HUGHES

Broadband Mobility Solutions

HUGHES Broadband Systems

Hughes is the market leader in broadband satellite products and services with over 1.5 milllion terminals shipped to customers in over 100 countries. Hughes products and services are used in a wide range of markets, including consumer Internet, where service offerings are similar to xDSL, and for enterprises, where structured Quality of Service (QoS) and Service Level Agreements (SLAs) are critical to service implementation. In support of these markets, Hughes has developed a set of powerful IP broadband satellite capabilities.

With the introduction of the HX System, an innovative IP broadband satellite system, Hughes has brought to market a solution specifically designed and optimized for small networks which require QoS crafted per individual link. The HX System leverages the best of the features and capabilities of the highly successful Hughes HN broadband VSAT system and offers additional new features to support applications that are predominantly high bandwidth and real time (telephony trunking, video conferencing, etc.).

The HX System provides advanced bandwidth management capabilities which give operators the ability to custom design various QoS and SLAs on a per-remote basis. As a pure IP-based solution, the HX System incorporates a strong set of IP functions and features. Leveraging the DVB-S2 (or DVB-S) transmission standard for the outbound channel, the HX System is able to achieve the best spectral efficiency of any TDM/TDMA network on the market. While the HX System allows operators to dedicate inbound/outbound bandwidth per remote, the aloha-based inbound TDMA channels provide the capability to dynamically allocate bandwidth based on usage and need—thus allowing operators to develop a wider range of service plans for their customers. Network management is highly advanced and includes an HTTP access which can be located remotely and shared with end users.

Hughes now has enhanced the capabilities of the HX System to include a set of features supporting mobile broadband services. This paper focuses on these mobility features and examines the solution provided to support mobile broadband services for trains.

Challenges of Mobile Broadband

Supporting continuous broadband satellite connectivity to mobile devices is challenging. 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. Satellite broadband using higher frequency services, such as Ku-band, can provide more bandwidth at a lower cost. But the very nature of these higher frequency services presents a significant challenge for the mobile terminal.

Some of the challenges are outlined below.

Changing Transmission Path

As mobile broadband terminals travel, they will move through various contours of the satellite footprint, causing the path to the satellite to change. The challenge is for the satellite broadband system to dynamically adapt to changing link conditions in order to maintain availability while not wasting satellite capacity.

Frequent Blockage

As mobile vehicles travel, they will pass under various obstacles such as trees, overpasses, and tunnels which will obstruct the channel path to the satellite. The challenge is to be able to recover the link as quickly as possible.

Antenna

Particularly for trains, the antenna must be of a very low profile as the clearance between the top of train car and tunnels and overpasses is often as little as 50 cm. The antenna must conform to these height restrictions while providing the performance demanded to close the link.

Harsh Locations

By their very nature, mobile vehicles provide a harsh environment for any type of electronics. This includes continuous vibrations, dust, and temperature extremes. For electronics to work well in this challenging environment, they must be of a robust design.

Hughes Mobility Feature Set

Hughes has enhanced and optimized our satellite broadband products and services to directly address the key requirements found in many mobile applications. These features have been fully incorporated and integrated into the HX satellite broadband systems. Some of the key features include:

- **DVB-S2/ACM** — The use of Adaptive Coding and Modulation (ACM) of the outbound channel enables the remote terminal to continually monitor the received signal level of the outbound channel and to dynamically request changes to the combination of coding and modulation. This allows the downstream channel to be continually optimized as the mobile terminal travels through the various contours of the satellite footprint.
- **AIS** — With the AIS (Adaptive Inroute Selection) feature, the TDMA channel (uplink from the mobile device) is continually monitored by the hub and the remote terminal is thus continuously advised of its optimal TDMA transmission coding and power levels. Similar to the DVB-S2/ACM for the outbound channel, this feature means that the TDMA channel is also continually optimized as the remote terminal travels through the various contours of the satellite footprint.
- **TDMA Channel Spreading** — To overcome issues with off-axis emissions, the HX System supports spreading of the TDMA channel by two times and four times the nominal channel bandwidth. A 256 ksps TDMA channel with a nominal channel spacing of 320 kHz can be spread to either 640 kHz (2x spreading) or 1280 kHz (4x spreading). This feature enables the use of very small antennas as it mitigates adjacent satellite interference.
- **Doppler Compensation** — The HX System is being used to support aeronautical broadband for commercial airliners. As these vehicles move at a very high rate of speed, Hughes has made enhancements for a Doppler update.
- **Outbound Flywheel and Fast Reacquisition** — As land mobile units will frequently encounter obstructions (trees, bridges, etc.) which prevent receipt of the outbound channel, Hughes has implemented a "flywheel" for the timing synchronization of the outbound channel. The flywheel can "spin" for as long as 30 seconds, whereby if the outbound signal is seen within the 30 seconds, the reacquisition of the outbound channel occurs immediately upon receipt of the first superframe marker.
- **External 10 MHz Reference** — To ensure fast TDMA transmit capability, the HX remote unit is capable of accepting an external 10 MHz reference. This eliminates the need for frequency stability to be derived off the outbound carrier (which is not accurate during the flywheel period) and enables the remote terminal to transmit the TDMA carrier immediately upon reacquisition of the outbound channel.
- **IP Steady State** — The HX System maintains the IP session during periods of link outages so that even if the signal is lost for longer than 30 seconds, (i.e., a train in a tunnel) once the link is restored, the users do not have to reestablish IP connectivity.
- **Ruggedized Chassis** — The HX remote terminals are configured with a ruggedized chassis permitting mounting in a 19 inch rack. Hughes' experience is that mobile terminals are often installed in environments with high heat, humidity, dust, and vibration.

