Advantech Wireless
DVB-RCS VSAT Solution for Governments and Enterprises

A Technical Description

TABLE OF CONTENTS

TABLE OF FIGURES

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Introduction

This white paper describes the fundamental aspects of Advantech Wireless' Satellite Networks' DVB-RCS Very Small Aperture Terminal (VSAT) network implementing Governmental and enterprise-grade solutions for private networking purposes.

Advantech Wireless Technologies is a world leader in satellite communications, delivering equipment for hundreds of satellite and ground systems for over 40 years. Advantech Wireless Satellite Networks (SatNet) offers VSAT[1] solutions that provide:

- Always-on, broadband connectivity
- Cost-effective content distribution and sharing
- Rapid deployment
- Reliability and quality of service
- Single platform solution for all needs
- Flexibility and scalability

All the solutions adhere to the internationally adopted DVB-RCS open standard architecture for 2-way VSAT networking and have been certified by Satlabs, the international, not-for-profit association whose members are committed to bringing the deployment of the DVB-RCS standard to large-scale adoption on a global basis. As a result, service providers and governments are providing and utilizing broadband access today using DVB-RCS VSAT solutions globally.

Advantech Wireless offers its certified DVB-RCS VSAT technology in order to accommodate a wide range of vertical markets such as the following:

- Federal Government
- Military Tactical Networks
- Enterprise & Private Networks
- Community Networks
- Distance Learning
- Tele-medicine
- Disaster Recovery and Emergency Management
- Mobile command posts
- Satellite News Gathering
- Internet Service Providers

The VSATs offered by Advantech Wireless provide two-way broadband access to remote locations within satellite footprints and are fully compliant with the DVB-RCS open standard for broadband satellite networks. Advantech Wireless' VSATs are designed to minimize cost, while maintaining DVB-RCS compliance and performance. Our implementation offers tremendous functionality and performance, often on par with or exceeding the multitude of proprietary VSAT solutions on the market today including the following:

- High speed inroutes (return channels) – up to 4 Mbps, starting as low as 64 kbps
- DVB-S outbound (forward channel) at speeds up to 45 Mbps giving the capability to saturate a full 36 Mbps transponder – Speeds start at 1 Mbps allowing for small initial operating expenses

[1] The reader should note that the DVB-RCS standard often refers to the VSATs as SITs, meaning Satellite Interactive Terminals. To be consistent with terminology commonly used in satellite communication networks, we will refer to the remotes as VSATs.

- The capability to use a signal line card architecture at the hub to support up to 32 inroutes (return channels)
- User-friendly Network Management System (NMS) for commissioning, configuration, monitor & control of the network
- A hub solution established to allow for multiple clients/end-users to “share” the facility, yet have their data isolated from each other
- Scalability of the network supported by the hub to reach in the tens of thousand of remotes
- Simple remote VSAT commissioning process
- A path for DVB-S2 migration to allow for even higher bit rates on the forward channel
- Built-in uplink power control on the remote sites to adjust for potential rain fade attenuation
- Built-in bandwidth saving features via the open-standard access methods and efficient use of space segment

The DVB-RCS VSAT SYSTEM

DVB-RCS Network Overview

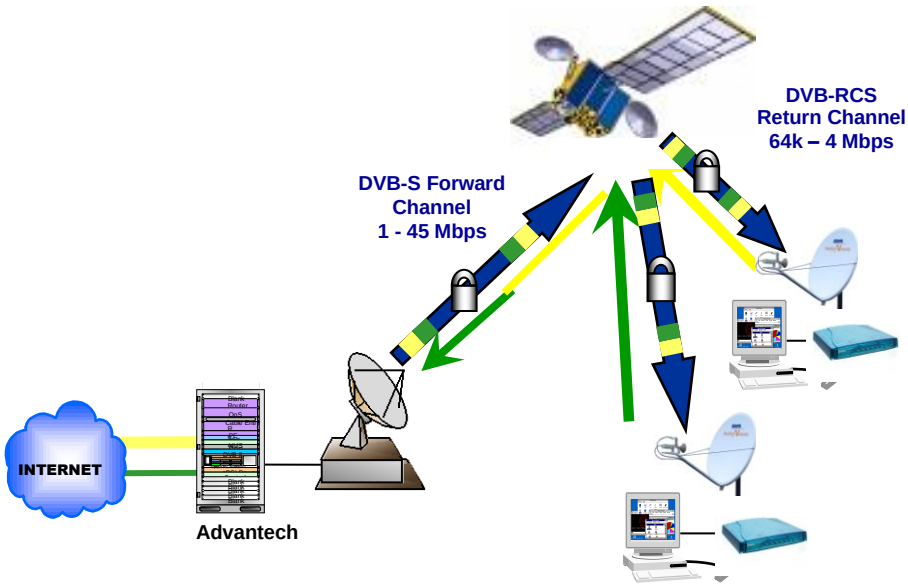
A DVB-RCS VSAT network is a satellite-based communications system that provides interconnection between users who are exchanging real time (and non-real time) applications based on several data types (e.g. text, voice, images, video etc…). There are two transmission paths, the Forward Channel from a centralized Hub location to the remote location and a Return Channel from the remote location to the central Hub.

The DVB-RCS VSAT system underwent final standardization by the European Telecommunications Standards Institute (ETSI) in 2000. The standard calls for a forward link based on a DVB/MPEG-2 data format and a return link using Multi-Frequency – Time Division Multiple Access (MF-TDMA) scheme, allowing a two-way exchange of data. The DVB/MPEG-2 format carries from 1 Mbps up to 45 Mbit/s in the forward link and the MF-TDMA scheme allows from 64 kbps up to 4 Mbps per carrier.

A recent revision of the DVB-RCS standard added support for the new DVB-S2 transmission standard, including adaptive coding and modulation features. Support for these features will be incorporated in Advantech Wireless' products in the near future, as they are required.

The network consists of a central earth station Hub station, the communication satellite, and VSAT at the remote sites

Figure 1 below shows an overview of the system architecture for a DVB-RCS network. The range of users can include Governmental users, Military users for tactical networks, corporate enterprises, small/medium-sized enterprises (SMEs), universities, hospitals and many more. Forward traffic to the users at the remote stations (VSATs) is multiplexed into a conventional DVB/MPEG-2 broadcast stream at the Hub and broadcast via the satellite to the VSATs. This broadcast stream is transmitted using QPSK modulation and concatenated convolutional and Reed-Solomon coding (providing a maximum forward data rate of approximately 45 Mbit/s in a 36 MHz transponder) in each transponder used. The return link uses the highly efficient and fast MF-TDMA satellite access scheme together with turbo-coding in order to provide seamless internetworking with other networks. Industry standards are used for carrying data from the VSATs to the Hub Station, in particular Internet Protocol (IP) and Asynchronous Transfer Mode (ATM), or MPEG.



Advantech Wireless | 657 Orly Avenue | Dorval, QC | Canada H9P 1G1
Tel.: +1 514 420-0045 | Fax: +1 514 420-0156
www.advantechwireless.com

Figure 1: System Architecture of a DVB-RCS System

The forward path (hub to remotes) of the system is based on the relevant ETSI/DVB standards that are shared with the current direct-to-home (DTH) delivery of broadcast television and radio. Thus, both data and video services can be paired (or multiplexed) together to take advantage of existing infrastructure and space segment capacity.

Users at the VSAT remote sites transmit on various inbound carriers to transmit the data (i.e., VoIP, FTPs, internet access, videoconference, etc.) from the remote users to the hub location where a dedicated backhaul to the customer's headquarters may exist or for connection to the Internet or even to the PSTN (Public Switched Telephone Network). Data at the remote site may even get routed by the hub station back to another remote site in order to provide "mesh" connectivity.

