support

IP devices connected to HX System satellite routers must implement the standard IP stack and provide an Ethernet interface; otherwise there is no constraint to the platforms and operating systems of devices attached to the satellite routers.

For example, PCs, MACs, SPARC and Alpha workstations, AS400 systems, and so on, can all be used with the HX satellite routers, running operating systems such as Windows, Linux, Solaris, MAC OS X, AIX, VMS and others.

This chapter describes HX optional features that provide additional functionality to the HX System but which are not included in the base HX System. These features include:

- *Enterprise package delivery* on page 73
- *IPSec* on page 74
- *ACP* on page 75

Enterprise package delivery

Enterprise package delivery (EPD) provides a reliable means of transferring large files from a centralized location to an unlimited number of receivers. Packages or files are enclosed in an envelope that is labelled with several parameters that define its source, destination, start/stop times, description, and so forth. Packages for delivery are posted to a customer-supplied server (which can be a simple Windows XP workstation) located at the HX gateway and running the EPD server software. The server then broadcasts these packages to the satellite routers.

The Enterprise Package Delivery software includes a client application that runs on target computers on the remote LAN. The client receives (or catches) the package files delivered with the EPD feature. Windows and Linux clients are available.

The client can be configured to associate a process (for example, an executable file) with received packages meeting predefined criteria, and to launch the associated process automatically upon receipt of a package. Figure 17 illustrates the Enterprise Package Delivery feature.
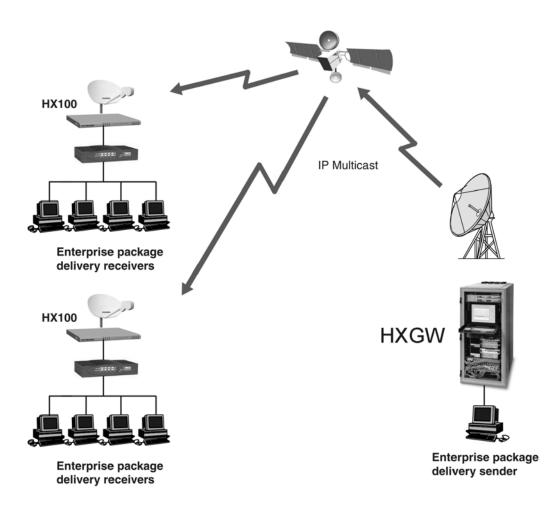
Figure 17: Enterprise package delivery

IPSec

IPSec support is provided with the addition of a VPN IP gateway server, typically located at the customer premises. The Vision UEM software provides the configuration and management features used to manage the IPSec feature on both the VPN IP gateway and IPGW-SATGW servers. No additional software is required.

Communication between the HX gateway and the VPN IP gateway is over a secure link provided by the customer.

ACP

ACP (Automatic crosspol server) is a new, optional feature. ACP requests are sent by the remote through an unacknowledged ranging burst, passed by the DNCC to the ACP server and via multicast broadcasting through the MUX LAN. Crosspol measurements are then conducted in ACP server and the result is sent back to remote through broadcasting from the satellite gateway.
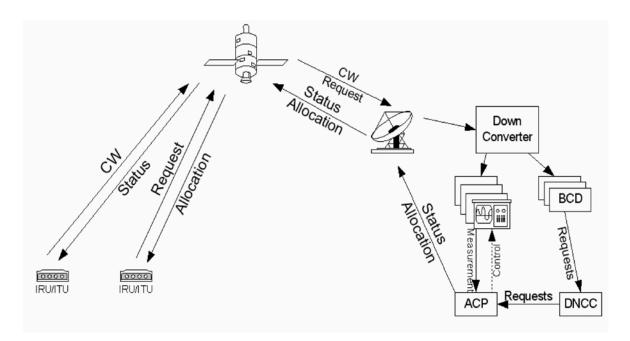
Figure 18: NOC Overview with ACP and DNCC

Technical specifications

This appendix discusses the following topics:

- *HX gateway specifications* on page 77
- *HX50/100 satellite router mechanical and environmental specifications* on page 78
- *HX150 satellite router specifications* on page 79

HX gateway specifications

Listed below are technical specifications for the HX gateway. This information includes: outbound and inbound channels, size and scalability, security, network management, and satellite routers supported in the HX gateway.

