WaveRider®
The World's Wireless Web Company

IMPLEMENTING BROADBAND FIXED WIRELESS ACCESS SERVICES IN LICENCE-FREE FREQUENCY BANDS WITH THE WAVERIDER *LAST MILE SOLUTION*â

An Overview

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INTRODUCTION

Communications service providers face several challenges in the current marketplace as a result of fundamental changes in the regulatory environment, rapid technological advances and growing customer demand. In order to succeed in this new environment, service operators need to: 1) increase new service innovation and velocity; 2) decrease the cost of doing business; and 3) improve relationships with customers. However, in order to grow and capture market share, service operators need to expand their service coverage.

The next wave of Internet access via broadband technologies provides operators with the opportunity to meet these challenges and expand their coverage. In both the consumer and business markets, the demand for broadband Internet service is accelerating, driven by requirements ranging from the need for faster Internet connections, to the growth of data transportation and the emergence of e-commerce. The Yankee Group has predicted that the number of U.S. dial-up users will drop from 54.4 million in 2002 to about 40 million by 2007, while broadband will grow from its 2002 base of 16 million users to 41.7 million in 2007.

The demand for broadband services in the business market shows similar trends. For businesses, both large and small, broadband services are not seen as a discretionary expense, but rather as a necessity. The key issue for businesses is access. Service operators who are positioned to meet this demand for broadband services will enhance their role in the access market and, ultimately, the revenues they earn.

Operators need a cost effective and profitable solution to meet this demand for broadband access. WaveRider Communications has developed a turnkey fixed wireless access system, the LMS (*Last Mile Solution*â), which will enable network operators to exploit these opportunities by providing broadband communications services to the residential, small office/home office (SOHO), and the small/medium enterprise (SME) business markets

There are a number of broadband access technology options available to network operators. These include cable modems, xDSL and optical fiber. Each of these technologies has its advantages, but they are not available in all markets and in some markets it is not commercially feasible for network operators to deploy them. Wireless technology has emerged as a strong alternative for providing high-speed and high-quality access, particularly in markets where the wired broadband options are not available.

Because of the huge market potential for broadband, service operators are looking at fixed wireless technology to enhance their service offerings and to take advantage of the opportunities presented by this technology. In addition to examining this technology, network operators are investigating the issues and benefits in becoming a **W**ireless **I**nternet **S**ervice **P**rovider or WISP. Becoming a WISP presents not only significant revenue and margin

opportunities but allows network operators to target specific customer segments, thereby differentiating themselves from the competition.

In order to assist WISPs in the planning process, this paper examines the business and technical issues that a WISP needs to examine before implementing a fixed wireless access system such as WaveRider's LMS system.

FIXED WIRELESS ACCESS SYSTEMS

Fixed wireless access (FWA) systems can be classed as either licensed or license-exempt systems. The two principal licensed systems are Local Multipoint Distribution Systems (LMDS) and Multichannel Multipoint Distribution Systems (MMDS). LMDS operates in frequencies that range from 27-31 GHz. The principal advantage of LMDS is that with a total of 1,300 MHz available it contains more spectrum than any other commercial wireless service. Because LMDS systems operate at higher frequencies, the transmission distances are limited; consequently LMDS systems are deployed in dense urban markets in order to achieve sufficient payback on the capital investment. The principal markets for LMDS systems are large businesses, office buildings and multiple dwelling units. Because of the high cost of subscriber units and installation, LMDS is not suitable for providing services to the residential and SOHO markets. LMDS systems are also more vulnerable to interference from weather and other environmental conditions because they operate at higher frequencies.

MMDS operates in the 2.5-2.7 GHz frequency band and originally was designed for the delivery of television broadcasts to areas not supported by cable or broadcast television networks. Regulatory changes in the United States and other countries have approved MMDS spectrum for two-way communications, enabling MMDS spectrum holders to offer voice, data, Internet and video services over their networks. Current MMDS technology requires line-of-sight, therefore subscriber equipment installations are complex and expensive. The business case for deploying MMDS services to residential market is not attractive with current generation technology. This is because of the cost of subscriber equipment, which is in the range of $700 to $1,000 per subscriber, plus the cost of a truck roll to implement services for a residential subscriber. As a result, several MMDS operators have announced that they will no longer provide services to the consumer and residential markets.

Licensed frequencies for MMDS and LMDS operators are controlled by national regulatory authorities such as the Federal Communications Commission (FCC) in the United States and Industry Canada in Canada. The practice in Canada, the United States and in most countries is to sell spectrum licenses through an auction process to the highest bidder. As a result of the high prices paid for these licenses, operators who have spectrum licenses for LMDS or MMDS spectrum are usually large and well capitalized. The high cost to acquire a license and to deploy a wireless network is a significant barrier to entry for most operators.

