Best of Both Worlds: WiMAX over VSAT

By Yair M. Sakov, Vice President and General Manager Wireless Business Unit, Gilat Satellite Networks

The unique communication needs of the Oil and Gas industry take technology to its very limits. The need to reach remote and desolated sites allowing both narrowband SCADA applications as well as full broadband connectivity exemplifies this technological challenge. Satellite communication has been used for many years to resolve the distance and location issues presenting a solution which is not cost sensitive to location or distance. However, when a group of sites is spread over a large area and requires multiple connection points, WiMAX technology can be a cost-effective solution. WiMAX is a wireless technology capable of delivering up to 25Mbps to distances as far as 30Km – can be used to connect a multitude of end points with broadband connectivity, allowing a variety of applications in a very cost effective manner. VSAT technology, now capable of delivering 30Mbps downstream bandwidth and 8Mbps upstream, can be used to backhaul WiMAX sites. The combination of WiMAX and VSAT presents a new paradigm where VSAT is used as a backhaul technology to WiMAX sites covering many end points.

WiMAX architecture is based on cell sites each covering a certain area. The coverage area depends on a number of factors. The antenna being used can be an Omni-directional antenna covering a certain radius, or an antenna covering a sector such as a 60º degree antenna. The frequency used for the WiMAX solution also has an impact on both distance and capacity. Lastly the topography of the covered area and its landscape is crucial in the coverage planning.

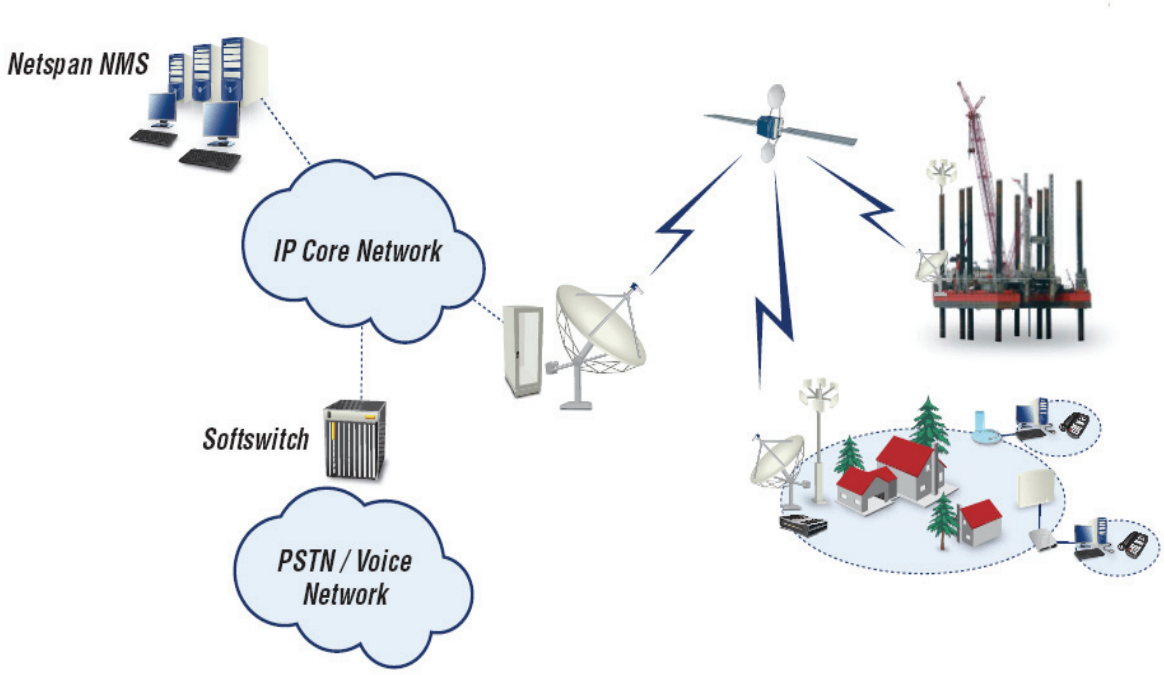

Figure 1

Coupling WiMAX with VSAT backhaul enables both long reach and wide coverage areas with a relatively simple network. The network architecture is shown in Figure 1.

In this example, two remote sites, an ocean-based rig and an inland area, are both connected via VSATs to a central hub. In each of the remote sites, a WiMAX base station illuminates a large area connecting a number of end-points through a WiMAX CPE (Customer Premise Equipment) connected to a LAN. The Hub location serves as a bridge to the IP core network and to the PSTN telephony network. A key element in the Hub is the network management system allowing the network operator to remotely manage not only the VSATs, but each and every CPE in the remote sites.

