Pocket Modem: Bringing Forth the Synergy between WiFi and WiMAX

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APPLICATION NOTE

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Abstract

WiFi has changed the way people connect today and has become the defacto wireless technology on most consumer electronic devices. Where WiFi faces limitation, particularly in terms of fixed usage, Mobile WiMAX complements through its mobility advantage.

This paper focuses on the portable Pocket Modem, a device that leverages on the synergy offered by WiMAX and WiFi. It examines how this synergy benefits users and provides a better connectivity experience.

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If WiFi Was A Phone, It Would Be The World's Best Seller

WiFi has played a dramatic role in empowering wireless Internet. By distributing high-speed Internet access from cable, Digital Subscriber Line (DSL) and other fixed broadband connections within wireless hotspots, WiFi has dramatically increased productivity and convenience. Today, WiFi delivers high-speed Wireless Local Area Network (WLAN) connectivity to millions of offices, homes, and public locations, such as hotels, cafés, and airports.

WiFi technology originates back to 1985 by the U.S. Federal Communications Commission and was commercially made available in 2000 by Commonwealth Scientific and Industrial Research Organisation (CSIRO). Since its inception, this technology has grown both in popularity and geographic penetration. It is the breakthrough technology that has enabled the mass adoption of wireless Internet.

WiFi technology is so successful that if it was a phone, it would be the world's best seller! Figure 1 shows shipment numbers of WiFi chipsets and leading smartphone by OS in 2010. WiFi chipsets hold the highest number with 366 million units shipped.

Item	2010 Shipment Numbers *(rounded to the nearest million)*
WiFi Chipsets	366 million
Symbian	102 million
RIM	61 million
iPhone	43 million
MS Windows Mobile	11 million
Linux	8 million
Android	104 million

Source : Gartner & www.isuppli.com

Figure 1 : Shipment numbers of WiFi chipsets and leading smartphone by OS in 2010

The Device Factor

Factors that have led to the success of WiFi include wireless convenience and multi-user broadband sharing. However, the primary driver is the role of WiFi-enabled devices. Initially, WiFi embedded laptops made an appearance, however, now, as the quest for connectivity continues to drive consumer electronics (CE), the market is buoyed by more categories such as handhelds, gaming consoles, cameras, audio devices and many more.

Figure 2 illustrates the evolution of WiFi-enabled devices from the early days of laptops to sophisticated smartphones and mobile hotspot devices today.

Source : Modified from WiFi Alliance

Figure 2 : Evolution of WiFi-enabled Devices

Figure 3 shows the growth in various categories of WiFi enabled devices. Overall, ABI Research expects a 65% growth over the next 6 years. It is obvious that this technology will continue growing in popularity in the future.

