# Feasibility Study:
# Deployment of a Wireless Network in Folsom

**November 8, 2005**


**Prepared by Tellus Venture Associates,**
**in collaboration with Coast2Coast Technologies,**
**for The City of Folsom, California**

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# Executive Summary

## Objective

As Folsom continues to grow and develop, the City recognizes the importance of having convenient, high-speed Internet access and other advanced data networking facilities available throughout the community. A ubiquitous wireless network offering broadband levels of connectivity has the potential for being a key economic development driver for Folsom. The City requested proposals from industry consultants to conduct a feasibility study for such a project. As a result of that competition, Tellus Venture Associates was selected to provide the necessary information and data to allow the City to assess whether a community-wide, wireless network deployment in Folsom is not only viable technically but, just as important, can also be financially successful.

## Market Overview

The entire City of Folsom appears to be well served by existing, "wired" Internet service providers and has a variety of wireless Internet services available in many different locations. This excellent infrastructure is due partly to the fact that much of it has been built relatively recently, and partly to the fact that the City, its businesses and its residents have a high-technology orientation and have been keener than most to adopt new data networking technologies.

The next generation of mass-produced wireless networking technology will be based on the WiMAX standard, which is due to be finalized early next year. Once adopted, this standard will allow consumers, small businesses, large institutions and corporations, or networks of professionals and businesses with a common interest, such as the health care community, to wirelessly connect to each other and access the Internet. Leading companies with a central role in the development of WiMAX technology are already well represented in the City of Folsom.

Equipment based on the older WiFi standard is increasingly widespread, and new applications are constantly being developed for general use by the public and for internal use by municipalities. WiMAX technology complements WiFi technology by making it faster and less expensive to deploy, and by making it easier for companies to pursue the sort of public/private partnerships that are developing in many cities around the country.

At the same time, major Internet service providers (ISPs) are facing a crisis. The Federal Communications Commission (FCC) has ruled that incumbent telephone companies, such as SBC, do not have to allow third parties, for example Earthlink and AOL, to resell DSL service. Consequently, these large ISPs will have to find other means to provide advanced broadband services to subscribers. This ruling will take effect the middle of next year.

This combination of a technology-oriented community, leading technology companies and service providers worried about survival provides the foundation for the creation of a ubiquitous wireless broadband system in the City of Folsom that can start small, adapt to changing technology and market conditions, and grow over time to serve a diverse range of needs.

## Conceptual Design

The WiMAX-suitable radio frequency spectrum in Folsom is very lightly used, which offers a near term window of opportunity. In unlicensed bands, the first to arrive have a significant advantage, and licensed frequencies will only become scarcer as time goes on. The sooner the system is built, the more successful it is likely to be. If a system operating in an unlicensed band is successful, it should be possible to expand into licensed bands as it grows, if doing so seems advantageous.

