ipstar
Broadband Satellite

IPSTAR White Paper

Community Broadband and Satellite Backhaul Solution for Remote Communities

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Content

Introduction

Intel invited IPSTAR to join a pilot project with the aim to bring broadband Internet access via satellite backhaul to the remote village of Ta Van in Lao Cai province, Vietnam.

The objective of the project was to demonstrate that it is both technically and economically feasible to bring broadband Internet access to remote regions using commercially available wireless Internet Protocol (IP) technology. IPSTAR joined the project in July 2007 as a satellite backhaul solution provider.

The first phase of the project used the Worldwide Interoperability for Microwave Access (WiMAX) technology linked to a fiber-optic backhaul to bring broadband Internet access and Voice over Internet Protocol (VoIP) services to residents of Lao Cai city in north-west Vietnam.

Building on this experience, the second phase of the project was deployed in Ta Van, a remote village two hours away from Lao Cai city and near the mountainous town of Sapa. Ta Van village has only two fixed-line phones, limited mobile phone coverage and no Internet access.

Unlike the first phase of the project, the Ta Van network was deployed using an IPSTAR broadband satellite connection, in combination with the WiMAX and Wi-Fi technology. This solution set succeeded in providing Internet coverage to the whole community.



Project objectives

There were three major objectives for the second satellite backhaul phase of the project:

1. Demonstrate that satellite technology is the technology of choice when deploying wireless communication networks in unserved or underserved areas.

2. Prove the economic feasibility of the satellite backhaul deployment by using commercially available equipment at realistic prices.

3. Demonstrate the educational and economic benefits that satellite broadband Internet access and affordable VoIP communications can bring to unserved or underserved rural areas.

Technologies

At each end user location, a PC and a wired VoIP phone were deployed to provide access to the Internet and its applications.

WIRELESS BROADBAND TECHNOLOGY

While wired broadband technologies, such as Digital Subscriber Line (DSL) and fiber-optic cable, are well established in the developed economies, the limitations of wired technologies impede the rollout of broadband in developing economies.

For example, a wired technology requires a well-established infrastructure that is often not available in emerging countries, particularly outside the urban areas. DSL lines, in particular, require good-quality copper lines that are often limited to several kilometers from a telecommunications exchange. Furthermore, with the rise of mobile telephony, many countries simply no longer deploy fixed copper lines.

Hence, in many areas, using wireless technology such as Wi-Fi or WiMAX to deliver broadband Internet access is oftentimes the only option.

WiMAX is a standard-based technology designed to deliver high-speed Internet connection across a wide geographical area. It is based on IEEE standards and enjoys wide industry support.

WiMAX with satellite backhaul

While WiMAX is suitable to tackle the problem of the 'last mile' - the final leg of delivering connectivity from a communications provider to a customer - it still requires a decent backhaul connection. A backhaul transports data between distributed sites and centralized points over long distances.

In many rural areas, a fiber-optic backhaul is often not available. Point-to-point wireless backhaul solutions such as microwave links may provide good bandwidth in some areas, but they are generally not always cost-efficient. In many areas, wireless backhaul solutions require multiple 'hops', with each hop requiring a tower, a sophisticated networking equipment and a separate backup power. It is often not economically feasible to extend network access to these rural areas.