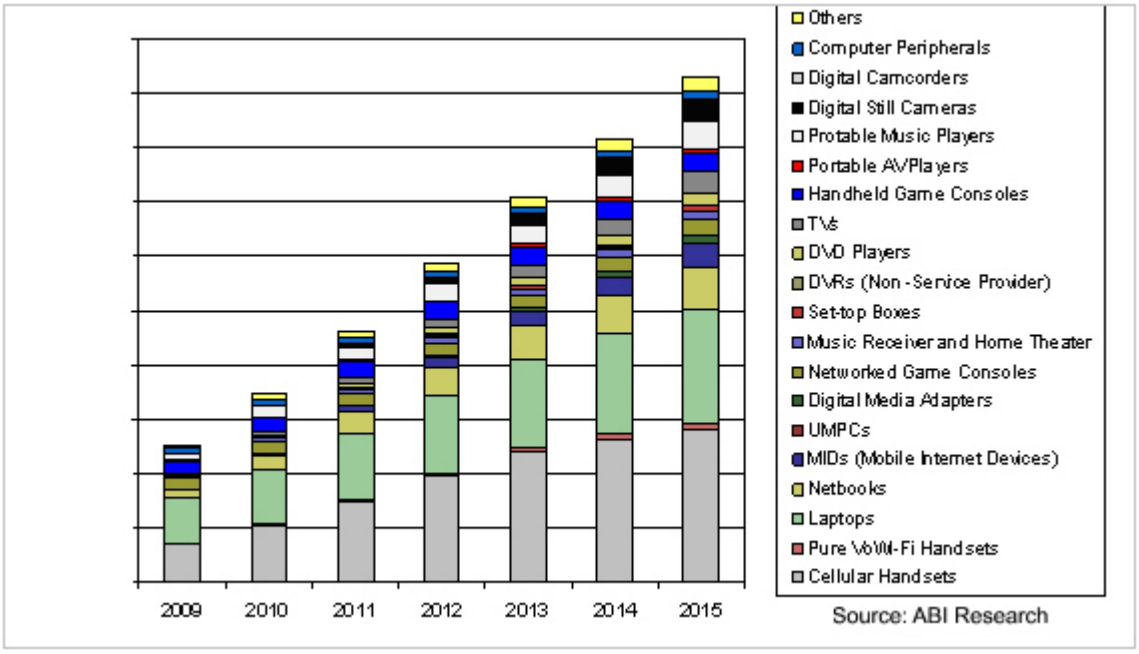


Figure 3: Categories of WiFi-enabled Devices

Cellular handsets will be highest in demand over the next five years (estimated CAGR of 25% between 2009 and 2015), which reflects users' preference for Internet access while on the go. Handsets, laptops, netbooks and MIDs/Tablets are the next segment which will see an increase over the years. Together, these trends point to one direction – data demand will continue to sky-rocket in the coming years and WiFi-enabled devices, particularly handsets, laptops, netbooks and MIDs/Tablets provide the best approach to consume data.

Not to be discounted is the growing preference for WiFi-enabled cameras, home entertainment products, set-top boxes and game consoles. These devices, for example game consoles allow multiple players to engage in a game, whereas WiFi cameras facilitate immediate uploading of photos and videos to the Internet.

With so many consumer electronic devices available in the market, it is evident that users own multiple WiFi-enabled devices and often use at least two of them simultaneously. This increases the need for WiFi hotspots to cater for these WiFi-enabled devices.

The Problem with WiFi

While WiFi is applauded for the advantage of wireless convenience and multiple device/user access, it has the following limitations:

a. **WiFi is shared.** Sharing is not always the best form of caring. WiFi is widely made available through public and private hotspots. As the number of users accessing the same hotspot increases, throughput rates decline and in some cases congestion occurs.

b. **Hassle to set up.** WiFi require access points which are not easy to set up and configure for the layman. Most often, public and private hotspots are established by IT technicians.

c. **Fixed access.** WiFi hotspots are confined to a physical location and do not provide mobility unlike cellular technologies. Hence, a user is not able to bring along his WiFi hotspot when he leaves the home of office.

d. **Power consumption.** WiFi generally has higher power consumption than other 2.4GHz wireless standards, such as Bluetooth, Zigbee, and other wireless standards. Therefore, many Wi-Fi-enabled mobile devices turn off Wi-Fi automatically via the connection utility by default.

c. **Interference.** WiFi operates in an unlicensed 2.4GHz band and is easily subjected to interference both on the device and to other devices operating under similar frequencies. These devices include Bluetooth, Zigbee, microwave ovens, WiMAX devices in the (2.3GHz and 2.5GHz version), and in the near future, even to LTE bands (i.e: band 38, 40 and, etc)

WiMAX–WiFi Synergy

In today's highly connected world, network integration is vital to ensure ubiquitious connectivity. Different broadband technologies are optimized and used for different usage models where possible.

Since its commericial deployment 5 years ago, WiMAX has been making waves all around the world and establishing itself as competition to both wired and wireless broadband technologies. The structure and capabilities of this technology empowers users to explore the Internet in ways not done before.

a. **Mobility advantage.** WiMAX is built on IEEE 802.16e standard which enables it to support fixed, portable and mobile usage. Although other WWAN technologies such as 2.5G and 3G offer mobile data services, these technologies do not provide the broadband speeds user have become accustomed to.

b. **Cost-effective deployment.** WiMAX's wireless framework is cheaper and faster to deploy compared to wired broadband for the simple reason that signals are carried through the air via radio waves as opposed to copper lines.

c. **High data capacity.** WiMAX is built from ground up for IP-based applications and hence, is optimized to support high data rates.

Overcoming WiFi's Limitation with WiMAX

With WiFi increasing in popularity and becoming the defacto broadband technology supported by most devices, the supply of WiFi hotspots will never be enough to meet users' demands. The complexity of setting up hotspots does not help in proliferating WiFi. As the industry advances technologically, can users create instant hotspots by themselves? Taking the idea one step further, are mobile hotspots possible?