HX gateway technical specifications
Outbound channel
DVB-S2 compliant
Frequency: C-, Extended C-, Ku-, Extended Ku-, Ka-band
Modulation: QPSK/8PSK
Symbol Rates: 1-45 Msps (in steps of 1 Msps)
Encoding DVB-S2: Convolutional with concatenated Reed Solomon; Viterbi 7/8, 5/6, 3/4, 2/3, or 1/2
Encoding DVB-S2: BCH with LDPC 3/5, 2/3, 3/4, 5/6, 8/9, or 9/10 (8PSK); 1/2, 3/5, 2/3, 3/4, 4/5, 5/6, 8/9, 9/10 (QPSK)
Bit Error Rate: 10^{-10} or better
Inbound channel
FDMA/TDMA
Transmit modulation: OQPSK
Transmit encoding: Rate 1/2, 2/3, 4/5 TurboCode
Transmit bit rates: 256 kbps–3.2 Mbps
Size and Scalability
Base Configuration: – Single 26U rack (GTWY) – Supports up to 500 modems – Supports up to 9 inbound channels or total inbound aggregate bandwidth of 3.6 Mbps – Expansion capable via additional equipment rack

HX gateway technical specifications (Continued)
Security
Integrated Conditional Access and DES encryption of outbound channel
Optional bidirectional 128 bit AES encryption
Network Management Systems
Hughes Vision® NMS
Satellite routers supported
HX50
HX100
HX150

HX50/100 satellite router mechanical and environmental specifications

Listed below are the physical, satellite, and antenna specifications common to the HX50 and HX100 satellite routers. Also included are mechanical and environmental specifications for each satellite router.

Satellite router(s) technical specifications
Physical Interfaces
Two 10/100BaseT Ethernet LAN RJ45 ports
One RS-232/RS-422 compatible serial port
Satellite & Antenna Specifications
Outbound transmission format: DVB-S2
DVB-S2 supports adaptive coding and modulation
Information Rate (Receive or HX System Outbound Channel): up to 121 Mbps
Information Rate (Transmit or HX Inbound Channel): up to 3.2 Mbps
Symbol Rate (Receive): 1-45 Msps (in 1 Msps steps)
Symbol Rate (Transmit): 256, 512, 1024, 2048 ksps
Encoding DVB-S2 (Receive): Convolutional with concatenated Reed Solomon; Viterbi 7/8, 5/6, 3/4, 2/3, or 1/2
Encoding DVB-S2 (Receive):   – BCH with LDPC 3/5, 2/3, 3/4, 5/6, 8/9, or 9/10 (8PSK)   – 1/2, 3/5, 2/3, 3/4, 4/5, 5/6, 8/9, 9/10 (QPSK)
Transmit encoding: Rate 1/2, 2/3, 4/5 TurboCode, Rate 1/2 Convolutional
Frequency Range: C-. extended C-, Ku-, and Ka-band
Modulation (Receive): QPSK or 8PSK
Modulation (Transmit): OQPSK
Bit Error Rate (Receive): 10^{-10} or better
Bit Error Rate (Transmit): 10^{-7} or better

Satellite router(s) technical specifications (Continued)
Radio: – 1 and 2 watt Ku-band – 2 watt C-band – 1, 2, and 3 1/2 watt Ka-band
HX50 Mechanical and Environmental Specifications
Weight (IDU): 4.8 lbs (2.18 kg)
Dimensions (IDU): 11.5" W x 1.8" H x 11" D (29.21 cm W x 4.7 cm H x 27.94 cm D
Operating temperature: – IDU: 0° C to +40° C° – ODU: -30° C to +55° C
Input power: 90–264 VAC; 50–60 Hz
DC power supply (optional): 12–24 VDC
HX100 Mechanical and Environmental Specifications
1U enclosure for 19" rack
Weight (IDU): 5.5 lbs (2.5 kg)
Dimensions (IDU): 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: – IDU: 0° C to +50° C – ODU: -30° C to +60° C
Input power: 90–264 VAC; 50–60 Hz
DC power supply (optional): 12–24 VDC
Input power: 90–264 VAC; 50–60 Hz

HX150 satellite router specifications

Listed below are technical specifications for the HX150 satellite router.