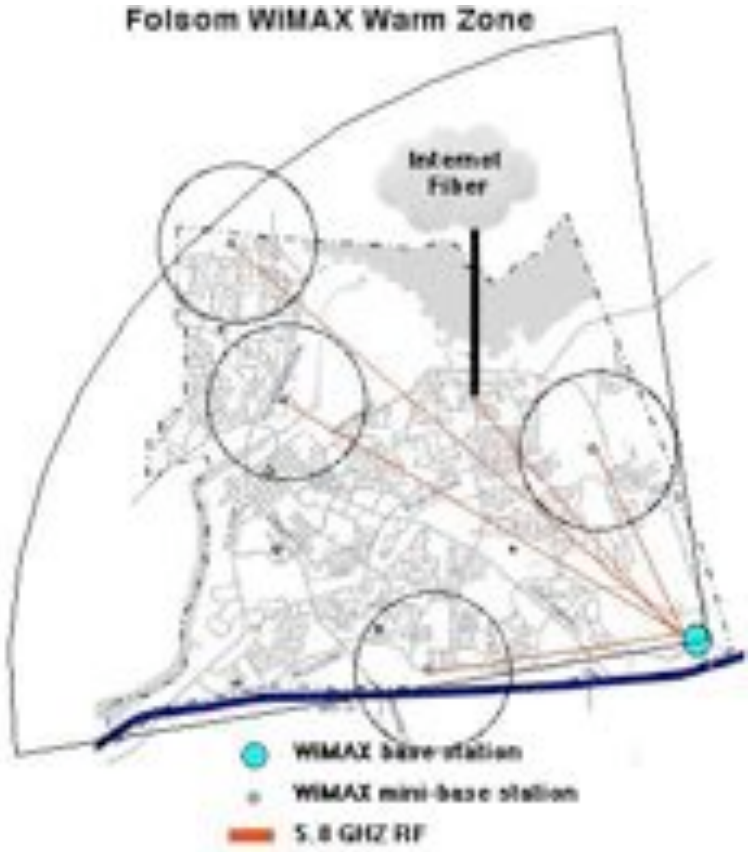


**Figure 1: WiMAX "Warm Zone" for the City of Folsom.**

Rather than making the entire City a WiFi "hotspot" as some municipalities are doing, the City of Folsom would be better served by creating a citywide WiMAX "warm zone". Private entrepreneurs could add WiFi hotspots in suitable locations, while the entire City could eventually see the benefit of ubiquitous broadband access. WiMAX technology is designed to provide citywide "back bone" coverage, while WiFi is best suited for more casual, short-range use. The two technologies complement each other well.

## Business Model

A series of business models and scenarios were developed from the conceptual, WiMAX-centric design. This approach takes advantage of the considerably lower cost of using WiMAX to cover metropolitan-scale areas, while opening the door for private ventures to fund and deploy WiFi

networks and other technologies where it makes sense financially. One objective was to insure that income covers ongoing operating expenses by the second year of operation and that the initial capital investment can be paid back out of operating surpluses, sooner rather than later. By relying on large institutional users, revenue can be secured before major costs are incurred.

Four different business model scenarios were developed and analyzed. The first is the "base business model", which assumes that a Folsom-wide wireless broadband system would be a fully self-contained enterprise, with independent finances.

| Scenario | Assumptions | Capital Required ($000) | Years to Positive Cash Flow | Years to Break Even | 5 Year IRR | 10 Year IRR |
|---|---|---|---|---|---|---|
| Base Business Model | Self contained, self supporting business | $174 | 3 | 7 | (15.6%) | 21.8% |
| ISP Partner Scenario | Major ISP brought in as operating partner | $128 | 2 | 4 | 46.9% | 65.5% |
| Local Consortium Scenario | Joint commercial venture, resource sharing by major users | $106 | 2 | 4 | 28.5% | 51.5% |
| Membership Scenario | Private joint facility, only for partners | $83 | 2 | 6 | (4.5%) | 16.7% |

**Table 1: Folsom wireless broadband system scenario comparisons. IRR means internal rate of return, which measures the effective return on investment produced or expected to be produced by project expenditures.**

The second scenario assumes that an existing Internet service provider (ISP) would be brought in as an operating partner and, potentially, as an investor. The third scenario envisions the creation of a local consortium of major institutional users to own, manage, operate and be served by the system. Groups of associated professionals and businesses, such as health care providers, might also participate. Finally, a "membership" scenario was considered. In this scenario, service would not be offered to the public. Instead, the system would be jointly financed and run as a private, shared facility by a handful of large users.

The base business model, which is built around a standalone, profit-oriented venture, would eventually pay for itself, but would not generate a return on investment sufficient to justify the risk involved. Both the ISP partner and local consortium scenarios improve on the base model, primarily by reducing costs through economies of scale, and by leveraging existing assets. Risk is reduced in the ISP partner scenario by bringing in an experienced player, and by securing advance revenue commitments in the local consortium model. The membership scenario is not intended as an investment-oriented enterprise, but the analysis shows that a few large users could justify the cost of the core system elements simply on the basis of internal needs.

## Conclusions

A wireless broadband system serving the entire City of Folsom is technically and financially feasible. WiMAX technology will make it possible to create metropolitan-scale wireless

broadband networks that are compatible with mass produced consumer-grade products, enabling a wide range of services that can be accessed by everyone.

The necessary capital outlay is on the order of one-tenth of what would be required to achieve the same service level with the current generation of technology. Combining a WiMAX overlay network with exiting WiFi, public safety and other mobile technologies, and with existing wired networks will help to create an integrated telecommunications system that will add to the value of incumbent service providers' existing investment, and promote community cohesiveness and economic development.

This study has concluded that:

- Market, technology and regulatory developments are coinciding to create a window of opportunity for the deployment of a city-wide wireless broadband system in the City of Folsom over the next one to two years.