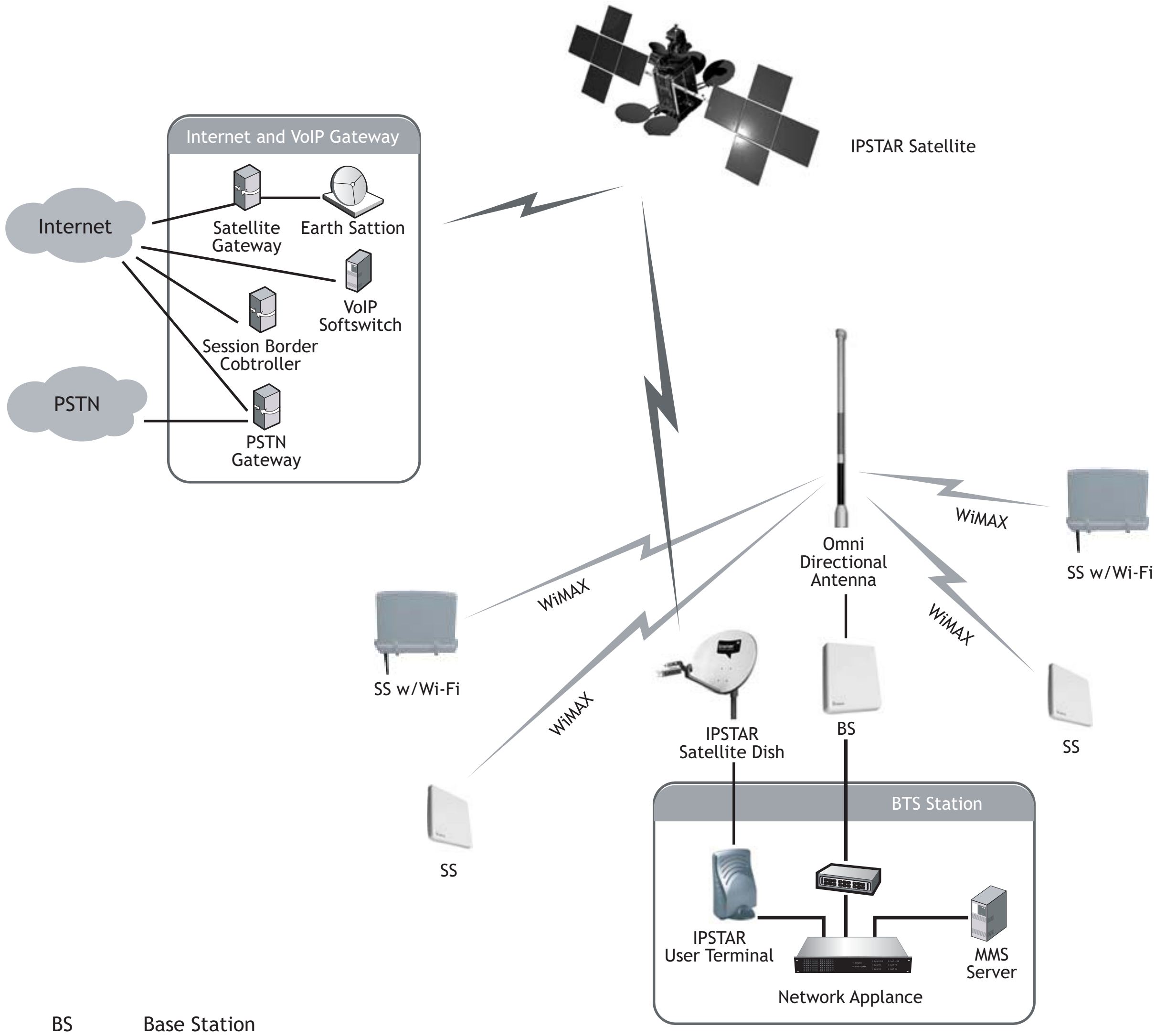
Satellites on the other hand can be deployed easily to any location on earth. The great operational cost has made it cost prohibitive. However, this is no longer the case with the recent deployment of new satellites that deliver dedicated IP bandwidth at reasonable cost.

IPSTAR is such a satellite capable of delivering IP bandwidth to the Asia-Pacific region by using the latest modulation and beam-forming technologies. The broadband satellite's overall bandwidth capacity is 45 GBps and can provide bandwidth of up to 4MBps downlink and 2 MBps uplink to an end user location.

By combining a satellite backhaul with WiMAX or Wi-Fi technology, connectivity can be distributed to many user locations rather than to a single user, making two-way broadband satellite the most economically viable option in rural areas.