License-exempt spectrum which encompass the Industrial, Scientific & Medical (ISM) bands in the 900 MHz and 2.4 GHz frequency range and 5 GHz U-NII band, are an attractive option for WISPs who want to obtain a rapid and cost-effective entry into their markets. In most countries, wireless products can be operated in the ISM bands without a license if the products do not exceed certain output power specifications. The principal benefits of the ISM bands is that there is no cost to use the spectrum, and equipment designed for the license-exempt bands is generally less expensive than equipment designed for the licensed bands. As a result, services can be delivered at a lower cost to the end user. License-exempt FWA systems have the following additional advantages:

- *Attractive business model* – FWA systems are scalable and can be deployed quickly with incremental capital investment. The majority of required capital investment is spent when a customer is set up, enabling the service provider to build the network as customers come online. As a result, return on investment is rapid and directly related to the number of customers.
- *Complementary to other technologies* – CLECs and network operators can use broadband wireless as a complementary option to xDSL, fiber or cable. Since fiber is expensive to deploy and cable and xDSL do not reach all businesses and homes, FWA is an effective solution to reach under-served residential and business customers.
- *Alleviates the bottleneck in the last mile* – although there have been significant improvements in network capacity; little has been done to improve the bandwidth that reaches the end-user. FWA provides an effective solution to alleviate this bottleneck.
- *Control over the network infrastructure* – a CLEC or an ISP who deploys a FWA system is not dependent on an ILEC or cable company, and as a result can control the quality of service delivered to its customers and at the same time maintain greater profit margins.
- *Rapid installation* – Once roof rights have been secured for base stations and cell sites, FWA systems can be installed in days rather than months or years.
- *No stranded assets* – If a customer moves or is shifted to a wired connection, radio equipment can be re-deployed in another location.

Fixed wireless access technology that operates in the license-exempt ISM bands (902-928 MHz and 2400-2483.5 MHz) utilize spread spectrum technology. Spread spectrum technology is a modulation technique that spreads data transmissions across the entire available frequency band in a prearranged scheme. This type of modulation makes the signal highly resistant to noise, interference, and interception. Spread spectrum technology also permits many users to share a frequency band with minimal interference from other users.

In the license-exempt bands, outdoor wireless bridges such as the WaveRider NCL series that utilize spread spectrum technology have been used by ISPs and other network operators to extend high-speed Internet access to their business customers. Most of these installations are used for point-to-point links for a wide variety of applications. Point-to-multipoint links has become more common with the introduction of newer features and functionality. Systems developed with wireless bridges work well in small markets with a few customers, however, many ISPs have discovered that the scalability and flexibility of these systems is limited. Lacking network and subscriber management capabilities, wireless bridges by themselves are insufficient for deploying a FWA particularly if there was a significant customer base and demand was growing significantly.

Another significant limitation of wireless bridges is that from a business case perspective, they are not suitable for servicing the residential or SOHO market. The cost of subscriber equipment needs to be significantly below $1,000 in order to service these markets profitably. Line of sight issues associated with wireless bridges operating in the 2.4 GHz and the 5.8 GHz bands also limit the size of the addressable market. The need for external antennas for equipment operating in this band adds significant costs to providing service to these clients because of the need to send experienced personnel to install antennas and equipment. Having equipment that can operate with an indoor antenna simplifies installation and reduces these deployment costs; making the business case for servicing this market more realistic and attractive.

THE WAVERIDER *LAST MILE SOLUTION*®

Recognizing the need for a scalable solution for network operators wanting to deploy a FWA system, WaveRider has developed the LMS4000 (Last Mile Solution®). The LMS4000 enables operators to deliver both business and residential Internet connections and services via a single fixed wireless system that operates in multiple license-exempt frequencies. Integrating the non-line-of-sight (NLOS) capabilities of WaveRider's 900 MHz product and the high-speed connection delivered by its 2.4 GHz products, the LMS4000 is the most flexible and scalable fixed wireless system available today.

The LMS4000 provides operators with a cost-effective way to deliver high-speed wireless Internet access. By providing network operators with an alternative solution to wire-based Internet access, the LMS4000 substantially reduces the ongoing operating costs of broadband Internet access. In addition to creating this new class of Wireless Internet Service Provider (WISP), the LMS4000 affords the benefits of higher levels of service and functionality to a WISP's subscriber base. The features of the LMS4000 are summarized in the following table.