- Partnerships with local companies and institutions, and with existing service providers can greatly increase the financial attractiveness of such a venture, reduce its risk, and insure that it remains focused on the changing needs of the community.

- The geography and current wireless technology usage in the City of Folsom make it well suited to the rapid deployment of next generation WiMAX-standard wireless service, once the standard is finalized early next year.

- The current wireless data networking needs and budget of the City of Folsom, as well as other large public and private organizations, are consistent with the capabilities and cost of a WiMAX standard system.

**Recommendations**

To take advantage of these conditions, the following next steps are recommended:

1. Establish a pilot project that stakes a claim on available and currently unused wireless spectrum in the City of Folsom, and can be used to assess and validate both the technology and the associated business case going forward.

2. This pilot project should begin as a small scale public-private partnership that minimizes cost and risk by using existing City of Folsom facilities and complementing existing research and development efforts by companies located in Folsom. It is estimated that the value of the required WiMAX or pre-WiMAX equipment will be in the $15,000 to $30,000 range, however in-kind contributions of equipment and facilities will keep actual out-of-pocket costs low. Likewise, it is expected that associated technology assessed during the pilot project will be made available on a loan or in-kind contribution basis.

3. Interested local residents, businesses and institutions should be offered a chance to assess the results of the pilot project at key points.

4. Existing Internet service providers (ISPs) should be kept aware of the pilot project's progress, and encouraged to explore opportunities to participate as partners in a later stage.

5. Once the WiMAX standard has been finalized and first generation technology can be assessed, a small group of local organizations and/or people with suitable needs should be formed as the core users and stakeholders in the system.

6. This core group, with the participation of existing service providers if appropriate, should determine the initial technical design and business structure of a city-wide, WiMAX-based broadband enterprise for the entire City of Folsom, and offered the opportunity participate in a self-funded expansion of the pilot project.

7. Once the initial technical and financial parameters have been established, this enterprise can be funded and launched on a scale and timetable that best suits the available technology and equipment, and the real-time needs of the market.

This approach allows the City of Folsom to quickly position itself to take advantage of current opportunities by claiming unused wireless spectrum and involving key prospective customers and partners in jumpstarting the creation of the system.

**Timeline**

| Step | 4Q05 | 1Q06 | 2Q06 | 3Q06 | 4Q06 | 1Q07 | 2Q07 | 3Q07 |
|---|---|---|---|---|---|---|---|---|
| Identify potential City facilities | • | | | | | | | |
| Recruit local R&D resources | • | | | | | | | |
| Involve ISPs | • | | | | | | | |
| Install prototype facility | | • | | | | | | |
| Finalization of WiMAX standard | | • | | | | | | |
| Community-based evaluation | | • | | | | | | |
| Form core stakeholder group | | | • | | | | | |
| Self-funded pilot project expansion | | | • | | | | | |
| DSL resale ruling takes effect | | | | • | | | | |
| Determine design & organization of city-wide broadband enterprise | | | | • | | | | |
| Fund enterprise | | | | | • | | | |
| Issue RFPs | | | | | | • | | |
| Launch full city-wide service | | | | | | | | • |

**Table 2: Timeline (in Calendar Years) to launch citywide wireless broadband system in the City of Folsom.**

By moving fast with a low-cost pilot project, risks and benefits can be minimized and properly assessed by all concerned. At the appropriate time, when the technology and the market are ripe, this pilot project can be converted into a community-focused enterprise built on revenue and other assets committed in advance by early stakeholders.

## Market Overview

The City of Folsom takes in approximately 22 square miles of territory, some of which is uninhabited open space or lake area. The 2000 Census found 48,656 people living in the City, comprising 17,196 households. The current non-prison population is estimated to be 57,233, with an eventual build out of 69,333 people in 2009.

There are about 2,300 businesses in Folsom, with the largest employer by far being Intel with 7,000 workers. It's estimated that about a third of the Intel workforce lives in the City of Folsom. Other major employers include the State of California, Verizon, Agilent Technologies, a variety of retailers and technology companies, and the hospitality industry. Folsom is also fortunate in having two major health care facilities, with a diverse network of associated health care providers, that could greatly benefit from improved information and networking technology.

Geographically, Folsom enjoys proximity to the highest point in Sacramento County, the 858-foot Carpenter Hill. The City tends to be hilly, but not overly so. Although uneven terrain can present some problems for radio-based services, it can also provide benefits, and the advantages of Folsom's geography appear to significantly outweigh the disadvantages.