The VSAT employs a scheduled MF-TDMA scheme to access the network and participate in bi-directional communications. MF-TDMA allows a group of VSATs to communicate with a Hub using a set of carrier frequencies, each of which is divided into time-slots. The Hub allocates to each active VSAT a series of bursts; each defined by a frequency, bandwidth, start time and duration. This collection of carrier frequencies and time-slots is referred to as a frame. Each time/frequency slot contains exactly one packet (the packet content being either portions of IP packets or concatenated ATM cells). Frequency-agile VSATs access a pattern of time/frequency slots within these frames. Having established knowledge of the MF-TDMA structure via forward link tables, the VSAT accesses the network using a slotted ALOHA burst. Thereafter, traffic capacity is allocated dynamically, allowing the VSAT to operate in a contention-less mode. A VSAT can only transmit once the VSAT has forward channel reception. Moreover the VSAT must have synchronized itself to the forward link, logged in and have been allocated capacity (in terms of MF-TDMA slots).

Measuring System Performance

Overall system performance can be measured in several ways. At the highest level, Advantech Wireless' DVB-RCS network solution balances tradeoffs between bandwidth efficiency, power efficiency, network scalability, and lifetime equipment costs.

Bandwidth and Power Efficiency

Since bits/Hz drive data transmission costs over satellite, and today's satellite bandwidth costs can represent over 20% of direct costs for service to end users, it is in this area that service providers and satellite operators often first focus their evaluation of a DVB-RCS system vs. that of other access systems. Advantech Wireless' DVB-RCS solution provides for highly-efficient bits/Hz on the forward channel – utilizing 45 Mbps in a 36 MHz transponder as well as taking advantage of every iota of satellite power available rather than wasting it as can happen in a system that is non capable of saturating a satellite transponder.

Multiple Access vs. SCPC

The return channel for DVB-RCS is by its nature a multiple access system, designed to aggregate traffic from multiple different users on individual carriers. In SCPC systems, each user much have a dedicated carrier, SCPC becomes very inefficient for even a small number of users.

Network Scale Efficiency

DVB-RCS is fundamentally designed to be scalable to large populations of terminals. MF-TDMA offers a significant efficiency advantage over other access schemes through the "pooling effect" inherent in statistical multiplexing of large terminal populations in not just one, but two dimensions (frequency and time) simultaneously.

MAC Layer Efficiency

Performance of access layer protocols is highly dependent on traffic profile. Advantech Wireless' implementation of DVB-RCS, using the Combined-Frequency Demand Assignment Multiple Access (CF-DAMA) protocol, has been specifically designed and tuned for multi-media traffic. In comparison, other VSAT systems are tuned for transactional applications with narrowband capacity needs.

Frame Overhead
Given Advantech Wireless' implementation of a short preamble burst structure, the overhead imposed by the burst frame structure is kept to the bare minimum. Most TDMA systems utilize a longer preamble and incur an additional efficiency penalty. The Advantech Wireless solution is optimized for bandwidth efficiency while still allowing demodulation of the received signal.

Channel Coding
Channel coding effectively sacrifices bandwidth efficiency for improved reliability of transmission. DVB-RCS uses Turbo coding, which offers excellent bandwidth efficiency for given bit-error ratio (and therefore power efficiency).

Burst Composition
The burst payload size is an element of a trade-off of physical layer (demodulation) performance and efficiency issues such as granularity of assignments. Advantech Wireless generally recommends a payload size of one or two ATM cells for most applications, but the product line offers choices that cover most of the options provided in the DVB-RCS standard, including MPEG packets.

Modulation Scheme
Advantech Wireless' return channel uses QPSK, which is commonly acknowledged as the optimal trade-off between power and bandwidth efficiency in modulation for multiple access IP over satellite applications. An open standard modulation scheme using QPSK which permits use of linear radios allows the remote VSAT user to use any qualified L-Band Block Upconverter (BUC) manufactured on the market.

Advantech Wireless has been involved in trade-off analyses for each of these dimensions, and several others at further levels of detail, for more than a decade. As a result, Advantech Wireless has determined that the most efficient satellite multiple access method for accessing inbound channels is short preamble MF-TDMA. Advantech Wireless' implementation of DVB-RCS incorporates both short-preamble MF-TDMA and a high-performance MAC layer capacity scheduling technique known as CF-DAMA. Furthermore, was have determined that using a burst composition of one or two ATM cells per burst on the MF-TDMA channel is often more efficient than using MPEG packets, and therefore initially developed our system based on one ATM cell per burst. We now also offer MPEG bursts, which may preferable for certain video-only oriented networks such as for SNG applications. We are 110% confident that our VSAT solutions offers can match up with and quite often, outperform many of the proprietary VSAT solutions on the market today.

System Benefits

Governments and corporate enterprises can benefit from the Advantech Wireless product line by using satellite technology as an alternative to terrestrial-based transmission systems. For those cases when governments and enterprises have activities and personnel based in remote areas, communication satellite technology may be the only means to support broadband transmission.

Organizations with many remote affiliates can create a private high-speed satellite intranet, which links the main office reliably with all remote VSATs. These networks, comparable to the corporate or institutional networks of large multinational companies or international institutions, today need high speed, reliable and cost-effective communications. This is especially true when the locations are dispersed over remote regions and multiple countries, and barely connectable via a terrestrial network infrastructure.

Advantech Wireless products enable advanced network solutions to provide private or secure data and voice networks. We make it possible to establish a complete network capable of interconnecting all VSATs to the desired network whether it is the Internet or a private facility.

Applications efficiently supported include but aren't limited to the following:

- Internet access
- Intranet access
- VoIP & Fax-over-IP transmissions
- Client/server connections
- Video/Data Broadcasting & Multicasting
- Videoconferencing
- Interactive distance learning (IDL)
- Remote monitoring (including video transmission)

Advantech Wireless products offer world-class security options. The basic requirements for secure data transmission are based on encryption and other security mechanisms to ensure that only authorized users can access the network and that the data cannot be intercepted. Virtual Private Networks (VPNs) provides the essential functions of a private network while using the data transport capabilities of an open network architecture.

Solutions implemented with our product line allow the following:

- Delivery of bandwidth anywhere, anytime using a single network topology
- Seamless integration into existing one-way DVB-S Business TV (BTV) or IDL networks, allowing dynamic sharing of bandwidth between existing one-way video and two-way applications
- Cost-competitiveness for networks as small as 20 VSATs
- Industry-leading performance at lowest cost, with an open-standard guarantee

In addition to being DVB-RCS compliant, features that are a part of the system including the following:

- TCP acceleration over satellite
- Support for VPN & encryption over satellite
- QoS provisioning of the inbound and outbound traffic
- VoIP Support
- Broadcast/Multicast support.

Accelerating the TCP traffic → PEP

For any commercial implementation of a multimedia-via-satellite platform such as DVB-RCS, to be successful, it is often necessary to include a Performance Enhancing Proxy (PEP). PEP overcomes the limitations on TCP performance imposed by networks with large bandwidth-delay product and substantial variability on both the forward and return links. All of these are characteristics of a Bandwidth-on-Demand (BoD) Satellite Network such as DVB-RCS. In addition to increasing the user experience performance in terms of transfer times to beyond that of DSL, the use of a PEP can, in many conditions, lead to more efficient bandwidth usage; thereby making the system less expensive. PEP generally requires the use of an un-encrypted transport header for enhancement.

Many common applications and services used across IP networks require reliable service to ensure data is delivered correctly. For this purpose the Transmission Control Protocol (TCP) is most often used, for example for email, Web browsing and file transfers. TCP does however have well known and researched issues in any geosynchronous satellite environment. Specifically, the long propagation delays slow all of TCP's closed loop control mechanisms. Also, the combination of long delay and broadband capacity requires the use of large buffers if high performance and reliability are not to be mutually exclusive. Bit errors and terrestrial congestion (even when very minimal) often degrade TCP performance by orders of

magnitude in a GEO environment. Finally, using bandwidth on demand mechanisms for bandwidth efficiency purposes presents an environment to which TCP is not well suited.