Wireless network architecture at Ta Van village

A shared 2MBps downlink and 512Kpbs uplink from IPSTAR was used as the satellite backhaul at Ta Van. Connected to a WiMAX network with a star topology and a single Micro Base station, broadband could be delivered to multiple user locations in the community.



BS	Base Station
SS	Subscriber Station
PSTN	Public Switch Telephone Network
VoIP	Voice Over IP

Figure 1: Satellite backhaul wireless network architecture at Ta Van village, Vietnam

In the past, such a network would have required a good civil infrastructure with a reliable power source and a climate-controlled environment to house both the satellite on-ground and WiMAX equipment.

However, the IPSTAR satellite system requires only one Very Small Aperture Terminal (VSAT) satellite dish and a small indoor user terminal. At the same time, a WiMAX base station equipment is available in small form-factors for outdoor use; and contains all the necessary radio circuitry in one compact outdoor unit, only requiring one small indoor unit for switching and power.

In the Ta Van network architecture, only three components were needed to be installed outdoors at the base station location.

1. IPSTAR satellite antenna
2. Omni-directional antenna
3. Micro base station

The indoor components of the base station are deployed without the need for expensive and energy-hungry air-conditioning. It consists of

1. The IPSTAR satellite user terminal
2. The indoor unit of the micro base station
3. An Edgewater Networks multi-function network appliance

Two types of Subscriber Stations (SS) - basic SS and SS integrated with Wi-Fi - were deployed in user locations. The basic SS provides a single Ethernet connection, which is connected to a switch or a Wi-Fi access point to provide indoor connectivity.

The integrated Wi-Fi SS provides the same wired Ethernet connection but also integrates a Wi-Fi access point into the same chassis. Thus, WiMAX provides the last mile access while Wi-Fi provides the last inch access. Furthermore, an integrated unit provides good outdoor Wi-Fi coverage that can be utilized for Wi-Fi bridges.

One Subscriber Station (SS) for multiple end users

One of the current challenges of WiMAX is the high cost of Subscriber Stations (SS).

The cost of SS is expected to drop once high-volume production starts and true intra-operability enables operators to mix-and-match equipments from different base station vendors and SS vendors.

In the meantime, the high cost of the SS tends to inhibit the mass-deployment of WiMAX networks in rural areas. However, the Ta Van project proved that in many cases one SS can deliver broadband connectivity to several end-users.