By riding on the advantages of WiMAX, particularly mobility and high data rates, plus the convenience of WiFi, mobile hotspots have become a reality today. Together, WiMAX and WiFi form a synergy to deliver mobile, convenient and affordable broadband services to users. Both technologies share open IEEE wireless standards (IEEE 802.1x) and are built for IP-based applications.

How does this synergy benefit users?

a. There is a common user experience for wireless broadband which is important in accelerating user adoption.
b. The common standard protocol and certification facilitates volume production and global economies of scale which leads to cheaper devices.
c. An all IP-based network supports high data rates and minimizes congestion for a better surfing experience.

Pocket Modem : The Synergy Applied

Pocket Modem is one of the products in the market that leverages on the synergy offered by WiMAX and WiFi. Above this synergy, Pocket Modem combines the aspect of mobility to give users WiMAX and WiFi connectivity while on the go.

Pocket Modem, as shown in Figure 4 is a small and light-weight device that empowers users to take the Internet to the next level through the mobility advantage of WiMAX and the ease of WiFi.

Figure 4: Greenpacket's Pocket Modem

Empowered by WiMAX

Pocket Modem is designed for broadband sharing and to date, no other technology supports this better than WiMAX. WiMAX has an advantage over cellular technologies such as 3G and among many reasons, the cost per Mbyte. From analysis conducted by industry experts, in terms of delivery cost per MB, WiMAX is ranked the lowest[1].

Technology	Delivery Cost/MB (USD)
HSPA	$0.015
LTE	$0.005
WiMAX	$0.003

Figure 5: Delivery Cost/MB of Different Wireless Broadband Technologies

For this reason, WiMAX operators offering Pocket Modem are able to offer more attractive pricing plans compared to 3G operators. Figure 6 compares Pocket Modem package plans of 3G and WiMAX Operators in the US. It is evident that WiMAX packages are priced cheaper compared to 3G. At the same time, WiMAX offers better data capacity and allows more devices to be connected simultaneously (up to 8 devices) compared to 3G (up to 5 devices).

Operator	Technology	Monthly Charges	Data Limit	Recommended No. of Simultaneous Devices
Sprint-Nextel	3G	USD 59.99	5GB	5
Clearwire	WiMAX	USD 25	Unlimited	8

Figure 6: Pocket Modem Pricing Packages - 3G vs. WiMAX

[1] *Monica Paolini, Senza Fili Consulting*

Not many countries have introduced Pocket Modem on both 3G and WiMAX networks such as US. However, Pocket Modem is a relatively new device in the WiMAX industry but it is gaining traction throughout the world for the simple reason that users own multiple devices that require WiFi connectivity. As seen in Figure 3 earlier, WiFi-enabled devices do not merely comprise of laptops, instead more and more consumer electronic devices such as cameras and television have WiFi capabilities. Leading WiMAX Operators such as Clearwire, Yota and UQ are currently offering WiMAX based Pocket Modem to their subscribers.

More Than a Modem

Pocket Modem is a device that combines various elements – two broadband technologies, access point and mobility. It is a league of its own and offers more than a modem. WiMAX modems today require a trade off either from the aspect of mobility, Internet sharing (multi device/user) and ease of browsing (for example, large display screen). Figure 7 maps the characteristics of different types of WiMAX devices.