Fortunately, the solution to these problems is well known. PEP is a device used to intercept all TCP connections at either side of the satellite link and allow the use of a dedicated satellite protocol over the satellite hop. Advantech Wireless has developed in-house a high performance solution to the problems of TCP performance and is one of the very few manufacturers of DVB-RCS equipment to have this solution available in a truly embedded (single box) IDU platform. This offers optimum performance, reduced hardware costs and automatic configuration at the IDU when compared to competing solutions. This solution is uniquely designed for DVB-RCS and any combination of return channel capacity types, providing consistent performance even with high bandwidth usage at high data rates. Many aspects of Advantech Wireless' unique DVB-RCS PEP solution are patent pending.

The current Advantech Wireless PEP solution has the following key features.

- A distributed PEP solution - comprising two PEP nodes in the traffic path
- A gateway PEP server node located at the satellite gateway.
- A client PEP node, implemented within in the Advantech Wireless IDU itself
- A connection splitting approach with three connection segments
- Generic TCP acceleration with reliable, ordered service
- Accelerated connection opening and fast start of data transfer
- End-to-end flow control and also rate control capabilities
- Performance optimized for DVB-RCS bandwidth-on-demand mechanisms
- Bandwidth fairness on a connection basis

Virtual Private Network Implementation

Security of information is a large concern in modern communications and networking. Advantech Wireless has three variations of VPN operations on a VSAT network:

- End-to-end VPN tunnel without PEP
- End-to-end VPN tunnel with PEP
- VPN Tunnel and PEP over Satellite Only.

End-to-end VPN Tunnel

There are some solutions to provide a secure VSAT to gateway communication over satellite. The first solution is an end-to-end VPN tunnel using any VPN client on the Host, which communicates with any Internet standard VPN server installed at a corporate center. This VPN link is totally transparent to the Advantech Wireless two-way Satellite network. Figure 2 presents the end-to-end VPN tunnel solution. This solution provides end users security over the satellite link and over the Internet. The tunnel is established as soon as the Host wants to communicate with the Corporate Center. The unicast user traffic data is encrypted in both direction, the forward and the return links. TCP acceleration can be done if the Gateway PEP is installed at the Corporate Center; otherwise if the Gateway PEP is installed at the Advantech Wireless Gateway, the TCP acceleration is not possible because all packets are viewed as IPSec packets, not TCP.

This solution offers isolation to different corporate centers. The IP address range of a corporate center can be the same as that of another corporate center. For example, the IP addresses of the hosts behind the terminal are known by the corporate center only. The Advantech Wireless Gateway does not have to route these IP addresses, they are hidden in the IPSec tunnels. Only the IPSec IP Addresses of the IDU and the IP address of the IPSec Server at the corporate center are known and routable by the Advantech Wireless Gateway. To give Internet access to the hosts behind the terminal, a NAT function is required at the Host LAN, because the Advantech Wireless Gateway does not know and does not route the Hosts IP Addresses. The NAT function is used to convert Host IP addresses to an IP address range known by the

Advantech Wireless Gateway, which is the Ethernet IP address range of terminals. A NAT Router is added in the Host LAN to allow Internet traffic from Hosts LAN.

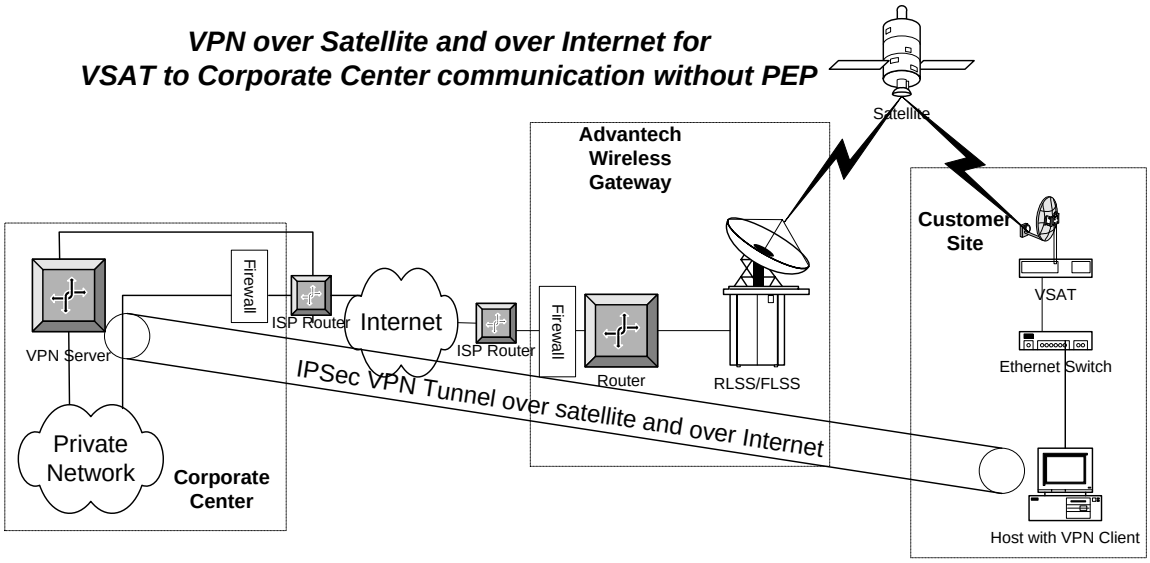


Figure 2: End-to-end VPN Tunnel

End-to-end VPN Tunnel and PEP

Figure 3 illustrates a PEP compatible VPN tunnel over the satellite and over the Internet.

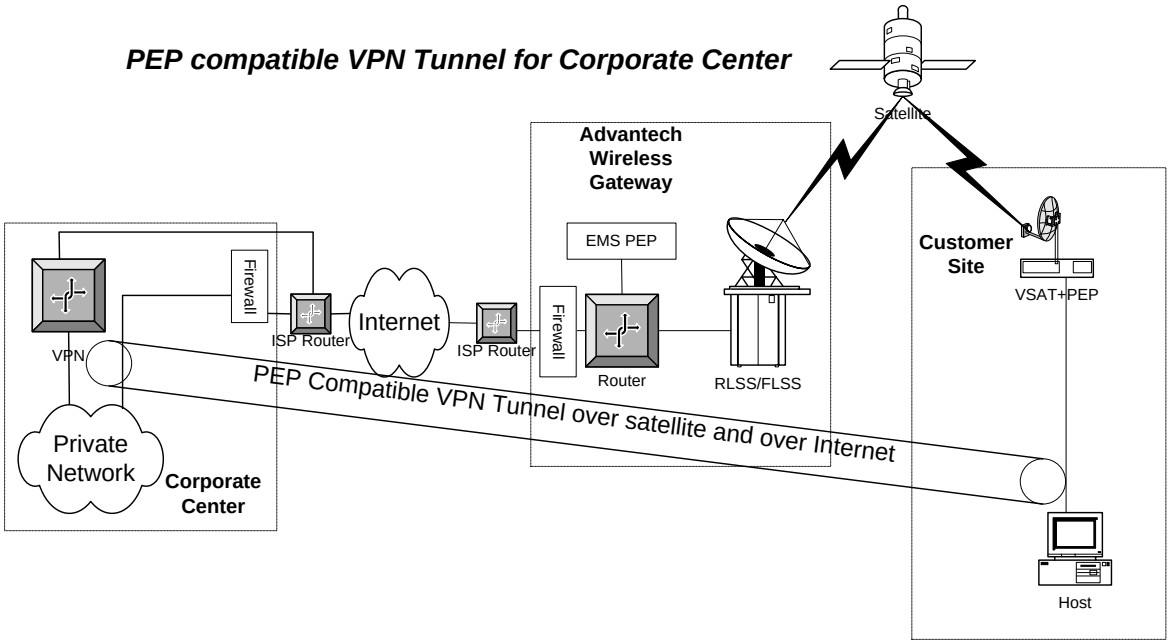


Figure 3: End-to-end VPN Tunnel with Advantech Wireless PEP

The PEP compatible VPN server is installed at the Corporate Center and the client is installed at the Host. The PEP is enabled in the terminal and a Gateway PEP is present into the Advantech Wireless Gateway. This solution provides end users security over the satellite link and over the Internet. The tunnel

is established as soon as the Host wants to communicate with the Corporate Center. The unicast user traffic data is encrypted in both direction, the forward and the return links. The packets are not encrypted if in the case the Host wants to access web servers over the Internet.