### Existing Service

Folsom appears to be well served by Internet access providers. The two major incumbents, Comcast and SBC, provide high-speed Internet access via relatively new plant.

Digital Path Networks and its partner Earthlink, also offer high-speed Internet access via proprietary wireless technology in the Folsom area, although the service is not currently available everywhere in the City. Verizon offers a lower speed wireless Internet service via its cellular telephone network. In a number of other major metropolitan areas, Verizon offers a more advanced service. The company intends to expand availability of the higher speed service, but has not announced specific plans to do so in the Sacramento metropolitan area.

There are more than 30 WiFi hotspots in the City limits, including wireless access at the City's aquatic center and the downtown historic district. Starbucks, Borders, McDonalds and many small businesses offer wireless Internet access, either for free or on a paid basis. As the spectrum survey demonstrated, Folsom has a high density of existing WiFi users, no doubt due in large part to the many Intel employees who live in town.

### Potential Operating Partners

The FCC's August 5, 2005 ruling that ends mandated access by third-party resellers to telephone company-owned DSL lines should increase what is already growing interest by those resellers in wireless broadband technology. Earthlink is one such company, and it already has a partnership with Digital Path Networks to provide wireless Internet service in Folsom.

There are many other DSL resellers who will have to change their business models, among them AOL, AT&T and Covad. The FCC allowed resellers a one-year grace period to make the

adjustment. Some are already known to be evaluating WiMAX, the rest can assumed to be doing the same: replacing lost DSL resale revenue and associated growth will be essential to their survival. This changeover has created an opportunity for new players to form partnerships with established companies with significant customer bases.

DirecTv is also investigating wireless technology. Chase Carey, DirecTv's CEO, stated on August 4, 2005 that the company is "actively engaged" in looking for ways to enter the wireless broadband area. Alvarion, a major pre-WiMAX manufacturer, is negotiating with DirecTv to supply equipment. There are also reports that DirecTv is seeking out other potential service partners.

Verizon is the third largest employer in Folsom, and although its primary focus is on its cellular network, the company has also taken a position in the WiMAX world. In Grundy, Virginia, Verizon has built a pre-WiMAX wireless broadband system serving a market of 1,400, also using Alvarion equipment.

**The Opportunity**

New technology and recent regulatory rulings have combined to create a window of opportunity for the deployment of citywide wireless broadband infrastructure, and to continue to position the City of Folsom as a leader and innovator.

Typically, high capital costs provide a significant barrier to entry for new companies that try to enter the broadband services game. Before the dot-com bust, WINfirst tried to do it in the Sacramento area and ended up in bankruptcy. The Roseville Telephone Company, now SureWest, bought up approximately $100 million worth of assets for about $12 million and is making significant inroads into the local cable television, broadband and telephone market. A business model that was a flop when it cost $100 million to initiate can succeed when the cost of entry is discounted by 90%. However, such opportunities are rare.

The timing appears to be good for creating wireless broadband partnerships. The finalization of the WiMAX standard allows ventures to claim a presence on unlicensed frequencies, and to make use of licensed spectrum assets. It coincides with the end of the DSL reselling business, creating a unique window of opportunity to enter the broadband services business with a comparatively small capital investment while at the same time leveraging the operating experience, ongoing revenue and existing assets of well-capitalized partners. The business model well supports a partnership with such an established industry partner. It also provides opportunities for new or existing WiFi hot spot operators to expand coverage within the City or to realize greater operating efficiencies.

## Business Model

The business model for a wireless broadband system in the City of Folsom is based on the "WiMAX Warm Zone" design elaborated below. A WiMAX base station would be installed on Carpenter Hill, the highest point in Sacramento County, and used to provide blanket wireless broadband coverage of the City of Folsom. This base station would be supplemented by mini-base stations throughout the City, which would provide coverage in pockets that cannot be well served from Carpenter Hill, either because of obstruction or distance.