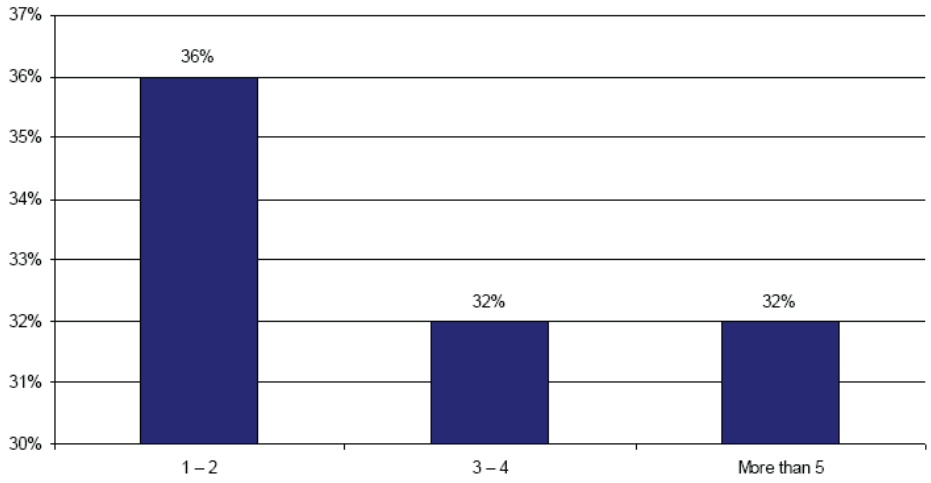
Figure 7: Characteristics of WiMAX Devices from the Aspect of Mobility, Internet Sharing and Ease of Browsing

Meanwhile, Pocket Modem offers the combination that none of these WiMAX devices can offer – mobility, multi-device access, WiMAX data rate and speed and the convenience of WiFi. In short, through Pocket Modem, users can create their very own hassle-free mobile hotspot anytime and anywhere through a single, sleek device.

Why are hotspots so much in demand? Many consumer electronic devices are WiFi-enabled and therefore need WiFi connectivity for data applications. Though many also support cellular technologies like 3G, access to such technologies can be slower and more expensive. On the other hand, connecting through cable (where possible) is troublesome and limiting.

Additionally, most users in this generation own multiple WiFi-enabled devices. Devicescape conducted a worldwide research and discovered that 64% of respondents owned three or more WiFi-enabled devices in their household (Figure 8). With more than one WiFi device in a home or per user, WiFi hotspots are needed to provide connectivity multiple devices or users simulataneously.

Pocket Modem is the ideal, quick and easy way to establish a hotspot. Once turned on, Pocket Modem automatically creates a hotspot and multiple devices can connect to enjoy WiMAX connectivity.



Source: Devicescape, Q4 2009

Figure 8: Number of WiFi Devices in a Household

Enables Dual Mode Access

There is a variety of broadband technologies available and unfortunately, users are not technology faithful, instead they are driven by preferences and convenience. As such, these users might have multiple devices which connect to different networks for example a cable and WiFi-enabled laptop as well as a WiFi/3G iPhone. On the other hand, being a relatively new technology, WiMAX is not widely supported by consumer devices unlike WiFi or 3G. However, WiFi is the common technology across all these devices.

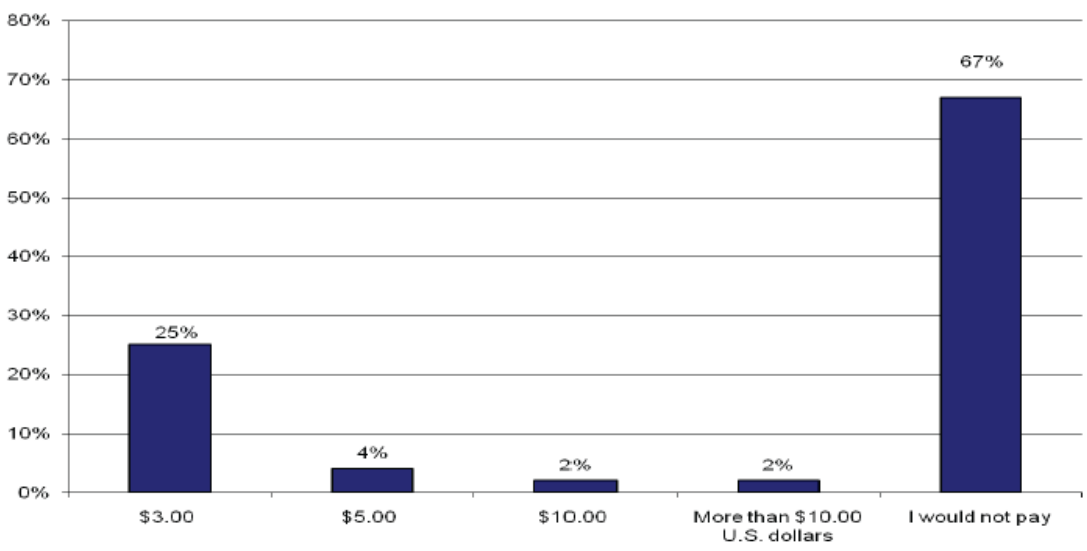
As such, operators can position Pocket Modem as a device that enables dual mode access so that 3G devices (with WiFi) can benefit from WiMAX's speed and bandwidth advantage. One such operator is Clearwire, who recently launched iSpot (a Pocket Modem), to establish 4G hotspots for Apple's iPhone and iPad[2]. iSpot will allow users of Apple's iPhone, iPad and iPod Touch to access its WiMAX network, which can be shared by multiple devices. Aside from widening its product range, launching the Pocket Modem is part of Clearwire's strategy to combat competition.