VPN Tunnel and PEP over Satellite Only

Another solution is to use the IPSec capability from the Advantech Wireless terminal. For the Gateway, an IPSec server must be added. It must support authentication and encryption of data through AH and ESP respectively and standard key exchange through IKE. It must also implement the expected DES and 3DES algorithms (using 3 independent keys) and, additionally, AES also provides a comprehensive suite of IP network functionality (if necessary) and can act as a stateful inspection firewall.

Figure 4 illustrates the IPSec tunnel over satellite for all VSAT to Gateway communication.

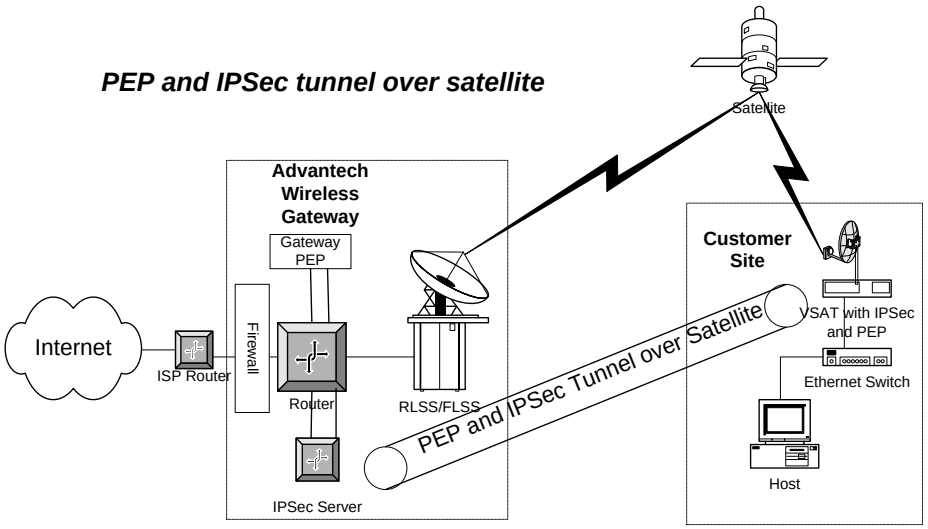


Figure 4: PEP and IPSec Tunnel

To offer TCP acceleration to all TCP traffic, the IPSec function has to be done after the TCP acceleration at the Gateway and at the terminal.

Quality of Service

The general approach to Quality of Service (QoS) provisioning in DVB-RCS networks developed by Advantech Wireless is based on the realization that QoS provisioning, as an end-to-end performance issue, relies on components/processes that need to be implemented at various protocol layers in all networks on the end-to-end path. Various QoS components are best captured in the QoS layered model illustrated in Figure 5.

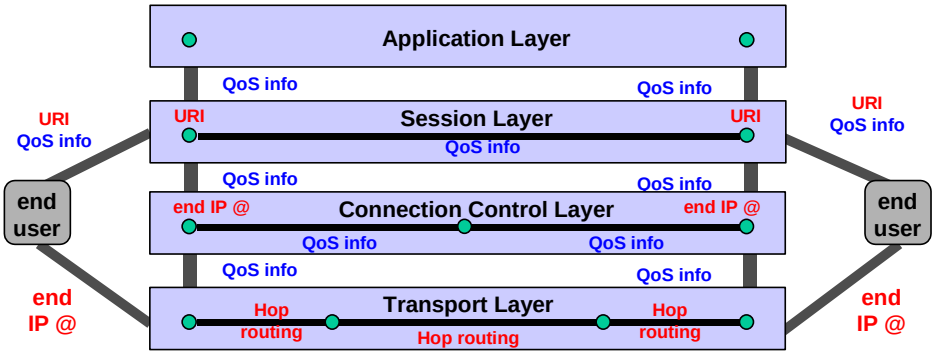


Figure 5: Layered QoS Model

The **Application Layer** defines the multi-media services to be provided to the end-user (e.g., Internet browsing, conference handling etc.) and the QoS associated to each service, independent of the transport technology.

The **Session Layer** handles the signaling procedures to establish a session between end users and to negotiate the session characteristics, as a function of the application's needs and availability of resources in the bearers' networks. Session establishment involves the end users, logically identified by their Uniform Resource Identifier (URI) (e.g., a mail-like address user@domain) and the network elements providing session signaling capabilities (e.g., signaling proxy). A potential candidate for session signaling is the Session Initiation Protocol (SIP).

The **Connection Control Layer** handles the set-up of the transport network for each media component. It includes admission control and resource reservation consistent with negotiated QoS characteristics; they are part of the Connection Control Protocol (CCP).

The **Transport Layer** is responsible for conveying the data packets from source to destination, using the physical networks. The transport mechanisms are network dependent; therefore the overall transport is performed hop-by-hop.

The layered model suggests that the QoS information is propagated from the application layer down to the transport layer, where the QoS parameters and policies are configured in the transport network. QoS parameters and policies are typically captured in the terms of a Service Level Agreement (SLA).

The last two layers above are network-specific, while the first two layers apply across all networks on the end-to-end path. For each network there should be a single interface point between the session layer and the connection control layer, associated with a generic Session Broker (SB) or Bandwidth Broker (BB).

Layered Advantech Wireless QoS Model

The Advantech Wireless QoS solution, based on the previous model is detailed as follows:

- The **session layer** is based on the use of components specific to VoIP and SIP (i.e., VoIP Gateway in Gateway, Analogue Telephone Adapter (ATA) at the VSAT). In addition, the interaction between the session layer and connection layer is performed in the VSAT. The terminal intercepts the SIP session and advises the Call Manager (CM) for capacity reservation. The CM is responsible for reservation, assignment and release of the capacity.
- The **connection control layer**, is based on SNMP, and is fine-tuned to support VoIP calls. The Call Admission function performed by the Hub supporting a Connection Control Protocol is restricted to the return link and terminal resources.

- The **transport layer** on the forward link consists mainly of the configuration of the Forward Link QoS Device for resource partitioning.
- The **transport layer** in the return link relies on MAC layer (DVB-RCS) functionality of the Hub Capacity Scheduler. The terminal supports class-specific forwarding, but only for two classes (high priority and low priority).

QoS Benefits

The benefits of the Advantech Wireless QoS solution can be summarized as follows:

- Good overall network resource utilization, with potential higher revenue for the network operator.
- QoS guaranteed for VoIP application, based on dynamic bandwidth, resulting in better overall performance
- Application prioritization in the forward and return directions.
- Throttling of bandwidth to remote users when required.

Voice over IP

Voice over IP (VoIP) has become the fastest growing application on the Internet and the demand is spilling over into IP based satellite networks. VoIP in a satellite environment has several challenges such a bandwidth-on-demand, jitter, latency and perception quality. Advantech Wireless has developed field proven techniques and strategies to meet all these challenges.