The network allows many benefits. For example:

- Multi-service networks for voice, data, and video
- QoS for different applications
- VLANs
- Remote management of all network elements and services
- Satellite OPEX savings and reduced delays for traffic running between remotes sites that are covered by a common WiMAX base station.
- Local Call Forwarding for calls within the same rig without need for satellite backhaul
- Cost effective services independent of terrestrial infrastructure

From a deployment standpoint, such an architecture can serve many Oil and Gas operation scenarios. Here are a few examples:

- Covering a single rig (on sea or inland) with multiple connections – one VSAT and one WiMAX base station with multiple CPEs.
- Using a land-based WiMAX base station to cover multiple sea rigs. The base station is usually connected in this case to terrestrial backhaul but can also use VSAT for backhaul.
- Using a WiMAX base station on one rig to illuminate a number of rigs. This is very effective when a seaborne rig moves and can maintain connectivity and network setup in the new location (assuming it is covered by the WiMAX base station).
- Coverage of large areas of inland pumps requiring SCADA or some broadband connectivity. A single WiMAX base station can cover a radius of 30km or more depending on frequency and bandwidth requirements.

While the benefits are very clear, implementing a WiMAX over VSAT network requires in-depth understanding of both technologies, their advantages, limitations, and how they would work together. Careful attention should be given when integrating between these technologies to maintain their inherent advantages and to address their unique needs. These issues, to name a few, are network management, end-to-end QoS, and authentication.

Network Management

A key requirement for any network solution is the ability to manage, control and monitor the network from the Network Operation Center (NOC). Since WiMAX was originally designed as a last-mile solution it was assumed that it will be connected and backhauled by Metro-Area-Network which is fiber, copper or microwave based. The WiMAX management uses SNMP and proprietary protocols expecting low latency and high throughput medium between the NMS server and the WiMAX base stations and CPEs.

The geo-synchronous satellite network suffers from inherent latency of several hundreds of milliseconds. A typical round trip delay will take about half a second or even longer if the network is loaded.

As the network diagram indicates, the WiMAX Network Management System (NMS) is located at the Hub site allowing control of the entire network from that point. This configuration, however, requires the management traffic to be able to handle unexpected traffic delays as well as jitter.

Moreover, with space segment capacity being scarce and costly, it is required that NMS overhead traffic will be minimized. For example, it would be unacceptable for the NMS to poll every subscriber unit (as many WiMAX management systems do). Instead, for example, base stations should act as a “proxy” to the NMS in order to save precious bandwidth.

Gilat's WiMAX over VSAT solution uses flexible network management protocols which are insensitive to the inherent delay of satellite networks. Furthermore, in order to minimize management overhead, the NMS communicates with the base stations only, and gets all information from them instead of querying each subscriber individually. Still, the NOC operator can configure each and every CPE with the desired services and SLAs allowing one subscriber to have 512Kbps bandwidth and no telephony services and another, on the same rig, to have 1Mbps service and telephony.

Managing end-to-end Quality of Service (QoS)

Quality of Service (QoS) is the ability to provide different priority to different applications, users, or data flows. Applications such as video streaming and voice which are delay and jitter sensitive will be given a higher priority in order to guarantee an acceptable service level. In some cases, certain users will require higher priority (QoS) to allow for the execution of critical applications.

Both VSAT and WiMAX networks have well-developed QoS mechanisms allowing adequate management and prioritization of applications and users. However, each of these manages QoS differently and focuses on the specific challenges and market needs they are targeted for – VSAT is tuned for satellite communications and WiMAX for last mile broadband access. The problem arises when applications require maintaining QoS parameters and SLAs throughout the entire link. In other words, the VSAT and WiMAX QoS mechanism needs to be tightly integrated to allow end to end QoS management from behind the Hub, through the WiMAX base station and all the way to the WiMAX CPE.

Gilat's SkyEdge II platform offers Virtual Route Forwarding (VRF). This mechanism allows the operator to create multiple data streams for each VSAT and assign each data stream with a different priority or different addressing schemes. Gilat's WiMAX solution features advanced networking capabilities including automatic VLAN tagging based on service classification. End-to-end QoS mapping can be achieved by combining these unique WiMAX and VSAT features. Each packet can be classified and tagged automatically by the WiMAX CPE. The VSAT will use different queues for each data stream and provide the designated QoS. For example, a service provider can define separate virtual networks for different organizations working on the rig, with three classes of data services (Gold, Sliver and Bronze) in addition to voice services. Figure 2 shows the data flow mechanism in such a scenario.