HX150 Technical Specifications
Physical Interfaces
Two 10/100BaseT Ethernet LAN RJ45 ports
Two RS-232/RS-422 compatible serial ports
Satellite & Antenna Specifications
Outbound transmission format: DVB-S2
DVB-S2 supports adaptive coding and modulation
Information Rate (Receive or HX System Outbound Channel): up to 121 Mbps
Information Rate (Transmit or HX Inbound Channel): up to 3.2 Mbps
Symbol Rate (Receive): 1-45 Msps (in 1 Msps steps)
Symbol Rate (Transmit): 256, 512, 1024, 2048 ksps
Encoding DVB-S2 (Receive): Convolutional with concatenated Reed Solomon; Viterbi 7/8, 5/6, 3/4, 2/3, or 1/2

HX150 Technical Specifications (Continued)
Encoding DVB-S2 (Receive): – BCH with LDPC 3/5, 2/3, 3/4, 5/6, 8/9, or 9/10 (8PSK) – 1/2, 3/5, 2/3, 3/4, 4/5, 5/6, 8/9, 9/10 (QPSK)
Transmit encoding: Rate 1/2, 2/3, 4/5 TurboCode, Rate 1/2 Convolutional
Frequency Range: C-. extended C-, Ku-, and Ka-band
Modulation (Receive): QPSK or 8PSK
Modulation (Transmit): OQPSK
Bit Error Rate (Receive): 10^{-10} or better
Bit Error Rate (Transmit): 10^{-7} or better
Radio – TX IF: Type-TNC Female, 50 ohms, 950 to 1700 MHz, composite power -5 dBm/-35 dBm – RX IF: Type-F, 50 ohms, 950 to 2150 MHz, -68 dBm (per carrier at 1 Mbps), -8 dBm (composite) – Available LNB Power (IFC): +19.5 V (nominal) – 10 Mhz reference available
Mechanical and Environmental Specifications
1U enclosure for 19" rack
Weight (IDU): 5.5 lbs (2.5 kg)
Dimensions (IDU): 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: – IDU: 0° C to +50° C
Input power: 90–264 VAC; 50–60 Hz

Transportable Gateway (TGW)

This appendix discusses the HX Transportable Gateway.

The following topics are included:

- *TGW Overview* on page 81
- *Features* on page 81
- *Services Supported* on page 82
- *DVB-S2/IPoS with ACM Advantages* on page 82
- *HX Transportable Gateway specifications* on page 82

TGW Overview

The transportable gateway (TGW) is based on and is fully compatible with the same architecture as the larger, fully redundant HX system. However, the TGW's equipment is contained in a single rack that can easily be packed, moved and reassembled.

The system is well suited for applications where network transportability is critical - including homeland security, continuity of operations, tactical military, and remote news gathering. At only two feet in height, the system is a size and cost-efficient solution to support the rapid deployment of smaller satellite networks in difficult operating conditions.

Features

As with the larger, fully redundant HX system, the TGW supports the following HX features:

- Star and star/mesh configurations
- AES encryption option for both outroute and inroute channels
- Seamless, geographically diverse redundancy option
- Intelligent, protocol-sensitive bandwidth assignment for optimum performance and efficiency for each application
- Wide range of QoS options including dedicated bandwidth assignments
- Efficiently engineered IP transport that supports data and real time voice (VoIP) applications
- Network Management Support Services used to manage the gateway and satellite modems

Plus, due to the transportable nature of the TGW, the system supports satellite on-the-move modems.

Services Supported

The TGW supports the following services (some require an expansion pod for full support):

- Broadband WAN connectivity to corporate and government intranets
- Secure, private IP networking
- High-speed video streaming
- Multicast data delivery
- Multimedia applications including MPEG-4 video and DVR capabilities
- VoIP telephony
- Serial protocols including Async, SDLC, X.25
- On-the-move operation

DVB-S2/IPoS with ACM Advantages

The TGW advantages include the following:

- Optimum transmission efficiency through a combination of coding and modulation of the outbound channel that can be configured for each satellite modem
- Continually optimized link performance, particularly during high rain conditions, through dynamic adjustment of error-correcting codes and modulation based on signal quality feedback from satellite modems
- Truly dynamic bandwidth assignment - satellite modems with no traffic are assigned no resources
- Multiple inroute quality of service options - Committed Information Rates (CIRs) per active satellite modem or group of modems

HX Transportable Gateway specifications

Listed below are technical specifications for the HX transportable gateway. This information includes: outbound and inbound channels, size and scalability, security, network management, and satellite routers supported in the HX gateway.