[2]*Fierce Wireless*

Cost Savings

Pocket Modem help users save money through two ways.

Firstly, it eliminates the need to pay for external WiFi connection. Free public hotspots are normally congested, while a WiFi subscription with providers such as Boingo and iPass involves a fee. In contrast, users are not willing to pay for WiFi. In a similar survey by Devicescape, 67% of respondents said that they would not pay to use WiFi (Figure 9).



Source : Devicescape, Q4 2009

Figure 9 : Respondents' Reaction Towards Willingness to Pay for WiFi

Secondly, Pocket Modem allows users to maximize the use of their WiFi-enabled devices. For example, what if a user bought the first generation of iPad only to realize he would like to connect anytime and anywhere? Upgrading to the next generation of iPad that supports 3G incurs additional cost, plus the user needs to sign on a 3G data plan. An alternative is to purchase the iPad WiFi and use it with the Pocket Modem, powered by WiMAX connectivity (see Figure 10). Not only is this option cheaper, users can enjoy unlimited data.

	AT&T	Clearwire
	iPad 3G	**iPad WiFi + Pocket Modem**
iPad 3G 16GB	$629	$500
Pocket Modem	N/A	$99
Data Plan for 12 months	3G package: $300 ($25/month)	WiMAX package: $300 ($25/month)
Data Limit	2GB	Unlimited
TOTAL	$929 (cost for iPad only – single device)	$899 (cost for multiple devices/users)

Using the iPad WiFi with Pocket Modem is cheaper with unlimited data limits. Additionally, with WiMAX based Pocket Modem, multiple devices can be connected/ tethered and/or multiple users can share the connection within the personal WiFi hotspot/PAN.

Figure 10: Comparison between iPad Packages

Indoor Solution for Improved Coverage

Indoor coverage is always a limitation for wireless technologies. This is because in wireless transmission, higher frequencies dampen the signals' ability to penetrate through building material. In the case of WiMAX, with (high) frequency ranging from 2.3GHz to 3.5GHz, indoor penetration is often a concern. The effect is more adverse in the 3.5GHz operating frequency.

Like all wireless technologies, WiMAX signals experience loss during building penetration and these signals further weaken as they transmit deeper indoors. Due to such penetration loss, users need to sit close to the window for optimum coverage, which is not always practical, convenient or comfortable. As a workaround, Pocket Modem can be placed near the window while users can enjoy WiMAX through WiFi from any location within the perimeters of the home or office without the need of additional WiFi routers.

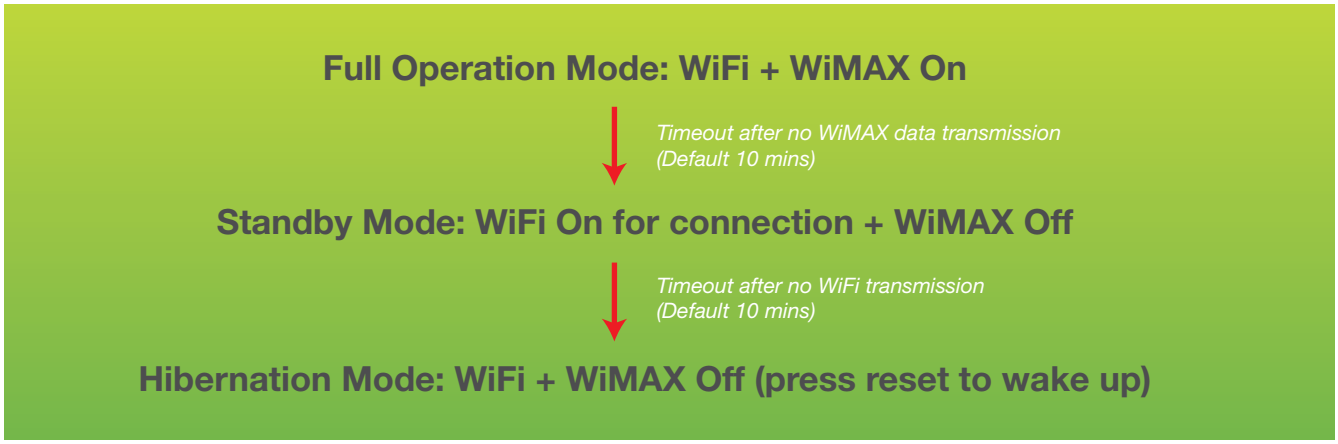
Perfectly suited to serve the portable and nomadic segment of broadband users, the design, function and features of the Pocket Modem is uniquely different from a USB dongle. Conveniently selected as a complimentary 2nd device to satisfy mobility and multi connectivity needs, Highlighted in the following are 6 key selection criteria of a Pocket Modem:

1. **Small and Lightweight:** Second to performance, practicality and convenience of design is likely the most important selection criteria from an end consumer perspective to appeal them to purchase a product, from a survey conducted by Greenpacket with a group of random wireless broadband consumer looking for similar products, 63% cited practicality of design as a must, where consumer similarly ranked the top two main criteria to prioritize slim (pocket size) and lightweight as a must. Fulfilling this criteria and within its product category, Greenpacket's pocket modem is the slimmest and lightest WiMAX pocket modem in the market to-date weighing in at only 62 grams. Designed to slip comfortably without intrusion into any pockets from clothes to bags.

2. **Good Aesthetics:** Similar to mobile phones, pocket modems are fast becoming part of the clothing urban accessories as a lifestyle item. Pocket modem users put extreme details on the product's appearance, color, and finish and material. Green Packet's MF series pocket modem is applying the latest cutting edge IMF (In Mold Forming) technology where the enclosure is made from an hardened semi-transparent printed film and plastic. This ensures the best exquisite color, resolution, and finish appearance is archived of on the enclosure to be both sleek, minimalist and scratch free.

example Greenpacket MF series in black and white color themes

3. **Long Battery Use-time:** On performance, the ideal daily usage model for Pocket Modems is similar to mobile phones, where the device is never turned off with expectation that it will be available as and when the connectivity is needed. Imagine a user having instant internet connectivity via any of its WiFi enable devices (i.e: Smartphone, notebook, tablet, gaming console & etc) at anytime and anywhere throughout the day without limitation with total wireless freedom. This can only be archieved with a Pocket Modem that will last throughout the use duration of the day. Greenpacket's Pocket Modem is designed to fulfill this need, allowing continuous non-stop usage of up to 7 hours and on occasional use, instead of having to turn on and off the device on every use, the Pocket Modem is also designed to go automatically go into intelligent power saving modes and remain functional on call for up to 18 hours on standby, and hibernation of 9 days.



Intelligent Battery Saving Algorithm

4. **Low Power Consumption:** The criteria to archieve long battery use-time directly relates to an often overlooked feature governing the Pocket Modem which is the actual power consumption. Conventional computer's USB port generally has typical output power of 500 mA/h, therefore, in order for the pocket modem to be used while being charged, the typical consumed power of the pocket modem in active mode has to be below this limit without the need of a special USB power adaptor. Greenpacket's Pocket Modem has a typical active usage power consumption of 450mA/h (RSSI=-62, CINR= 25dB),well below the 500mA/h limit. In addition, the typical power consumption for and on standby mode is about 100mA/h, way below the 500mA/h limit, allowing the Pocket Modem to charge on-the-go.

5. **Plug-and-Play:** Pocket Modems are meant to be portable. Preprovisioned to the operate setting, the pocket modem comes alive with a touch of a button and any provisioning and upgrade has to be instant via the air. Greenpacket's Pocket Modem is designed exactly to be plug-and-play supporting remote management (TR069, OMA-DM, etc) features for convenient operator management.