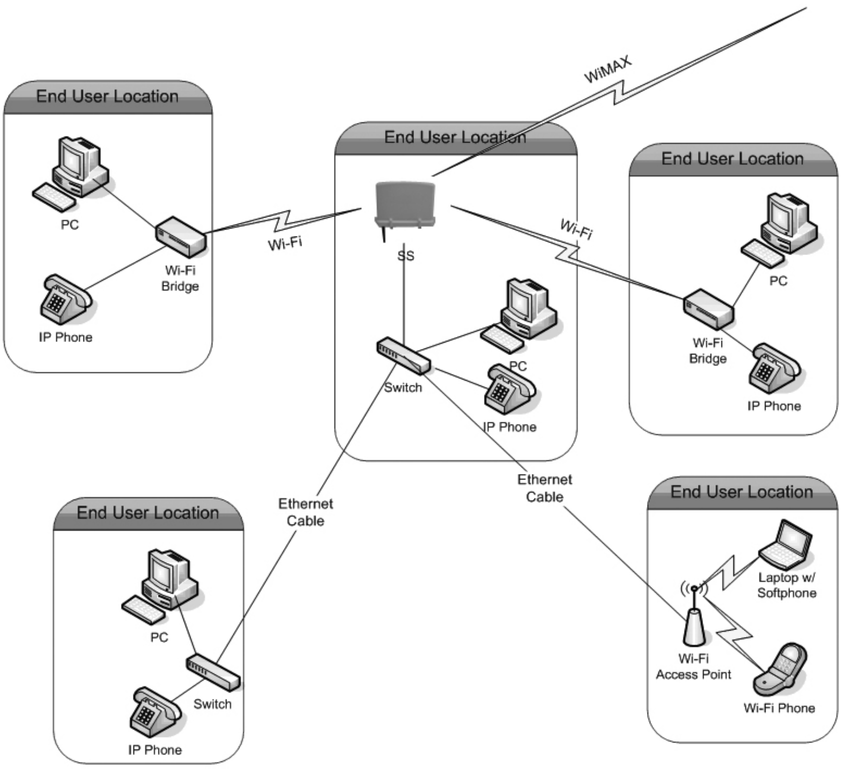


Figure 2: One Subscriber Station, multiple end-users

An integrated Wi-Fi SS was mounted in a suitable outdoor location. Using outdoor Ethernet wires and Wi-Fi bridges, multiple households were connected to the single SS. A Wi-Fi bridge receives a Wi-Fi signal, distributing it via the built-in switching capability.

This solution is extremely cost-effective because it is using a standard access point and an open source firmware. Thus, using a combination of wired and wireless connections, a single SS can easily support five or more end-users, reducing the cost per user significantly.

VOIP TECHNOLOGY

Voice capability is the "killer application" in communication technology. The centerpiece of IP networks is the ability to deliver voice communication cost-effectively with VoIP technology.

While mobile telephony has experienced tremendous growth in many countries, VoIP offers unbeatable cost advantage, particularly when used for long distance and international calls.

Though several protocols can be used to deliver VoIP, Session Initiation Protocol (SIP) has emerged as the leading technology. To date, there are several different SIP end-user devices, including wired and wireless SIP phones and Analog Telephone Adaptors (ATA)—all available at affordable prices. In addition, software-based SIP 'softphones' that run on PCs or PDAs are widely available for little or no cost.

In a SIP network, media gateways handle the connection to the Public Switched Telephone Network (PSTN) so that the network can be seamlessly integrated with the traditional fixed-line or mobile phone network.

For the Ta Van village and Lao Cai city deployment, a Communications Application Server was installed in Hanoi while the media gateway was deployed in Lao Cai city. This enabled an efficient connection to the PSTN.

Simplified SIP session

Simplified SIP is used to establish the connection between two end-points (phones). In general, end-user devices register with a central switch. The central switch then connects the two end devices. Once the connection is established, a separate protocol (usually Real Time Protocol [RTP]) delivers the audio or media.

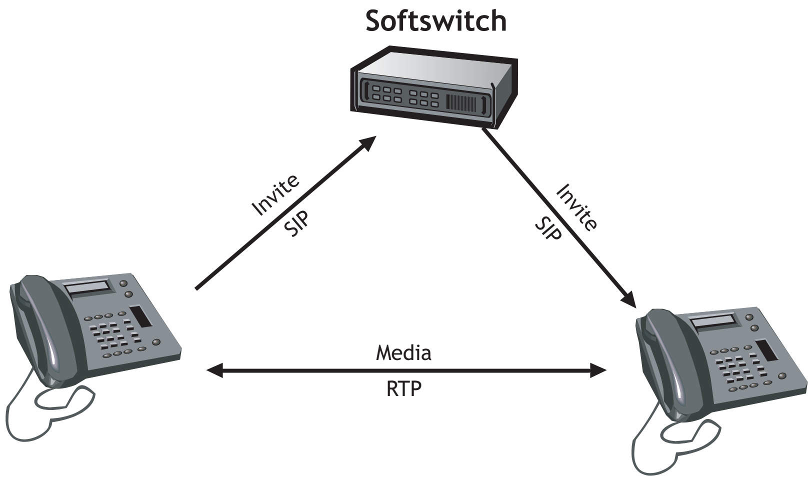


Figure 3: Simplified SIP session

Figure 3 illustrates a simplified a SIP session. After a call is established using SIP, the end devices (phones) connect directly and communicate in a peer-to-peer manner.