Four scenarios are considered. The first is the "base business model", which treats the system as a stand-alone company. In other words, a private entity would invest the money to build the system and operate as an independent profit-making enterprise, like any other start-up. This venture would have to bear the full cost of all the resources needed to run the enterprise, even if those resources were not fully utilized.

| Scenario | Assumptions | Total Capital Required | Years to Positive Cash Flow | Years to Break Even | 5 Year IRR | 10 Year IRR |
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**Table 3: Folsom wireless broadband system scenario comparisons. IRR means internal rate of return, which measures the effective return on investment produced or expected to be produced by project expenditures.**

The second scenario assumes that a large Internet service provider (ISP) will be brought in either as a partner to operate the system after another organization builds it, or as both system builder and operator. This "ISP partner" scenario is different from the base business model in that an existing ISP would already have critical expertise, many of the necessary capital assets and would already be bearing the cost of a significant portion of essential operating resources. Leveraging existing investments and tapping relevant expertise should lower barriers to entry and decrease risk in the near term and increase profitability over the long term. As explained above, there is currently a unique window of opportunity to pursue such a partnership.

In the third scenario, a public/private "local consortium" scenario is envisioned. In this scenario, the owners and operators would be the system's anchor customers, which presumably would be large organizations with a significant, ongoing need for data networking capability within the City of Folsom. Members of the consortium would make in-kind contributions to the system, and in return receive an ownership stake and a discounted rate for service. In many ways, this scenario is similar to the ISP partner scenario, in that the existing investment and ongoing operating expenses of partners would be leveraged to reduce cost and risk. It differs in that,

unlike incumbent ISPs, these partners are not already in the broadband services business and would not necessarily have directly relevant expertise.

Finally, a "membership" model was considered. In this scenario, the anchor customers use and support the system by themselves, without opening it up for resale to other users. The system would be all but closed to the public and to small-scale users, but it would be capable of serving the needs of large institutional users. Costs are greatly reduced because users would already have sophisticated information technology capabilities, and because some expenses, such as marketing, billing and customer service, would disappear. Risk would be very low since the system's users would be on-board before any expenses are incurred.

Market take-up and revenue rates were assumed to be the same for the first three scenarios, while the fourth assumed only four institutional and/or corporate customers. However, a discount for anchor customers was included in the consortium model. Cost figures for the ISP partner, consortium and membership models were adjusted to account for in-kind and other contributions made by stakeholders.

These four scenarios should be considered as benchmarks along a continuum of possibilities. Many different combinations are possible, initially and over time. For example, the system could begin operation under the membership model, gradually convert to the open-access consortium model, and then privatize as a stand-alone venture.

**Market and Revenue Analysis: Wholesale and Retail**

Revenues were conservatively projected on the basis of the existing price of comparable existing services already being used in the City of Folsom, such as cellular-based data services and wireless "hot spots".

Two different service modes, wholesale and retail, are employed to estimate revenues for the base business model and the three alternate scenarios. Wholesale customers are large institutional customers, who can buy in bulk, and smaller businesses that are either using the unique capabilities of the system to create new ventures, expand existing ones (such as WiFi hotspots), or are simply reselling service to individual users. Retail users are consumers or small businesses that want a relatively low level of service. The fourth case considered – the membership scenario – does not factor in these sources of revenue and relies instead on a small number of highly committed users to support the system.

Wholesale customers, who are major users of the system themselves or add value to it and resell services to others, and retail customers, either individual consumers or small to medium-sized business form the basis for the revenue assumptions in the base business model as well as the ISP partner and local consortium scenarios. One of the keys to making a city-scale broadband service financially viable is to find ways to serve a very diverse set of users and needs, in order to maximize revenue by combining many relatively small revenue streams into a single large one.

The wholesale revenue model assumes that intra-city data networking capability will be purchased by companies and organizations, and, with one exception, connectivity to the Internet will be the individual responsibility of each customer. The wholesale revenue model breaks customers into three categories: anchor, hosted and vertical market customers.

Anchor customers are, in effect, the charter members of this enterprise. It's assumed that four anchor customers can be found, who have a vested interest in seeing broadband connectivity expanded in the City of Folsom, from both a strategic position as a community partner and an operational standpoint as a significant user of such capacity. In the local consortium and membership scenarios, these anchor customers play key roles as backers, users and, to a degree, guarantors for the financial viability of the system.

In the course of conducting this study, contact has been made with public and private sector organizations that have expressed interest in such participation, with the nominal expectation that it will be on the basis of value given for value received. These customers would use the system primarily as an extension of their existing enterprise data networks, and not as a means of accessing the Internet.

Hosted customers are defined as small start-ups that would use the system as a launch pad. Two are identified in the model: a WiFi hotspot aggregator that would use the system to provision and connect a collection of public Internet access points throughout town, and a value-added service provider that would offer services such as email, web hosting and served applications to other customers on the system. The hotspot aggregator would share revenue with the system, and pay for Internet access, while the value added service provider would work on a simple revenue sharing basis. This plan would allow small entrepreneurs to participate in the system, without having to bear large capital or fixed operating costs.