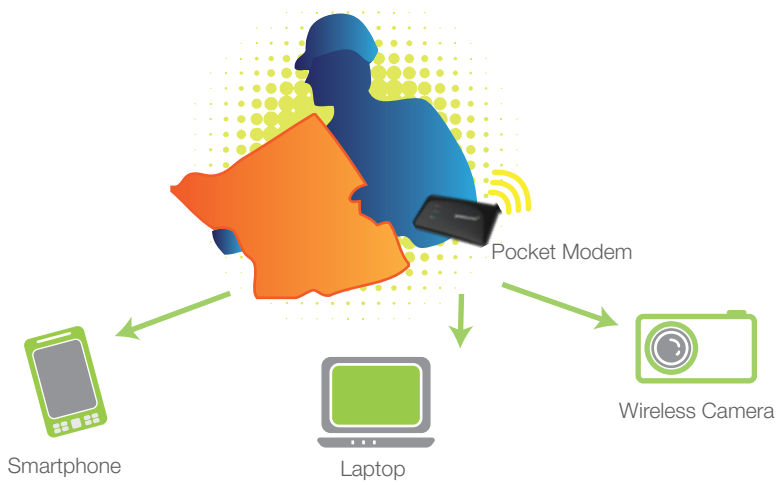
6. **Support advance CPE based Features:** Essentially, the Pocket modem is designed with the functionality close to a CPE supporting basic features similar to an indoor modem which requires high processing power capability. Greenpacket's Pocket Modem uses a Dual Core Chipset architecture with integrated Ethernet Switch and PHY as well as DSP, delivering enough processing power to support most WiMAX and WiFi router features including NAT, DNS, VPN passthrough, DHCP and firewall capabilities.

How Do Users Benefit from Pocket Modem?

Improves Productivity

Some professions require a person to be based at a client's office (for example auditors) or a field site (for example, network engineer, civil engineer). These personnel often work on multiple devices that require Internet access at the same time. It may not be possible to gain access to the client's office WiFi or set up a WLAN at a construction site. Carrying multiple USB modems is too troublesome.

The answer is Pocket Modem – through this small and simple device, multiple devices can be instantly connected anytime and anywhere without any hassle. Having constant connectivity allows the personnel to access the Internet or office intranet immediately, thus improving productivity.



An engineer on field assignment may use different WiFi-enabled devices for various purposes – a laptop for testing field conditions, smartphone to quickly check emails and wireless camera to take photos of the site and send to colleagues in the office. With a Pocket Modem, these three devices can be connected to the Internet simulataneously.

Figure 11: The Pocket Modem Helps to Improve Productivity

Start an Instant Workgroup

Pocket Modem enables a small team to work and collaborate effectively by enabling on the spot Internet connectivity, instead of having to search for WiFi hotspots. Often field groups, for example medical mobilization teams require Internet access everywhere they go. Through Pocket Modem, these workgroups can create a hotspot for all to share – a convenient and cost-effective solution.

Similarly, Pocket Modem is very useful for students who rely heavily on the Internet both for education and entertainment purposes. Students can gather and work together anywhere, instead of confining themselves to the library or cafeteria for Internet connection.

Pocket Modem enables a small team to work and collaborate effectively by enabling on the spot Internet connectivity, instead of having to search for WiFi hotspots.

Figure 12: Workgroups can Instantly Collaborate Effectively

Mobile Broadband Sharing

With Pocket Modem, occupants within a home can easily share the same broadband connection, which is a more economical approach. It is also more practical compared to every member of the family waiting in line to check their emails. What's more, instead of confining the broadband access to the home, with Pocket Modem, connectivity can travel with the whole family during a weekend picnic or summer holiday.

Home	Outdoors
Occupants within a home can easily share the same broadband connection anywhere within the indoor perimeters.	With a Pocket Modem, connectivity can travel with the whole family during a weekend picnic.
	

Figure 13: Internet Sharing for the Family at Home and Outdoors

Connectivity Hub with Applications

In addition to providing basic connectivity for one or more devices, this device has the potential to provide access to applications. Similar to the concept of application stores deployed for smartphones, operators can launch their very own API-enabled applications which can be accessed through the Pocket Modem. While having an application store the size of Apple's may seem redundant, operators can look into software that are location, network and socially interesting to small-group computing activities, especially while on the go.

Currently, Portable 3G WiFi Pocket Modem have began the development of such applications through the establishment of developer programs to build Pocket Modem applications[3]. Nevertheless, bandwidth is often a constraint on 3G networks – in particular, when multiple devices or users are accessing Internet-based applications, user experience can be greatly jeopardized.