A Bandwidth on Demand (BoD) scheme is very desirable on a satellite network because operating costs are directly related to the satellite bandwidth consumed. However, bandwidth-on-demand suffers from latency issues because a request/allocation cycle is required repeatedly throughout the call. In addition, congestion on the network may cause allocations of bandwidth less than the respective requests. The answer to these issues is to use a guaranteed source of bandwidth that has priority over the typical bandwidth-on-demand applications. Furthermore the bandwidth should be made available at the onset off the VoIP call and then released at the end of the call. This is the approach Advantech Wireless has developed for VoIP and other real-time jitter-intolerant applications. The heart of this approach is the Advantech Wireless Call Control Protocol (CCP). The CCP is resident in the terminal and the hub. When a VoIP call is initiated at a remote VSAT, the terminal recognizes the call set-up signaling and immediately requests a constant rate assignment (CRA) of bandwidth for the call. The hub responds by assigning 16 kbps of bandwidth to the terminal in the form of a CRA assignment. The CRA assignment is maintained by the hub for the duration of the call without repeated request from the terminal. When the call is terminated the terminal recognizes the call tear-down signaling and advises the hub to stop the CRA assignment. Each terminal is equipped with two queues, high and low priority. The VoIP traffic is directed to the high priority queue while the SCADA traffic is sent to the low priority queue. Each assignment of bandwidth is used to service the high priority queue first and any excess capacity is assigned to the low priority queue. If in a pause in the conversation, there are no VoIP packets in the high priority queue, all the traffic assignment for that frame is used on the low priority traffic. Note the terminal is still requesting bandwidth for the low priority traffic during the call so the bandwidth assignment each frame will be the sum of the CRA for the VoIP for that frame and the bandwidth-on-demand assignment for that frame.

Using the Advantech Wireless CCP the VoIP traffic is assured adequate low latency and low jitter capacity in an economical manner that minimizes satellite resources and costs.

There are three main components for the Voice over IP (VoIP) solution over Satellite: the VoIP Analog Telephone Adapter (ATA) installed behind the VSAT the VoIP Hub and the IP Call Manager installed at the Advantech Wireless Hub.

The elements to be added to Advantech Wireless Hub equipment to support VoIP are shown in Figure 6.

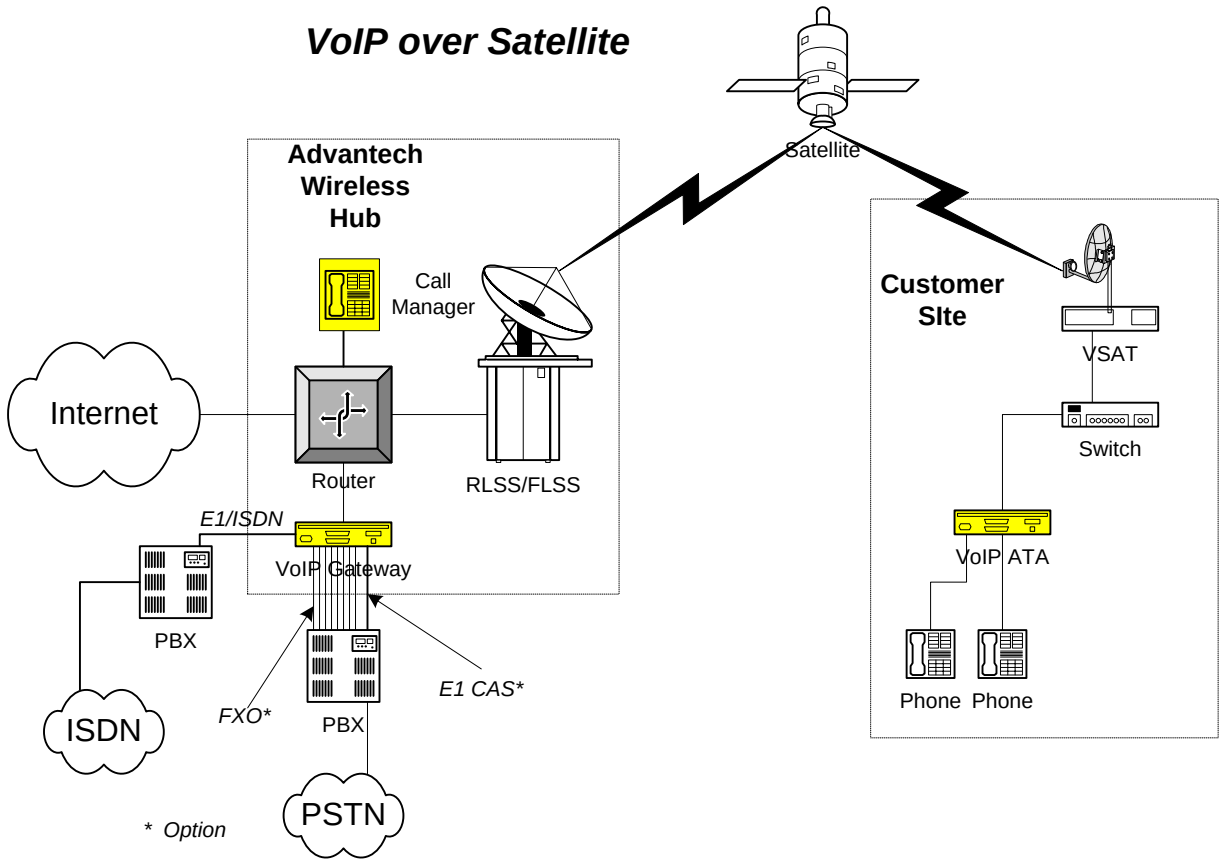


Figure 6: VoIP over Satellite

VoIP Hub

The main functions of a typical VoIP Hub are:

- Connect with PBX systems and with IP-based Telephony networks.
- Support both analog and digital voice solutions.
- Support PSTN/PBX analog telephone sets (FXO).
- Connect to IP network via 100 Base-T Ethernet interface.
- Support web management for easy configuration and installation.
- Voice Activity Detection (VAD), Comfort Noise Generation (CNG)
- Voice codec: G.729, G.729a/b, G.723.1, G.726, G.728.

IP Call Manager

The main functions of a typical call manager are:

- Control telephone calls
- Activate/deactivate telephone depending on the account status or for special occasions.
- Users can be programmed to either receive or make calls or both.
- Users can be allowed unique call patterns through the screen table and route table (ex. On-Net (IP) only and/or PSTN calls).
- Provides Call Detail Records.
- Bulk Administration Tool – allows the operator to perform bulk add, delete and update operations for devices and users.

- Supplementary Services: Last Number redial, Calling line ID, Speed Dial, Call Waiting, Call Forwarding, etc.

VoIP ATA

The main functions of a typical ATA are:

- Support of VoIP protocols: H.323 v2-v4, SIP (RFC 2543bis), MGCP (Media Hub Control Protocol) 1.0 (RFC 2705), MGCP 1.0/network-based call signaling (NCS) 1.0 Profile, MGCP 0.1, SCCP (Skinny Client Control Protocol)
- Support of two analog phone ports (FXS) (can be FAX machine as well)
- Support of a 10 Base T Ethernet port
- Voice codec: G.729, G.729A, G.729AB2, G.723.1, G.711a-law, G.711u-law
- Configuration via built-in Web server
- Touch-tone telephone keypad configuration with voice prompt
- Basic boot provisioning (RFC 1350 TFTP Profiling)
- Dial plan provisioning
- Security: H.235 for H.323, RC4 encryption for TFTP configuration profiles
- Voice Feature: Voice Activity Detection (VAD), Comfort Noise Generation (CNG), Dynamic jitter buffer (adaptive), Configuration of the number of voice frame per IP packet.
- Fax: G.711 Fax pass-through, G.711 Fax mode

Data Broadcasting & Multicasting

Satellite telecommunications are most effective for broadcast or multicast type applications: the larger the target audience, the cheaper the application per use. In this respect, satellites have an inherent advantage over switched terrestrial networks. TV and radio broadcasts as well as also other types of content delivery (e.g. pushing software applications, files, web pages, news content etc) from a central server to a large number of client locations, especially when these are very dispersed and difficult to access, are the most efficient uses of the technology.

Advantech Wireless equipment-based satellite network solutions enable broadcasters and content providers to improve their service offerings

Broadcast solutions implemented with Advantech Wireless Products can allow the following:

- Implementation on a single platform with the following capabilities:
  - Fast, secure distribution of digital content – anywhere
  - Distribution and origination to/from both fixed and transportable VSATs
  - Secure intranet communications for video, voice and data
- Providing industry-leading performance at lowest cost, with an open-standard guarantee

Key features of the broadcast solution include the following:

- Open standard overlay to industry-proven DVB-S technology
- Supports secure, reliable IP multicast from hub to terminals, and from any terminal to one or more other terminals
- Support for accelerated VPNs
- Powerful QoS which supports data, voice and video simultaneously.