HX Transportable Gateway technical specifications
Outbound channel
DVB-S/DVB-S2 compliant
Adaptive Coding and Modulation (ACM)
Frequency: C-, Extended C-, Ku-, Ka-band
Modulation: QPSK/8PSK
Symbol Rates: 1-45 Msps (in steps of 1 Msps)

HX Transportable Gateway technical specifications (Continued)
Encoding DVB-S: Convolutional with concatenated Reed Solomon; Viterbi 7/8, 5/6, 3/4, 2/3, or 1/2
Encoding DVB-S2: BCH with LDPC 3/5, 2/3, 3/4, 5/6, 8/9, or 9/10 (8PSK); 1/2, 3/5, 2/3, 4/5, 5/6, 8/9, 9/10 (QPSK)
Bit Error Rate: 10^{-10} or better
Inbound channel
Transmit modulation: OQPSK
Transmit encoding: Rate 1/2, 2/3, 4/5 TurboCode, Rate 1/2 Convolutional
Transmit bit rates: 128 kbps to 3.6 Mbps
Size and Scalability
Base Configuration: – Single 8 RU transit case – Supports up to 100 terminals – Supports up to 4 inbound channels
Security
Access and DES encryption of outbound channels
Optional AES bidirectional encryption
Network Management System
Hughes Vision® NMS
Remote Terminals and Appliances Supported
HX 50
HX 100
HX 150
Mesh Appliance
Voice Appliance
Serial Appliance

Acronyms and abbreviations

A

ACM – Adaptive Coding and Modulation

ACP – Automatic Crosspol

ACP – Automatic cross-polarization

AES – Advanced encryption standard

AIS – Adaptive inroute selection

ASI – Asynchronous serial interface

B

BGP – Border Gateway Protocol

BSC – Base station controller

BTS – Base transceiver station

C

CBR – Constant bit rate

CDDM – Configurable demodulation decoder module

CDIM – Configurable demodulation interface module

CDS – Configurable Demodulation System

CLT – Closed Loop Timing

COTS – Commercial, off-the-shelf

CP – Control processor

cPCI – Compact peripheral component interconnect (PCI)

CSV – Comma-separated values

CSV – comma-separated variables

D

DES – Data encryption standard

DFCP – Differentiated services code point

DHCP – Dynamic host control protocol

DNCC – Dynamic network control cluster

DNS – Domain name server

E

EiRP – Effective Isotropic Radiated Power

F

FDU – Frequency distribution unit

FEC – Forward error correction

FIA – Fenced Internet access

F-TDMA – Frequency-time division multiple access

G

GSM – Global system for mobile communication

GUI – Graphical user interface

GW – HX System gateway

H

HDU – HNSTC distribution unit

HNSTC – HNS timing control

HPEP – HTTP performance enhancing proxy

HPEP – HTTP performance-enhancing proxy

I

ICMP – Internet control message protocol

IDU – Indoor unit

IFDU – Intermediate frequency distribution unit

IFSS-TC – IF Subsystem-Turbo Code

IGMP – Internet group management protocol

IKE – Internet key exchange

IP – Internet Protocol

IPoS - IP over satellite

IPSec – Internet protocol security

IQoS – Inroute Quality of Service

L

LAN – Local area network

LDSP – Low-density parity checking

M

MFS – Management file server

MGS – Management gateway server (alternate name for MFS)

MIB – Management information base

MORT – Multiple Outroute

N

NAPT – Network address port translation

NAT – Network address translation

NMD – Network management domain

NMSS – Network Management and Support Services

O

ODU – Outdoor unit

P

PAT – Port address translation ,

PBP – PEP backbone protocol

PBR – Policy Based Routing

PEP – Performance-enhancing proxy

Q

QoS – Quality of service

QPSK – Quadrature phase shift keying

R

RCD – Return channel demodulator

RCM – Receive control module

RF – Radio frequency

RFT – Radio frequency terminal

RIP – Routing information protocol

RSOM – Remote Site Originated Multicast

RTP – Real-time transport protocol

S

SATGW – Satellite Gateway

SBC – Satellite-based commissioning

SCPC – Single channel per carrier

SDL – Software download

SFNP – Superframe numbering packet

SLA – Service level agreement

SNMP – Simple network management protocol

SRM – Software radio module

T

TCP/IP – Transmission control protocol/Internet protocol

TDMA – Time division multiple access

TGW – Transportable Gateway

TGW – Transportable gateway

TRCS – TDMA return channel subsystem ,

U

UDP – User datagram protocol

UEM – Unified element manager

URL – Uniform resource locator

V

VAR – Value-added reseller

VIP – VSAT information protocol

VLAN – Virtual local area network

VSAT – Very Small Aperture Terminal

W

WAN – Wide area network

WebACS – Web-based auto commissioning

X

XML – Extensible markup language

Index

NOC – nework operating center 3