This positions WiMAX based Pocket Modem as the better alternative as this technology has the ability and capacity to support high amounts of data.

[3] *www.readwriteweb.com*

King County School District Transforms Learning Experience Through Wireless Broadband

With the goal to “Enable every student with the access to World-class education” and realizing the immense benefit that can be harnessed from next-generation digital technology, the state of California under the Schwarzenegger administration embarked to created and facilitate the “Digital Textbook Initiative”. Giving birth to a new era of e-learning where students, teachers and parents now engage learning in an interactive and real time manner with digital textbooks, interactive applications, educational tools, a broad library of digital information and the internet through the use of smart devices (Tablets) in replace of textbooks.

For the Kings County School District, the delivery of this real time digital information was made simple through the implementation of a campus wide mobile WiMAX network. Digitel Corporation and Greenpacket implemented the pocket modem as a complete solution to bring together the WiMAX wireless access network and digital smart devices where each student is provided with a pocket modem paired with a tablet to be used on-campus. Beyond the compound of the school, student with the pocket modem could also share the wireless data connectivity around the clock, anytime, connecting the entire family to the internet through High speed WiMAX on one single data plan.

Within just 2 months into the project, Kings County showed a significant increase in teacher, student and parent communication, improved student attendance to an amazing 95% score, showed significant improved results in student discipline and most important of all, an 11% improvement in overall student test scores as students are now more engaged with learning than ever before, virtually extending the school hours throughout the day. As an added bonus, Districts official have also recorded significant savings on paper and pencil utilization which in due time will naturally extend to books and other paper based media. With such a successful case, District officials are now pushing to duplicate the Digital Textbook Initiative project in all other schools within the state and beyond.

The Kings County School project is just one of many verticals on how WiMAX could significantly bring an impact to improve lives.

You Can Bring Forth the Synergy of WiMAX and WiFi!

Greenpacket welcomes you to embrace Pocket Modem and bring forth the synergy of WiMAX and WiFi to your subscribers. At Greenpacket, we understand the demands placed on Operators like you. That is why we furnish you with the power to offer subscriber more than just high-speed connectivity. Our innovation will provide you with endless ways to engage with today's sophisticated subscribers and enhance relationships.

With Greenpacket, limitless freedom begins now!

Free Consultation!

If you would like a free consultation or more information on Greenpacket's Pocket Modem, feel free to contact us at marketing.gp@greenpacket.com (kindly quote the reference code, AP0810 when you contact us).

References

1. WiMAX and WiFi Together: Deployment Models and User Scenarios by Motorola & Intel.

2. Greenpacket Pocket Modem Consumer Survey Program 2011 (January 2011)

About Green Packet

Greenpacket is the international arm of the Green Packet Berhad group of companies which is listed on the Main Board of the Malaysian Bourse. Founded in San Francisco's Silicon Valley in 2000 and now headquartered in Kuala Lumpur, Malaysia, Greenpacket has a presence in 9 countries and is continuously expanding to be near its customers and in readiness for new markets.

We are a leading developer of Next Generation Mobile Broadband and Networking Solutions for Telecommunications Operators across the globe. Our mission is to provide seamless and unified platforms for the delivery of user-centric multimedia communications services regardless of the nature and availability of backbone infrastructures.

At Greenpacket, we pride ourselves on being constantly at the forefront of technology. Our leading carrier-grade solutions and award-winning consumer devices help Telecommunications Operators open new avenues, meet new demands, and enrich the lifestyles of their subscribers, while forging new relationships. We see a future of limitless freedom in wireless communications and continuously commit to meeting the needs of our customers with leading edge solutions.

With product development centers in USA, Shanghai, and Taiwan, we are on the cutting edge of new developments in 4G (particularly WiMAX and LTE), as well as in software advancement. Our leadership position in the Telco industry is further enhanced by our strategic alliances with leading industry players.

Additionally, our award-winning WiMAX modems have successfully completed interoperability tests with major WiMAX players and are being used by the world's largest WiMAX Operators. We are also the leading carrier solutions provider in APAC catering to both 4G and 3G networks and aim to be No. 1 globally by the end of 2010.

For more information, visit: **www.greenpacket.com**.