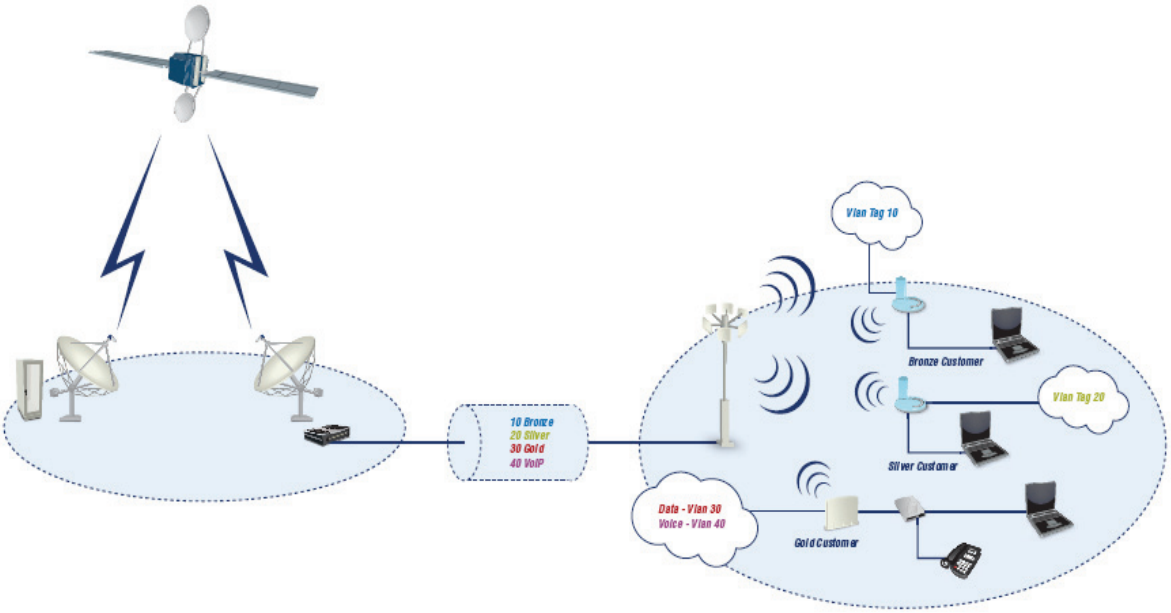

Figure 2

Authentication

Managing customers, their services, permissions, applications and the like, requires access control mechanisms for authentication, authorization and accounting (AAA). These mechanisms should be simple, and as much as possible, transparent to end-users. To address these needs, broadband networks (like WiMAX, DSL or Cable) typically use Layer 2 based authentication mechanism such as PPP over Ethernet (PPPoE) or Layer 2 Tunneling Protocol (L2TP).

When connected to a VSAT network, Layer 2 access control mechanisms are facing problems caused by the inherent technology implemented in satellite communications. A built-in limitation of the geo-synchronous satellite network is latency imposed by the time it takes the signal to travel from earth to satellite in the atmosphere. This delay negatively affects the throughput of a TCP connection. Lacking a timely acknowledgement that a TCP packet reached its destination, the TCP protocol will retransmit the packet but will also reduce its maximum receive window dropping its throughput by a factor of two. In most cases this will result in the TCP performing at the lowest possible packet rate.

In order to overcome the negative effect delay has over TCP connections, satellite networks implement TCP acceleration mechanism. In this mechanism, the TCP stream is terminated at the VSAT, accelerated for efficient satellite communication, and then regenerated at the Hub site. Similarly, this mechanism works for communication from the Hub to the VSAT. However this mechanism can not accelerate Layer 2 tunneling

protocols. These protocols, by definition, "hide" the TCP data in the tunnel. Hence, the data is not seen nor accelerated by the VSAT and Hub.

As a result, the WiMAX access network using VSAT technology for backhaul faces very poor performance for authentication, authorization and accounting. This performance will not be acceptable by end-users.

The Gilat solution offers multiple authentication methods, allowing operators to choose the best method for their specific needs:
Device Based Authentication - Each network element (VSAT/ Base Station and WiMAX CPE) are authenticated against a centralized management and authentication server. This method gives the operator full control of which element can register and get service from its network. This allows the operator to block specific CPEs immediately (for example: CPE reported stolen).
User Based Authentication - Each network user is authenticated based on user name and password. The authentication process is done on Layer 3 avoiding the Layer 2 acceleration issues.

The two methods can work together, providing the operator full control of who is using the network, from where, and with what equipment.

Summary
Indeed, the unique communication needs of the Oil and Gas industry take technology to its very limits. However, WiMAX by itself or coupled with VSAT back haul delivers a very compelling solution. WiMAX allows for high bandwidth connectivity while covering large areas. Furthermore, moving a rig within the WiMAX coverage area does not interfere with the communication set up of that rig. VSAT allows Oil and Gas operators to take communication anywhere in the world in a very cost effective manner. Using WiMAX to extend the reach of a VSAT network, both in terms of the reach and the number of users, brings a new level of service to this industry.

Building a communication network requires planning. Building access networks with different technologies requires development and close attention to all details. Satellite networks and WiMAX have a lot in common, both are managed point-to-multipoint networks, both need to provide traffic control, authentication and authorization. Both technologies are used to provide users with internet access and voice services and both are deployed mainly in underserved areas.

Although both VSAT and WiMAX deal with similar challenges, each technology uses different methods and algorithms to overcome them. The different approach affects the authentication mechanism, management and Quality of Service handling. With more than 20 years in developing and deploying networks all over the world, Gilat offers service providers an excellent solution for remote communities, providing a one-stop-shop, single source solution, to ensure end-to-end performance, transforming the network from "two networks connected together" to "a unified solution".