900 MHz Non-Line-of-Sight Components	2.4 GHz Line-of-Sight Components
• True non-line-of-sight capability with WaveRider's user-installed wireless modem and indoor antenna • Includes WaveRider's Dynamic Polling MAC • Over-the-air data rate of 2.75 Mbps and access speeds of up to 2.0 Mbps • Operates in the 902 - 928 MHz license-exempt ISM frequency bands • Range of up to 2 miles with indoor antenna, up to 8 miles with outdoor antenna • Profitable solution to deliver high-speed Internet access to residential and small business subscribers	• Over-the-air data rate of 11 Mbps with throughput speeds of up to 8 Mbps • Operates in the 2.4 - 2.4835 GHz license-exempt ISM frequency bands • Includes high-performance Polling MAC • Delivers broadband access over a range of up to 10 miles • Provides a profitable business model to deliver broadband services to commercial customers

In designing the NLOS solution for the LMS4000, WaveRider sought to develop a system that would address the following requirements for a wireless broadband network servicing the residential, SOHO and small business markets:

1. A mass-deployable turnkey system with a price point that will compete favorably to DSL and cable:
   - Low capital costs for installed customer premise equipment (CPE) and infrastructure
   - DSL/cable-like availability
   - Scalable solution that be expanded to serve thousands of subscribers
   - Easy management and rapid provisioning
   - No, or limited, truck rolls

2. True non-line-of-sight coverage
   - Multi-cell with large radius (at least 1 mile) and frequency re-use (scalable)
   - User installable CPE
   - High service coverage (number of homes and businesses passed)

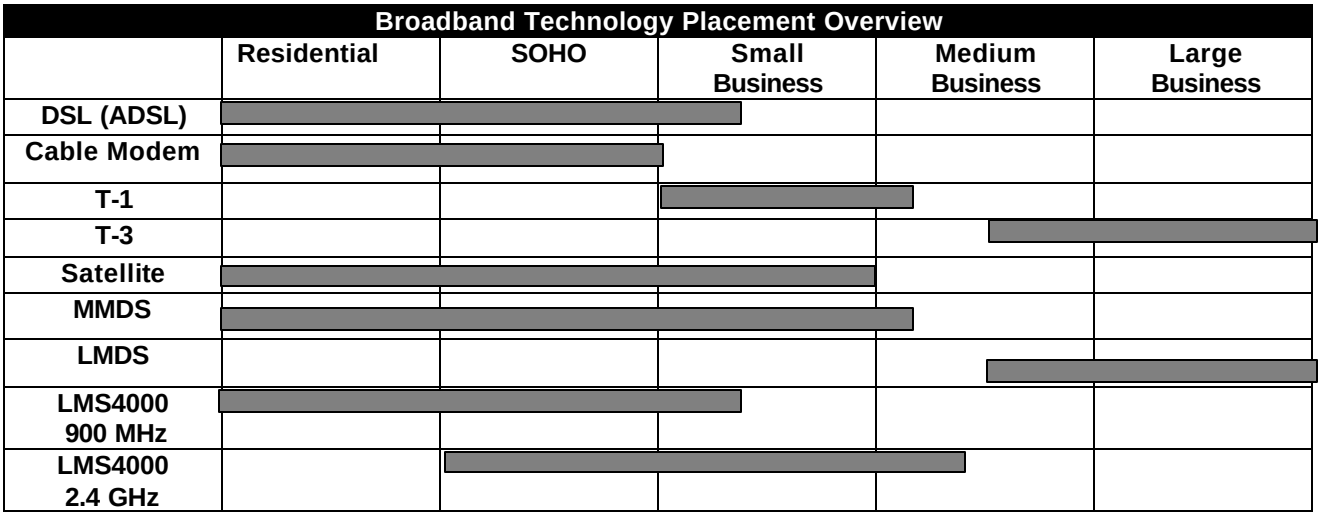
As WISPs move into the mass-deployment phase, they are demanding solutions that not only meet stringent NLOS, ease-of-installation and time-to-market requirements, but also aggressive cost targets. WaveRider's

LMS4000 provides a NLOS solution that provides these competitive advantages and enables WISPs to become legitimate competitors to cable modem and DSL service providers.

The LMS4000 provides WISPs with a strong business case for providing broadband wireless services to the consumer/residential and SOHO markets. Along with a competitive CPE cost, the NLOS capability has the potential to significantly reduce installation costs by eliminating or limiting the truck rolls needed to install subscriber equipment. The EUM3000 CPE is designed for user self-install, but in cases where the service operator needs to provide installation assistance, a customer can be connected in less than an hour with an indoor antenna. This compares favorably with typical installation times for LOS systems with an external rooftop antenna that requires about 4 to 5 hours to install. As a result, customers can be brought online more quickly using fewer resources, which increases revenue streams and profit margins.