Support of Broadcast/Multicast networks is a particularly complex (but useful) facility supported by the Advantech Wireless product line. Details are described below.

The current Advantech Wireless IP multicast over DVB-RCS solution is a unidirectional multicast system offering transmission of one copy of the data from a single point to between the Multicast Server and the whole network host population, efficiently and simultaneously. The DVB-RCS architecture comprises a

central Hub (uplink site) and a remote VSAT. Every VSAT listening can receive an IP multicast directed from the Hub. Behind each VSAT, IGMP is used to facilitate native IP multicast on each LAN.

Figure 7 below depicts for a typical configuration.

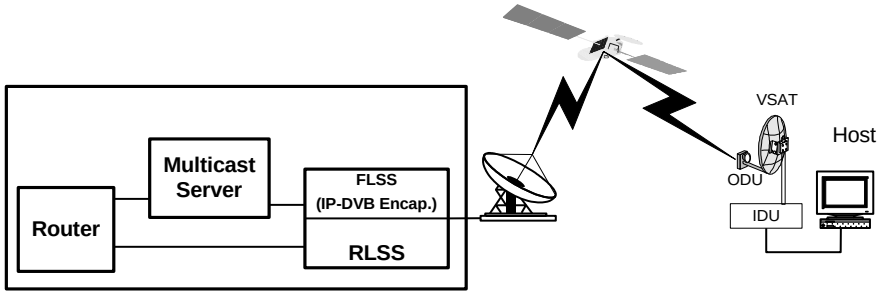


Figure 7: Baseline DVB-RCS Multicast Support with Hub

Interactive Distance Learning (IDL)

Advantech Wireless equipment is an enabler for IDL applications. Typically this type of application requires videoconferencing, VoIP and Multicasting, all of which are supported using the appropriate appliances in the Hub and VSAT.

Shared Service Provider Platform

A wide variety of new applications now make use of IP as a packaging protocol, to allow transport over any network, and many applications are now becoming available including telephony or voice over IP. The advanced capabilities that make this possible can be mixed together and used by independent Service Providers sharing the same network platform to offer the exact type of services required by their customers.

Advantech Wireless products enable advanced network solutions to Service Providers so they can deliver a range of services including broadband internet, distance learning, virtual private networks and a host of other services. Service Providers benefit from powerful QoS mechanisms that allow creation, monitoring and control of a wide range of SLAs.

Advantech Wireless' system design enables Service Providers to offer services concurrently on a wholesale basis to resellers, and on a retail basis to end customers. For wholesale services to resellers, Service Providers manage overall resource allocation for satellite and system capacity, and then allow each reseller, through a secure and partitioned interface, to control SLA parameters in the system for their own subscriber base.

Advantech Wireless is constantly extending the boundaries of satellite communications by converging data, voice and video applications over shared networks. Advantech Wireless supports solutions for video and voice capability that allocates prioritization to video or voice packets over data traffic. For example, Advantech Wireless' system can overlay a two-way service with QoS over existing DVB-S broadcast or multicast services, and can dynamically adjust bandwidth use by video and/or voice applications such that any unused capacity can be made available for data communications.

Advantech Wireless' Hub architecture provides unmatched scalability. Advantech Wireless enables Service Providers to offer a high-quality, competitively priced service.

SCADA

As in a wide range of industries, the utilities and environmental sectors are demanding comprehensive telecommunications services to meet their monitoring and control requirements. By offering a cost effective terminal as part of a comprehensive communication network, important value added services can be provided to meet the specific needs of security agencies, monitoring agencies, oil and gas pipeline companies, chemical firms, electric utilities, water management, earthquake monitoring facilities and environmental monitoring institutions, anywhere in the world.

While many technologies exist that can enhance performance and productivity, and/or improve communications for SCADA applications, companies must deliver a compelling economic argument in order for it to make business sense. When implementation and maintenance costs are too high, return on investment can be a long way off. This dilemma has been especially prevalent in the area of communications for the oil and gas industry - in particular satellite communications, which represents the only viable technology for access to and from remote locations. While it is generally acknowledged that there are considerable benefits to be gained by having voice, data and email communications available to crews in remote locations at sea or on land, the communications choices have been limited, the implementation cumbersome, and overall deployment far too costly to justify widespread usage.

Among other developments, many utilities are now leveraging communications capabilities to integrate their SCADA systems online to perform remote monitoring and control, trigger paging alarms, and other automated functions.

Many of today's remote locations require communications over the air, the Internet or PSTN (public switched telephone network) for ultimate connection with the home office. Field personnel can access monitoring and control equipment from virtually any location in the world - that is, as long as the connections are good. Coverage limitations of the various technologies used to date have created unnecessary complexities and precluded the adoption of a single, location-independent solution. At the same time, a single solution can prove to be the most cost-effective because volume purchase for equipment and service can be maximized and technology development costs more focused.

Now that satellite communications have become more cost effective, with equipment more portable and versatile, it is proving to be a feasible alternative to terrestrial communication. By using satellite communications, oil and gas enterprises can substantially expand communications in the field, as well as lay the groundwork for interoperability with SCADA systems over time. Utilities can expect to see some significant improvements both in terms of ease of access and cost savings, which will impact more than just a field technician's ability to phone home.

SCADA applications can be readily addressed with the Advantech Wireless DVB-RCS satellite network. SCADA systems are characterized by low data rate transmissions from remote locations to a central hub. This “star” network topology is the common design of DVB-RCS networks. Furthermore, the DVB-RCS network works with a bandwidth-on-demand traffic protocol. This means satellite resources are used only when required, thus providing significant savings in space segment costs.

The DVB-RCS network is IP-based. The VSATs are equipped with an Ethernet port and all traffic flowing in and out of the terminal is IP. In legacy SCADA systems the interface between the monitoring equipment and the transmission equipment was typically a proprietary scheme or serial data interface such as RS-232. More recently, SCADA systems use IP as the transmission protocol and so are well suited to the Advantech Wireless DVB-RCS network. If, however, interface converters are required between the monitoring equipment and the DVB-RCS network, these are readily available from a number of suppliers.

In summary, a DVB-RCS network can be installed anywhere, even in the most remote regions and can offer superior performance with very high network availability so that continuous communications is assured.

ADVANTECH WIRELESS DVB-RCS HUB EQUIPMENT

Advantech Wireless SatNet offers a full line of DVB-RCS products, available to assemble a Broadband DVB-RCS network based on the open standard ETSI EN 301 790.

Within the Hub Station, Advantech Wireless can offer the Return Link Subsystem, the Forward Link Subsystem, and the Network Management Subsystem. We can also provide the antennas and RF.

There are four varieties of Hub offerings from Advantech Wireless:

1. SatNet "Mini" - a mini-hub capable of supporting up to 200 remote sites
2. SatNet "Max" - a full hub with no real upper bound
3. SatNet "Max" redundant – a "hitless" hot redundant hub
4. SatNet RLSS – the return link sub system purchased as a stand alone system perhaps for use with an existing DVB-S one-way transmission system in place

Key features of the Advantech Wireless' broadband product line include the following:

- Adherence to the open standard (ETSI EN 301 790) ensuring interoperability with other compliant suppliers.
- Bandwidth-on-demand access, as per the scheme incorporated within the DVB-RCS standard, provides maximum efficiency and flexibility with minimum overhead.
- The Advantech Wireless Hub components have been designed from the ground up to incorporate modularity, scalability and flexibility. The Advantech Wireless Hub can be tailored to each customer's specific need in a cost-effective package that can grow in the future as the customer's client base expands.
- Advantech Wireless' DVB-RCS network solutions offer industry-leading performance. The network can be designed to provide forward link rates starting at 1 Mbps and increasing to 45 Mbps and return link rates of up to 4 Mbps for up to 200,000 simultaneously logged-in terminals.
- A key feature of the Hub equipment is the Advantech Wireless Multicarrier Demodulator (MCD). This card can simultaneously demodulate up to 32 separate carriers and can support a wide variety of transmission rates from 64 kbps to 4 Mbps

Advantech Wireless Hub Network Model

A typical Advantech Wireless Hub Network is divided into four subsystems:

- The Forward Link Subsystem (FLSS) which contains the components necessary for the DVB-S outbound link (forward channel)
- The Return Link Subsystem (RLSS) which contains those components necessary to process the inbound links (return channels) As noted above, Advantech Wireless can provide an RLSS as a stand alone system
- The Network Management System (NMS) which contains the components necessary to management the entire DVB-RCS VSAT system
- The ISP subsystem which contains the components necessary for connection to the Internet or to the customers premise site.