Obstacle to SIP

A major obstacle to SIP use is that, oftentimes, the end device is hidden behind a fire wall; a direct connection between the two phones is therefore not possible.

There are two methods to overcome this obstacle:

1. The first is to use a Session Border Controller (SBC). This device sits on the public internet and serves several purposes. One is to act as an intermediary between the two phones located behind a firewall. Thus, rather than communicating directly, the two phones exchange the media traffic via the SBC. The SBC maintains the session and handles the firewall. SBC offers most advantages in larger deployments.

2. The second method is to use an Application Layer Gateway (ALG). This network device sits between the end-user point (phone) and the public internet, and acts as the 'public interface'. The ALG thus handles all SIP communications with the central switch and other end points. In addition, the ALG allows the media (voice) traffic for local phone calls to remain local. Thus, if a user within Ta Van calls another user within the village, the central switch establishes the call and the voice traffic remains within the coverage of the ALG. Though the setup for a local call generates traffic (< 100 kb) that traverses via the satellite, the media (voice) does not. Thus, an ALG creates an efficient local telephone system.

   In the Ta Van deployment, an integrated network device was used. This device integrates all required network functions such as firewall, DHCP server, traffic shaper and ALG. It is a cost-effective device as it is the only network device required in this architecture.

   The only limitation of the device is that it must handle all NAT (Network Address Table) functions. This is restrictive in larger deployments, where a SBC is more suitable.

   However, there are several advantages in the integrated network device. First, it simplifies the network architecture and reduces cost. Second, it provides a crucial 'survivability' function. This function caches the switching information for local end points. Thus, if the satellite link is disrupted, end-users can complete local calls even though the central switch is unavailable. This increases the robustness of the network. Furthermore, the network device offers traffic shaping functionality and Quality of Service (QoS).

Cost of developing a sustainable community broadband solution

One of the key objectives of the Ta Van project was to demonstrate that it is feasible to deliver broadband connectivity at reasonable cost to even the remotest rural area using commercially available equipment.

The cost components of this architecture can be separated into capital and operational expenditures. For simplicity, capital expenditure focuses on network components while the operating expenditure focuses primarily on the satellite costs.

CAPITAL EXPENDITURE

A wireless network catering forty end-users, such as that deployed in Ta Van, can be delivered for around USD 22,000 at current prices.

The base station equipment costs about USD 14,000, inclusive of the WiMAX base station, network device, satellite equipment and other miscellaneous items.

If WiMAX SS, Wi-Fi bridges and outdoor Ethernet cables are used to connect 4-5 users to one subscriber station, the cost to connect forty end-user locations is about USD 225 per user.

OPERATING EXPENDITURE

The cost of the satellite connection is the deciding factor for this model.

The cost of a traditional satellite solution is often prohibitively expensive. However, IP-based satellites such as IPSTAR provide broadband connectivity at reasonable costs. However, the cost of the satellite transmission is only one factor that influences pricing. Other factors include the in-country cost of connecting to the Internet, as well as operational costs.

Assuming a cost range of USD 1,200 to USD 2,500 for a shared 2Mbps link, which can support forty users – provided that a reasonable satellite contention rate is used – broadband connectivity can be delivered for a monthly cost ranging from USD 30 to USD 50.

Summary

The satellite backhaul phase of the Intel-led rural connectivity project stipulated three objectives: to demonstrate that satellite technology is the technology of choice when deploying communication networks in unserved or underserved areas; prove the economic feasibility of satellite backhaul deployment by using commercially available equipment at realistic prices; and demonstrate the educational and economic benefits that satellite broadband Internet access and affordable VoIP communications can bring to unserved or underserved rural areas. All of which passed proof-of-concept.

However, questions pertaining to the 'right' business model for sustained rural broadband connectivity and funding issues remain. The Intel-led pilot project, with IPSTAR as a satellite backhaul solution provider, proved a powerful and effective community broadband solution from an economic and technical perspective for underserved communities in developing economies to overcome the digital divide.