The deployment of an LMS series network offers existing and future WISPs a number of substantial business benefits. The LMS network architecture is based upon a combination of cellular and local multipoint distribution system (LMDS) topologies, where cellular-type approaches are used for wide area coverage, and the LMDS approaches are used to provide high performance levels. This unique architecture of the LMS series permits scalable network growth as market demand dictates, while at the same time providing a high degree of reliability and redundancy via overlapping service coverage areas and a distributed control/routing subsystem. This translates into low network start up costs, as initial network deployments can be limited to primary target markets and the network later expanded as demand increases.

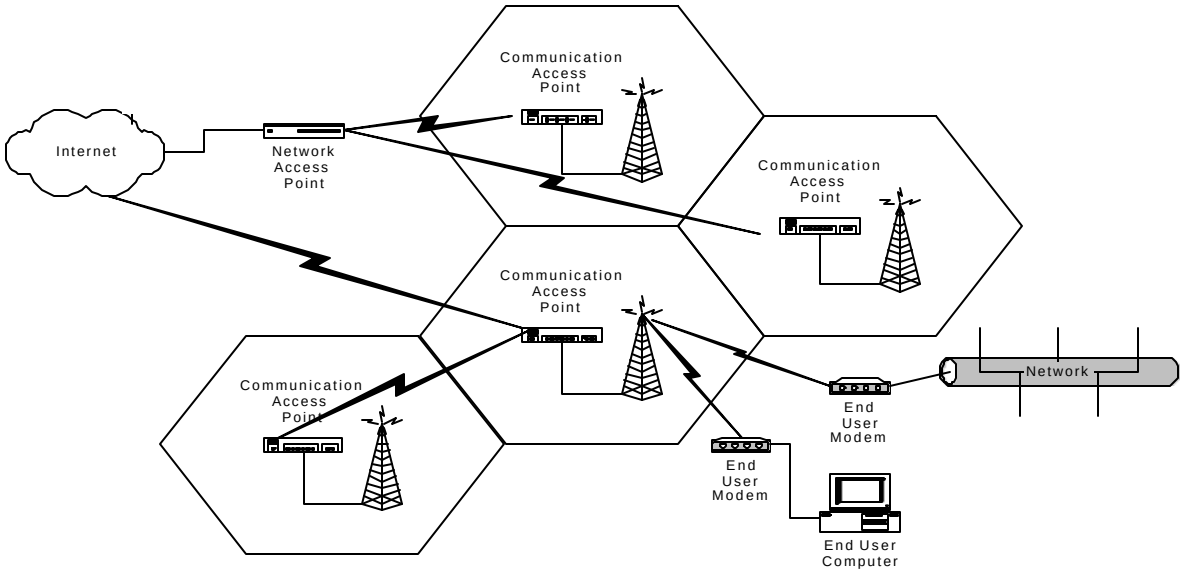
As well as scalability, the LMS series enables the delivery of a portfolio of access services based on data speed and access priority. In contrast, this ability to provide differentiated services is not possible with many wired broadband services such as DSL or cable modems. With the capability to develop a differentiated service portfolio, WISPs can offer services to the business, SOHO and consumer market segments that are tailored to each customer group's needs. With raw Internet access speeds ranging up to 11 Mbps, the LMS series addresses the reality of today's market needs while ensuring tomorrow's requirements for speed are satisfied. The following table illustrates how the LMS can be positioned to meet the broadband requirements for different market segments.



LMS4000 SYSTEM OVERVIEW

The basic building blocks for a LMS system, illustrated below, include the following:

- Network Access Point (NAP) – provides system access to the Internet and system management.
- Communications Access Point (CAP) – is the base station that provides the "last mile" connectivity between the end-user modems and the Internet. A CAP can consist of 6 Cap Channel Units (CCUs) depending on the number of subscribers and frequencies supported.
- Wireless Modem – connected to a LAN or directly to a PC, the wireless modem communicates with the CAP to connect to the Internet.