A block diagram of a hub is shown in Figure 8 below. Figure 9 depicts a fully-redundant "Max" hub and a "Mini" hub.

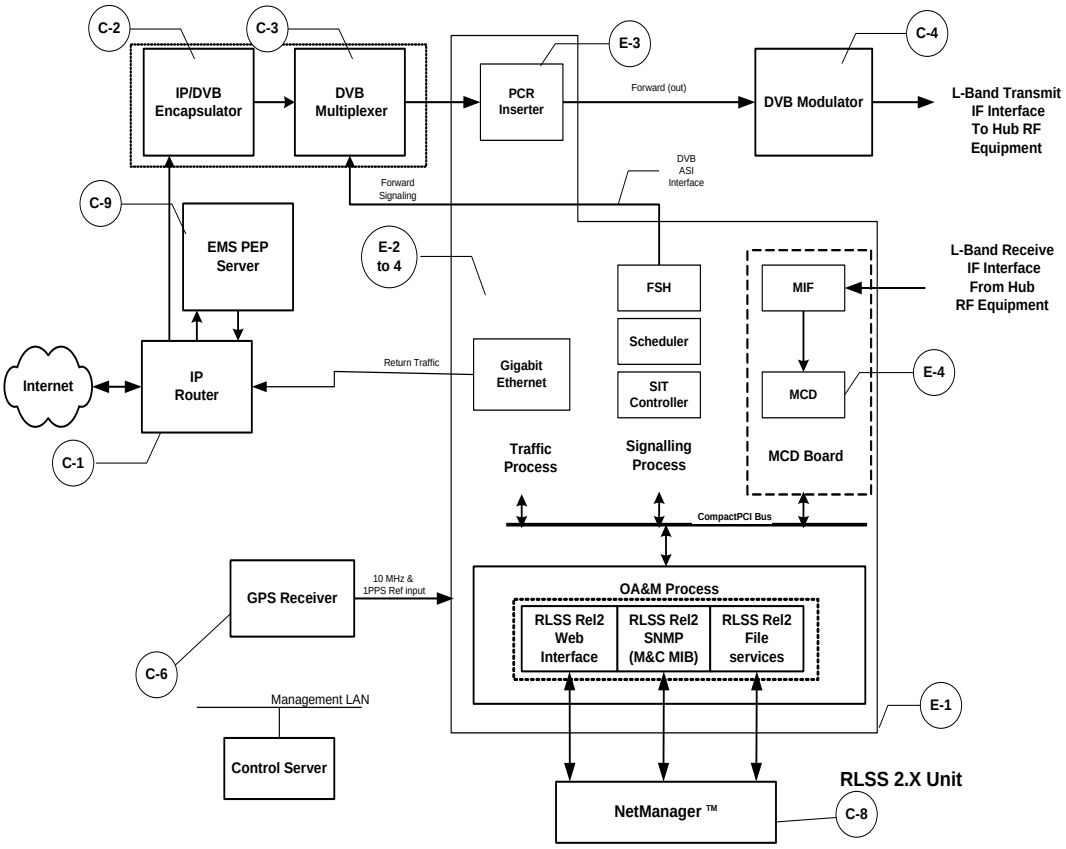


Figure 8: Advantech Wireless DVB-RCS Hub Block Diagram (generic)

Figure 9: Advantech Wireless "Max" (redundant version) and "Mini" Hubs

Return Link Subsystem

The basic RLSS functionality is fulfilled with 1 processor card which contains Traffic, Signaling & Operations, Administration & Maintenance (OA&M). This key component supports up to 200 terminals in the case of the mini hub and much more for in the "max" hub. In addition, it also contains 1 Multi-carrier demodulator (MCD) card. The RLSS can be expanded by adding additional processor cards and additional MCDs. Slots exist, in the "max" case for expansion of the hub to support huge numbers of remote terminals.

Each MCD (E-3 in Figure 8) is programmable to one data rate, and can demodulate multiple carriers at the selected data rate. Each MCD can demodulate up to 8Mbps of throughput. Each RLSS Unit (E-1) can support up to 5 MCDs (in the case of the "max") and up to 2 MCDs (in the case of the "mini"). MCDs run turbo coding (rates 2/3 or 4/5) and can demodulate up to 32 x 64/128/256 kbps carriers, 16 x 512 kbps carriers, 8 x 1024kbps carriers, 4 x 2048kbps carriers or 2x4096 carriers

One PCR Inserter (E-6) is needed for each forward (DVB-S) channel/transponder operated. Each RLSS Unit can support up to 5 PCR Inserters, or 5 separate transponders (in the case of the "max").

The Signaling portion of the Processor board (E-2) is the heart of all the scheduling and controlling of terminals in the DVB-RCS network.

Each RLSS can also support usage of two satellites (in the case of the "max") or of a single satellite in the case of the "mini" hub.

Forward Link Subsystem

The FLSS consists of an IP/DVB encapsulator with ASI multiplexing port for the forward signaling traffic from the RLSS and a DVB modulator. Advantech Wireless typically offers the SkyStream SMR-25. The encapsulator performs a number of functions:

- Encapsulates the forward link IP data traffic into MPEG packets
- Multiplexes the forward link signaling information from the RLSS into the composite MPEG transport stream, and
- Generates and inserts the network level DVB-SI tables (NIT, RMT and MMT) into the composite forward link transport stream.

The modulator is DVB-S compliant and performs the QPSK modulation and applies the selected forward error correction (FEC).

IP Sub-System

The IP Subsystem in the Hub consists of several elements:

- IP router, which provides for internet connectivity and merging of the Forward and Return traffic
- Time & Frequency reference
- Performance Enhancing Proxy (PEP)
- *SatNet NetManager*^{TM} Network Management System
- Optional application and functionality add-ons

SatNet NetManager^{TM}

As the market for DVB-RCS becomes more mature, operators are starting to demand systems that required less dedicated skill to configure and operate. Increasingly, the market is demanding

simplification of configuration, automation where possible, and also added capabilities for the monitoring and control of system health.

Advantech Wireless has responded to these market demands by developing the *SatNet NetManager*^{TM}, a powerful management system capable of meeting the functional and scalability requirements of a variety of system configurations. The NetManager controls all the key operational elements of the *SatNet Max or Mini* hubs, including RLSS, FLSS and IPSS elements.

The NetManager provides several functions, all presented through a common GUI, including:

- Subscriber Management
- QoS Management
- SLA Management
- Configuration Management

In addition, the *SatNet* hubs support the *SatNet Virtual Service Provider*^{TM} overlay to the NetManager, which allows multiple service providers to securely and independently control their own terminal populations on a hub controlled by a common network operator. These features, as well as the tools available to network operators and service providers are summarized below. Figure 10 below depicts an example screen.