Mobile Antenna Integration

Hughes has integrated the HX150 remote terminal with a number of antennas which are designed to support mobility. The HX150 is well suited for integration with mobile antennas as it supports an industry standard L-band BUC (Block Upconverter). This enables the HX150 to operate with an antenna which has an integrated BUC. Hughes has successfully integrated the HX150 with mobile antenna systems from:

- Raysat Systems
- Orbit
- Seatel

More Information Available

These are just some of the features that make the Hughes solution right for mobility applications. Visit www.hughes.com or consult your local Hughes representative for a more detailed briefing on Hughes solutions for mobility applications.

Case Study – Mobility For Trains

Hughes, in partnership with RaySat Antenna Systems, has successfully implemented its HX broadband services onto trains in North America. This case study focuses on one of these implementations and details the implementation and experience of this service.

Figure 1 illustrates the block level diagram for this implementation.

The technical details of the implementation include:

- HX150 remote terminal
- Intelsat G27 Ku-band satellite
- HX hub at Hughes Germantown teleport facility
- RaySat StealthRay antenna
- 40 watt BUC
- Spreading of 2:1 for the inbound channel
- Outbound DVB-S2/ACM of 5 Msps to support dynamic changes to the outbound channel
- AIS to support dynamic changes to the inbound channel

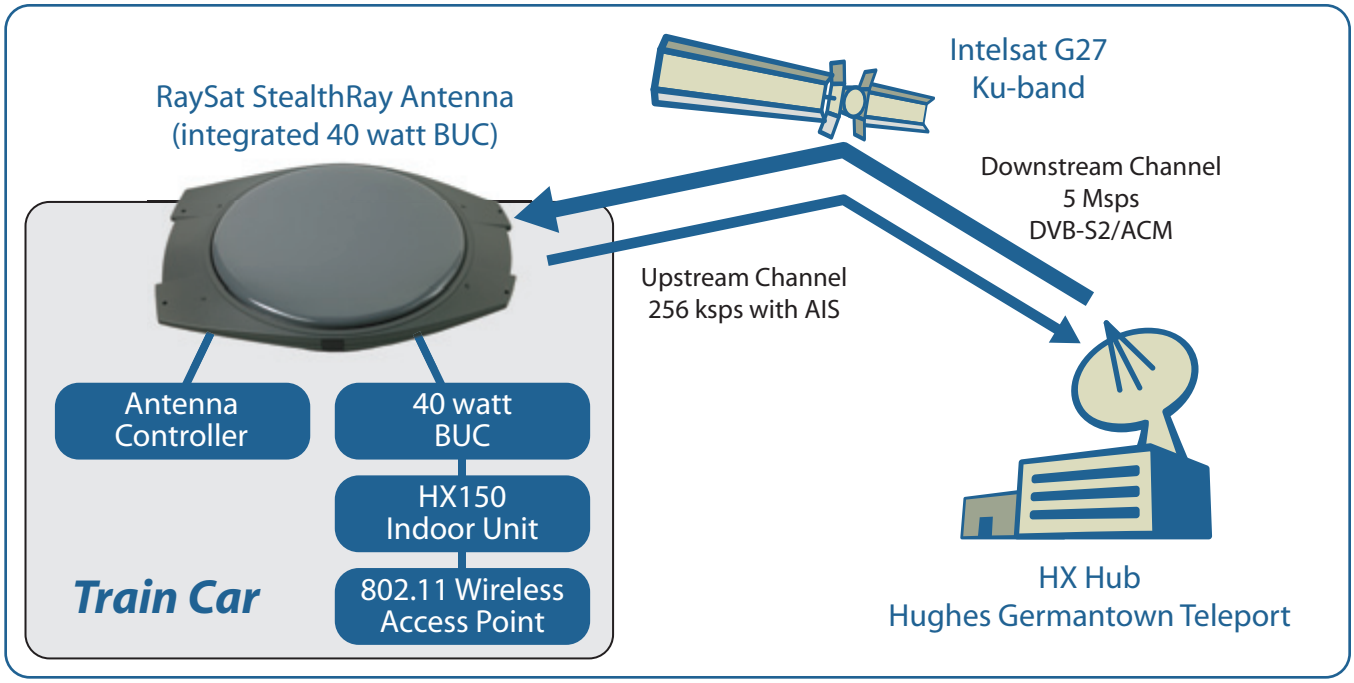

Figure 1. Network Architecture of Train Implementation

The antenna mount is a custom design. It uses a steel plate attached to the top of the train. The antenna is bolted to the plate via the four mounting brackets with rubber pads to absorb some vibration. A POE (point of entry) hole was drilled through the roof of the train, below which the equipment is mounted in a rack. The BUC was mounted as close to the ceiling POE as possible to minimize the cable length and losses. Figure 2 shows the remote antenna installation on the top of the rail car.

Figure 2. Remote Antenna Installation

A gateway and WiFi access point are used to throttle each individual user's throughput and provide access throughout the length of the train, respectively. Repeaters are required because the WiFi signal is weak toward the back of the train. Figures 3 and 4 illustrate the interior installation of the HX150, the RaySat antenna controller, and the WiFi access point.

Figure 3. Interior Installation

Figure 4. Interior Installation

The QoS is set to 1.5 Mbps downstream (to the train) and 380 Kbps upstream (to the Internet). Throughout the train's movement, the connectivity is continuous and train passengers are provided with continuous broadband coverage throughout the train's travels.

The Hughes HX System has many significant enhancements that enable mobile broadband services for a variety of transportation modes. The use of the HX System with these enhancements is extending broadband services to users no matter where or how they travel.

Proprietary Statement