LMS System Architecture

CAP Features and Functionality

The CAP provides the following services:

- Wireless modem airlink
- Data connectivity between the NAP and wireless modems.
- Support for user authentication
- Data distribution to end users in the CAP serving area
- Enhanced Operation, Alarms and Maintenance
- Redundancy

CCU3000 900 MHz Base Station

- Supports up to 300 end user modems (EUM3000) per base station (CCU3000)
- Operates in the 902-928 MHz ISM band using DSSS (Direct Sequence Spread Spectrum) technology
- Up to 2.7 Mbps raw data rate or 2 Mbps user data throughput
- High Performance Passive Band-Pass Filters
- Build-in static and Rip-2 Router Functionality
- Remote or local configuration with easy-to-use Windows GUI or telnet

- Fully SNMP managed
- Support for high gain 900 MHz Omni and Sectoral antennas
- High output power: +26 DBm eliminates the need for external amplifiers
- Scalable cellular architecture
- Dynamic Polling Mac provides:
    - Supports up to 300 subscribers per CCU3000 channel (CCU) or 900 subscribers per CAP
    - Automatic load balancing
    - Integrated Grade of Service Control
    - Eliminates the Hidden Node Problem
    - Dynamic Polling allocates bandwidth to active users
    - IP Port Filter
    - DHCP Relay Function
    - Utilities for faster installations and better diagnostics
    - Multiple PC's supported by a single EUM
    - EUM Authentication and Registration
    - SNTP Network Time Program

CCU2000 2.4 GHz Base Station

- FCC/IC approved for license exempt operation in the 2.4 GHz ISM band using DSSS (Direct Sequence Spread Spectrum) technology
- High Performance Passive Band-Pass Filters
- RF Surge Suppressors
- Remote or local configuration with easy-to-use GUI
- Up to 11 Mbps raw data rate or 8 Mbps data throughput
- Includes high performance Polling MAC architecture for superior point to multipoint performance
- High output power: +25 DBm eliminates the need for external amplifiers
- Scalable cellular architecture
- Supports up to 30 subscribers per channel unit

Wireless Modem Features and Functionality

EUM3000 900 MHz Modem

The EUM3000 modem is the wireless customer premises equipment that provides RF connectivity between the LMS4000 and the user's network or computer. The EUM3000 is a compact design for desktop use (8.2" x 5.2" x 1.5"). The EUM3000 serves as a wireless modem connecting the radio to a 10BaseT interface. It provides a user throughput of up to 2 Mbps.

The EUM3000 Indoor Antenna is a diversity receive antenna with optimized performance for an indoor environment. It is a convenient 6.2" x 6.2" x 2.2" size, and includes a mounting bracket to mount the antenna on a windowsill or wall. The antenna can be easily directed to get an optimized signal from the LMS4000. Alternative outdoor antennas can be used in line-of-sight applications to achieve connections over greater distances.

EUM2000 2.4 GHz Modem

The EUM2000 modems are used for commercial Internet access. They provides the end user with wireless Internet connectivity in the 2.4 GHz ISM band using Direct Sequence Spread Spectrum access technology with raw data rates up to 11 Mbps or useable data rates of up to 8 Mbps, and cover an area with radius up to 10 miles (16 km) with LOS outdoor antennas. These modems incorporate a proprietary polling MAC that provides excellent point to multipoint performance.

The End User Modem is the customer premise equipment that provides RF connectivity between the LMS4000 CAP and the user's network or computer. Connectivity is via standard 10Base T with layer 3 routing providing fast, reliable, flexible communications with ease of installation. Static and RIP routing at the End User Modem is standard.

EUM2000 Front Panel

EUM2000 Rear Panel

Dynamic Polling MAC

The Dynamic Polling MAC (PMAC) includes several enhancements that significantly improve the performance and operational efficiency of WaveRider CCU3000 and EUM3000 products was introduced by WaveRider in April 2002. The Dynamic nature of the Polling MAC is a feature that reduces the number of polls to inactive users. The result is that minimal channel capacity is wasted polling inactive devices, allowing large numbers of subscribers to be "always on". WaveRider's proprietary polling algorithms maximize throughput for up to 300 stations in Point to Multipoint mode. Compared to CSMA/CA, WaveRider's polling MAC dramatically reduces throughput-robbing packet collisions. In a point to multipoint mode polling can increase effective throughput by up to 500%. Among with higher data rates and subscriber capacity, the PMAC provides these additional benefits:

- **Automatic load balancing –** The CCU3000 Dynamic Polling MAC allocates available channel capacity "fairly" among all of the users on the channel. This prevents a very active user from dominating or hogging the channel at the expense of other users. This capability can ensure that all users on a channel get a share of capacity.