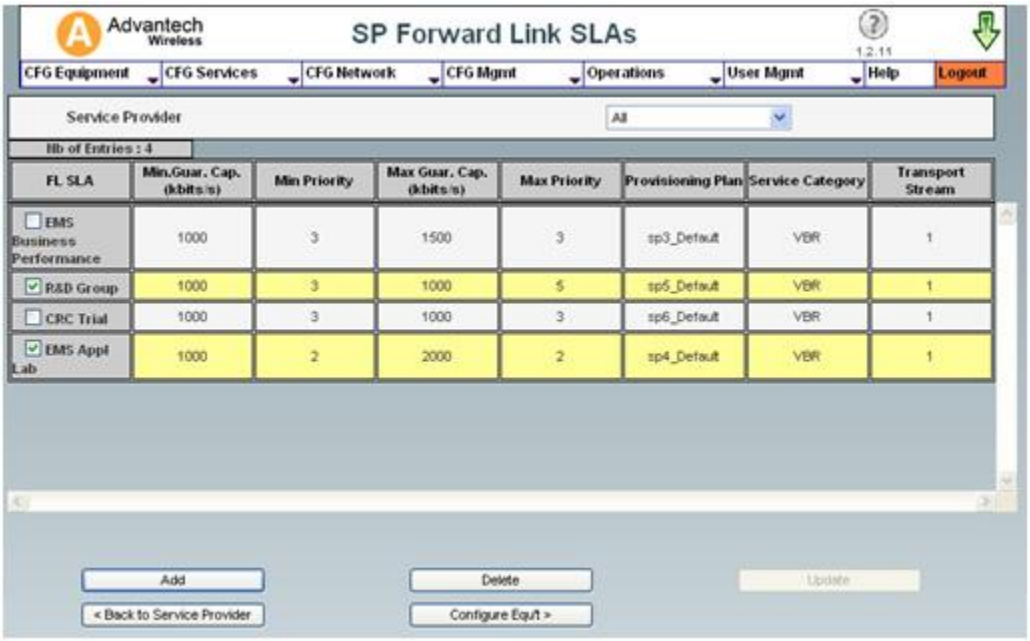


Figure 10: NetManager Screen Example

VIRTUAL SERVICE PROVIDER OVERLAY TO THE NETMANAGER (AVAILABLE ON SATNET MAX ONLY)

Multiple service providers can access the system simultaneously through remote connections. Web access allows service providers located in different regions to effectively operate a section of the hub. Security is provided at two levels.

- Remote access to the system is via secure mechanisms, e.g. Secure Socket Layer (SSL).

- Access to the database is restricted to ensure that any given Service Provider can view and/or make modifications only within the scope of the Service Level Agreements (SLAs) granted to them.

Functionality is provided to allow automatic VSAT configuration import via an XML file containing add, delete, modify commands, perform queries on VSAT configuration, faults and performance, as well as performance data relative to VSAT groups.

NETWORK OPERATOR TOOLS

The Network Operator tools are used for management of the hub configuration, for both a single-tenant and multiple service provider hub architecture. These tools provide the following functionality:

Gateway configuration management

- Configuration of Network Operator users (admin, operators and viewers)
- Configuration of the RLSS using its native application and export the results to a file.
- Import of RLSS configuration file into the NMS and automatic creation of Return Link Service Level Agreements (RL-SLAs).
- Interactive graphical display of the gateway's return and forward link SLAs and their relationships to VSAT Groups.
- Log of timestamped user modifications to the NMS database.
- Log of timestamped configuration commands sent to the gateway components.

Multiple Service Provider Hub management

- Definition of up to 25 service providers with the enforcement of a maximum number of configured VSATs per service provider.
- Centralized shared hub operations option restricting service providers to VSAT management tasks.
- De-centralized shared hub operations option enabling the management of bandwidth by service providers.
- Complete handover of VSAT Management operations by service providers via automatic configuration of routes in the SMR-25 IP/DVB encapsulator(s) and router(s).
- Configuration of FL bandwidth per service provider in the IP-DVB Encapsulator(s) or QoS device via their native interface.

Single-Tenant Hub management

- A configuration wizard creates a simple NMS configuration from a RLSS in a few simple steps.
- Configuration of FL total bandwidth in the IP-DVB Encapsulator(s) or QoS device via their native interface.
- Automatic configuration of N routes for each VSAT in the SMR-25 IP/DVB encapsulator(s) and router(s).

Service Provider Tools

The Service Provider tools simplify the management of SLAs, Return Link and Forward Link Quality of Service (QoS) and, most importantly, the daily management of VSATs. These tools provide the following functionality:

Management of Service Level Agreements (SLA)

- Configuration of forward link bandwidth offered collectively to groups of VSATs, independently of the network operator.

- Provisioning tools to plan the addition of SLAs and the control of the contention ratios.
- Storage of the previous 24 hours of return link traffic statistics, with graphing capabilities.

Management of QoS (FL and RL)

- Creation of custom forward and return link VSAT-Level QoS profiles.
- Creation of groupings of VSATs and association to QoS profiles and SLAs, both on the forward and return links.

Management of VSATs

- Automatic configuration of N routes for each VSAT in the SMR-25 IP/DVB encapsulator(s) and router(s).
- Commanding VSATs with any of the following: Tx Enable/Disable, DB Disable/Enable, Logoff, VSAT status access, ping
- Monitoring of VSAT software version.
- Visibility to a detailed connection management activity log.
- Storage of the previous 24 hours of return link connection statistics, with graphing capabilities.

Hub Turnkey Solution

Advantech Wireless can offer total turnkey integration solutions for an entire Hub including the following elements:

Hub Antenna
Specification, procurement, installation of C, Ku or Ka-band Hub antennas from 3.8 to 9 meters in diameter. In general the client will provide the antenna foundation, crane for antenna erection and IFL conduits from the equipment room(s) to the antenna.

HPA
Specification, procurement and installation of solid state, TWT or Klystron HPAs for any of the three frequency bands.

LNB
Selection installation and check-out of the receiving system based on either external-reference or internal-reference LNBs.

Content Delivery
Selection of content delivery systems/servers and their software based on a customers' needs.

Billing Systems
Integration of billing systems in the Hub to meet customers' requirements.

Uninterruptible Power Supply
Selection of UPS for Hub and/or VSATs and arranging for installation.

DVB-RCS TERMINAL (VSAT) EQUIPMENT

Advantech Wireless SatNet offers a VSAT product line that will support multiple types of users in all frequency bands including the C, Ku and Ka bands.

The key features of the Advantech Wireless VSAT product line are the following:

- Support of the opens standards DVB-RCS using DVB-S (and shortly DVB-S2 as well) on the forward link
- 2 indoor unit (IDU) models available to match customers' needs: Series 2000 and Series 3000
- Support of forward and return links
- Forward link up to 45 Mbps for DVB-S, and starting as low as 1 Mbps
- Return link up to 4 Mbps, starting as low as 64 kbps
- Turbocoded return links (inroutes) using FECs 2/3 and 4/5
- Support for uplink power control in order to mitigate the effects of rain-fade attenuation
- Easy integration with any antenna, either fixed or transportable
- Easy installation and commissioning process
- Return link IP traffic supported via encapsulation in ATM cells or MPEG packets
- Forward link IP traffic supported via encapsulation in MPEG packets
- Built-in 10/100 Base T Ethernet LAN port
- The end-user interface to the IDU uses IP on an Ethernet connection allowing seamless connection to terrestrial equipment and offers extensive IP and TCP/UDP/RTP/IP capabilities such as QoS, VoIP, multicast, TCP acceleration, IPSec, etc.
- Up to 36 Mbps of unicast/multicast/broadcast traffic can be delivered to the end-user's Ethernet connection for Series 2000 and 12 Mbps for Series 3000

Figure 11: Series 3000 VSAT

Figure 12: Series 2000 VSAT

Figure 13: Transportable VSAT with controller (AVL featured here)

Contact Information

This paper has presented Advantech Wireless' DVB-RCS VSAT networking and equipment solutions to implement Government and enterprise-based networks and to meet their application needs. For more information, please contact us online at: http://www.advantechwireless.com/contact/