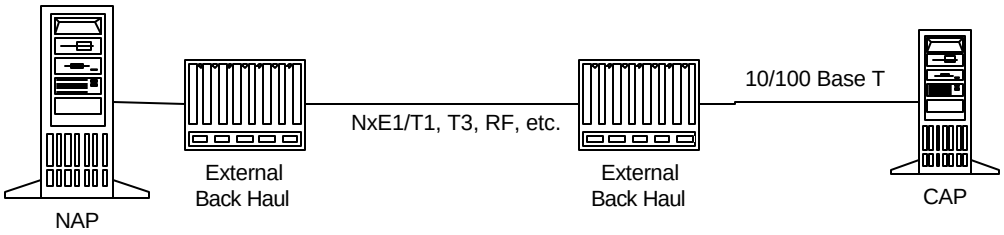
- **Integrated Grade of Service Control** – GOS control provide a level of bandwidth control right within the WaveRider CCU3000 and EUM3000 devices. This feature allows a network operator to set up to four levels of service within a CCU3000. For example, some users can be set as standard priority residential users limited to 384 kbps, while other users could be high priority business users.

- **Eliminates the CSMA/CA "hidden node" problem –** Point to Multipoint communication using CSMA/CA is often bogged down by the "hidden node" problem: frequent and continual packet collisions and retries caused when station units cannot "hear" each other directly, and therefore often transmit packets simultaneously. The CCU3000 Dynamic Polling MAC eliminates this problem.

Backhaul Requirements

Moving data between the CAP and NAP requires the deployment of network backhaul facilities.

The data backhaul connection at the CAP is 10/100 Base T. This may be directly connected to the NAP or via an



external backhaul device as shown above. A variety of backhaul options can be utilized including WaveRider's NCL wireless bridges, licensed microwave radios, T1/E1 lines or xDSL lines.

LMS4000 BUSINESS CASE

In advance of any deployment, a service operator needs to develop a business plan and model that can identify the capital expenditures and revenue potential of the planned system. WaveRider has developed financial models and tools that enable the service operator to assess potential return on investment. WaveRider can also provide assistance to the WISP in developing a business model to assist in optimizing costs and determining investment paybacks to raise investment capital or to secure financing.

Among many service providers trying to enter new markets there appears to be a significant "build it and they will come" flaw. For example with many wired broadband technologies, significant investments are made in infrastructure to pass every home or business in order to meet anticipated demand in particular area. The LMS provides the operator with the flexibility to deploy and target areas where there are existing customers. In addition it is a scalable system, enabling the operator to build and expand the network as customers are added in order to meet actual demand.

The process of developing a business case is unique to each WISP. The information required to develop a strong business case includes:

- Target market identification and proposed coverage area
- Service definition and pricing
- System equipment requirements and specifications
- Network deployment schedule

Target Market Identification

Sizing the potential market is usually the first part of any planning exercise. Assessing the size of a market involves more than demographic analysis, there are several elements which need to be examined in order to obtain an accurate estimate. In looking at opportunities in the SME and SOHO sectors, the WISP should begin by obtaining statistical information on the number and types of SME and SOHO enterprises in the target area. These numbers provide a base level on the size of the target market. The next step is to identify the proportion of the target market which is likely to require high-speed Internet access. This is accomplished by examining the following issues:

- Existing and potential customer usage patterns, characteristics and requirements
- Availability (or lack) of alternative high-speed access services
- Level of competitor activity and competitive pricing factors
- Satisfaction with existing providers and access services

SME and SOHO customers, depending on the nature of their business and telecommunications requirements, are willing to pay a premium for high quality, reliable service, and have a need for high-speed data transmission. Although there may be existing high-speed services available to these customers, a wireless solution can be positioned as a cost-effective alternative.

The presence of competitors in the target market also needs to be evaluated. The WISP needs to understand the position of all competitors in terms of their service offerings and pricing. A basic SWOT (strengths, weaknesses, opportunities and threats) analysis can provide a good snapshot on the nature of the competition in a particular market. A competitor profile can be created by looking at the following factors.

Strengths and Weaknesses	Opportunities and Threats
• Financial resources	• Service offerings
• Technology deployment	• Pricing
• Customer service	• Market position
• Management	• Customer segment profile
• Marketing	• Geographic coverage
• Strategic alliances	• Customer satisfaction

By evaluating the competitive landscape, a WISP can obtain a good indication of the risks and rewards of the proposed venture. This assessment will enable the WISP to establish some assumptions on how a new wireless service will be received by its existing customer base and how it can attract customers from a competitor. In addition, a profile will provide a good indication as to how competitors will react to the introduction of a new service in the market.

Service Definition and Pricing

Utilizing the market information obtained on the market demand and competitive landscape, the WISP can then identify the types of services that offer the best growth and profit potential. WaveRider's LMS system gives the WISP control over the "last mile" to their customers. Unlike cable modem or xDSL service, where the infrastructure is owned and maintained by a telco or cable company and the service provider only has access rights, the LMS is owned and maintained by the WISP. This additional control over the infrastructure enables the WISP to tailor services for their target market, ensure that the quality of service is maintained to achieve high levels of customer satisfaction, and react quickly to changes in customer requirements.

The other advantages of the LMS are its network and subscriber management capabilities. The Dynamic Polling MAC of the 900 MHz system supports up to four customer grades of service GoS. The WISP can deliver wireless access to targeted customers at speeds that match their requirements. Unlike a "one speed fits all approach" offered by most systems, the LMS enables the WISP to maximize the use of system resources and profit margins, and at the same time maximize value to their customers. With the ability to offer different service levels through GoS and different frequencies, the WISP can approach different customer segments and ultimately establish different revenue streams.

Once the service levels have been defined and the pricing established, the WISP can then develop a revenue model based on the target market projections. A typical revenue model can include the following elements as outlined in the example below of a small community of about 10,000 households and 2,000 businesses. The LMS is a scalable solution that can be expanded as demand dictates. The LMS provides the operator with the capability to install systems with as few as 5 or 10 subscribers, and then scale that system up to thousands of users. A 900 MHz base station or CCU can support up to 300 subscribers. A cell site can consist of up to 3 CCUs that can support up to 900 subscribers.

900 MHz RESIDENTIAL AND SOHO MARKET REVENUE MODEL

	Year 1	Year 2	Year 3	Year 4	Year 5
Market Size	10,000	10,200	10,400	10,600	10,800
Uptake Rate	20%	25%	30%	35%	40%
Market Share	10%	15%	20%	25%	30%
Projected Clients	**200**	**383**	**624**	**928**	**1296**

Service Definition	**BE-384 Kbps**	**BE-1 Mbps**	**128-256 Kbps**	**256-512 Kbps**
Subscribers	35%	30%	25%	10%
Monthly Charge	$ 30	$ 40	$ 60	$ 75

Revenue	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**
64 Kbps	$ 25,200	$ 48,195	$ 78,624	$ 116,865	$ 163,296
128 Kbps	$ 28,800	$ 55,080	$ 89,856	$ 133,560	$ 186,624
256 Kbps	$ 36,000	$ 68,850	$ 112,320	$ 166,950	$ 233,280
512 Kbps	$ 18,000	$ 34,425	$ 56,160	$ 83,475	$ 116,640
Total	**$ 108,000**	**$ 206,550**	**$ 336,960**	**$ 500,850**	**$ 699,840**

2.4 GHz BUSINESS MARKET REVENUE MODEL

	Year 1	Year 2	Year 3	Year 4	Year 5
Market Size	2,000	2,100	2,200	2,300	2,400
Uptake Rate	30%	35%	40%	45%	50%
Market Share	15%	20%	25%	30%	35%
Projected Clients	**90**	**147**	**220**	**311**	**420**

2.4 GHz Service	
Subscribers	100%
Monthly Charge	$ 250

	Year 1	**Year 2**	**Year 3**	**Year 4**	**Year 5**
Total	**$ 270,000**	**$ 441,000**	**$ 660,000**	**$ 931,500**	**$ 1,260,000**

TOTAL REVENUE	**$ 378,000**	**$ 647,550**	**$ 996,960**	**$ 1,432,350**	**$ 1,959,840**

These revenue projections provide a high-level overview of the potential of a target market. The obvious conclusion from these projections is that the average revenue for each business customer is significantly higher than the average revenue for each residential or SOHO customer. What is not evident is the cost of providing service for each type of customer. In addition to the cost of the subscriber equipment, there are other costs that need to be considered before a service provider can establish to total cost of providing service to a customer. To a large extent the location and the density of potential customers in a particular location will affect these costs. As a result, the service operator needs a thorough understanding of where these customers are located in their coverage area.

For example, are the majority of the business customers located in a business park, or are they spread out throughout the region? If most of them are located in a business park then it is possible that one CAP could provide service to this location. If the customers are spread out more CAP sites are required and this increases the network infrastructure costs. WaveRider can assist the service operator in assessing these requirements through its LMS System Implementation Process (see below).

System Requirements and Specifications

Although the system requirements and specifications determine the cost elements of the business case, there are several elements which have to be defined before the final system specifications can be prepared. The total cost of a system depends on a number of different factors:

- The portfolio of defined services will have an impact on the core network architecture.
- Estimated market demand will determine system capacity requirements.
- Redundancy requirements necessary to ensure system availability in the event of equipment failure.
- Rooftop and tower acquisition and rental costs for CAP and EUM antennas.
- Installation costs for antennas, end-user and network system equipment.
- Engineering expenditures for cell planning and network design.
- Backhaul requirements to link remote CAP sites to the NAP.
- Customer technical support and system maintenance costs.
- Sales and marketing expenditures to support service introduction and rollout.
- Financing costs for equipment and other capital expenditures.

For the operator who is not experienced in providing wireless services there are other expenditures which should be anticipated. These include staff training or the acquisition of staff with RF engineering backgrounds and experience.

The objective of the WISP is to deploy services in markets where the quickest payback and highest return on investment can be achieved. The decision to provide wireless services to a particular customer simply requires an assessment of the revenue potential for that customer versus the cost of providing those services. In order to ensure that other costs are covered and that it is a profitable installation, WISPs should expect a payback on their investment within 12 to 18 months.

In assessing the payback potential for a target market, the system operator needs to identify the revenue potential based on the number of customers, service and revenue mixes and penetration rates. The calculated revenue potential should then be compared with deployment costs to determine the potential return or payback on investment. The greatest yield of high profitability sites can then be identified. CAP sites can then be designed and deployed to achieve the highest profitability.

In advance of any system deployment there is much work that has to be performed. WaveRider has developed business-modeling tools to assist the operator in network planning and deployment. Coupled with WaveRider's technical expertise and assistance, the network operator can be assured that the necessary groundwork will be laid to ensure a successful system deployment.

LMS4000 SYSTEM IMPLEMENTATION

For operators who require engineering and project management assistance to design and deploy an LMS4000 network, WaveRider's Professional Services Group (PSG) has devised an implementation process to ensure that systems can be deployed in the most-effective manner by optimizing available resources and reducing time to market. Prior to the implementation process, WaveRider works closely with service providers to evaluate proposed system deployments by preparing business case models and preliminary network designs. By undertaking a vigorous needs analysis and outlining the objectives of the proposed network, both WaveRider and the service provider can obtain a preliminary assessment of the feasibility of a network before proceeding with the implementation of the system.

PSG can undertake a number of deployment tasks depending on the capabilities and the requirements of the operator. For example the WaveRider PSG team can prepare a site survey. This survey assesses existing IP resources to determine if they are adequate to support the proposed wireless network. A RF survey is then commissioned to check radio propagation characteristics of the area in which the network will be deployed. Concurrent with these studies, the service provider will investigate site acquisition for NAPs, CAPs and other system network infrastructure. Data from the IP and RF surveys and the service provider's investigations is then

used to complete a Network Feasibility Assessment which will outlines system requirements and options, including:

- IP capabilities and upgrade recommendations
- RF spectrum occupancy and problem areas
- Construction requirements
- Backhaul and infrastructure requirements
- Estimates on capital costs and other implementation expenses

Using data from these studies, WaveRider works with the service provider to review and modify the business case model to complete an assessment of the feasibility of the proposed network. The system project plan is then developed. WaveRider's PSG team working with installation and systems integration partners completes the project definitions and specifications. The activities in this stage include:

- Site requirement specifications verified and finalized
- RF Design developed
- System Design completed
- Construction schedule proposed

The final or implementation stage has a number of concurrent activities. At this stage the customer receives intensive training on the LMS system. The training covers all aspects of system operation and configuration. Once the customer has received training, WaveRider will work with the customer to develop a Network Test Plan appropriate for the customer's network configuration.

Construction and installation of the system begins at this stage once all the civil, mechanical and electrical approvals have been obtained. Equipment for the NAP, CAP and initial customer installations is then delivered to the customer. Following the completion of the installation, the system undergoes testing and results are reviewed in accordance with the baseline parameters established under the Network Test Plan. Corrective actions are taken if required following the test. Customer acceptance of the system is then obtained once the system has met the criteria as outlined in the Network Test Plan.

CONCLUSION

This brief White Paper has covered just some of the issues and benefits in deploying the LMS FWA system. The market opportunities are significant, and the LMS is a turnkey solution that is available today and can grow to meet the demands of customers tomorrow. The LMS provides a cost-effective broadband solution characterized by ease of installation and maintenance, rapid deployment, flexibility and scalability. It can be used to complement existing services or as a stand-alone solution for new market opportunities where the options for broadband access are limited or prohibitively expensive.

For additional information on the LMS visit WaveRider at ***www.waverider.com***.

To request additional information: via email: ***info@waverider.com***

Our Sales Department can also be reached by telephone at 416.502.8657