Vertical market customers are companies or organizations that see an opportunity to further their business by connecting with clients, vendors and partners throughout the City of Folsom. One example would be a hospital that wished to work more closely with health care providers, laboratories and suppliers. Another is a business services company, such as an accounting or IT firm, that wanted to offer integrated, real time service to clients. It is assumed that the system will add two such vertical market clients in each of its first three years, building to a total of six. This estimate should be conservative, because companies with a need for such service are likely to take advantage of it sooner rather than later.

Also, given Folsom's economic profile and industry projections for telecommunications services growth in vertical markets, there are likely to be considerably more prospective customers. A study by Insight Research Corporation, extracts of which were published in OSP Magazine, identifies seven industries which will account for 85% of business telecommunications expenditures over the next five years: Wholesale trade, financial, insurance and real estate services, professional business services, communications, durable manufacturing, health care and retail trade.

An economic development and industry study conducted for the City of Folsom by the Sacramento Regional Research Institute identified "10 key industries with potential clustering effects":

1. Accounting, auditing and bookkeeping.
2. Advertising.
3. Alcohol and spirits manufacturing.
4. Business services.
5. Communications equipment and apparatus.
6. Computer and data processing services.
7. Computer and electronic equipment and devices.
8. Educational services.
9. Medical equipment and devices.
10. Water supply, refuse, and wastewater treatment systems.

These key industries fall primarily in the business services, manufacturing, communications and health care sectors identified by Insight Research. Additionally, the retail, manufacturing and health care sectors are heavily represented in the top 30 existing employers in the City. The conditions for success for vertical market wireless broadband service and applications are present in Folsom, particularly for the health care community.

An average price point of $25,000 each per year is used to estimate the revenue potential of anchor and vertical market customers. This figure is based on a discount of the cost of existing wireless GPRS (general packet radio service) in Folsom for heavy users. For example, the City currently spends approximately $35,000 per year for wireless data service via an existing cellular-based GPRS system. The assumption is that a ubiquitous wireless broadband service would provide an equivalent or greater value than GRPS, with a discount added to offset the immaturity of the technology, relative to GPRS.

Intel, Verizon and Agilent Technologies are among Folsom's largest employers, and are all significant players in the wireless broadband industry in general, and WiMAX in particular. The convergence of WiMAX-oriented high technology companies, telecom-dependent industries and a population that has adopted wireless technology to a greater degree than most (as demonstrated by the spectrum analysis) creates a unique opportunity to pursue a WiMAX-based wide area networking solution for the City.

For the purposes of this study, retail service is defined as Internet access service provided to individual users. Retail customers could use the system to communicate with other users on the network, but the selling proposition would be as a supplemental Internet access service for use outside the home or office, or anywhere else a customer's primary Internet service is unavailable. It would also be possible for retail customers to use the system as a primary source of Internet access, however quality of service levels would be substantially less than what is commonly available through existing wire line-based service providers.

Two segments of the retail market were estimated, consumer and commercial. The size and growth rate of the consumer market was estimated by first estimating the likely adoption rate of

consumer grade WiMAX technology by people living in the City. Because the City has a high concentration of companies, with thousands of employees, that have a vested interest in WiMAX technology, generic market projections based on broad, nationwide consumer and business research are not of much use in generating specific estimates for Folsom. People with a personal interest in a new technology and, potentially, with access to employee discounts on equipment, can be expected to adopt it more quickly and use it more intensively than the general public. This tendency has already been observed in connection with WiFi technology in Folsom.

Absent quantitative, primary market research, a rough estimate of this early adopter segment can be made by looking at the number of employees of high tech companies that live in the City. Based on figures provided by the City and Intel, it is estimated that just over a fifth of households in the City of Folsom house an employee of a high tech company. This figure was then assumed to be the maximum number of households that would purchase consumer grade WiMAX technology over the first six years it is available, beginning in 2007.

A wireless Internet service "subscription rate" of 33% was then applied to this small group. In other words, it was assumed that one-third of the households that have WiMAX equipment will subscribe to a WiMAX-based Internet service offered via this system. This figure comes from both market research and actual operating results in other communities where wireless Internet service is offered. Applying the 33% figure only to households that will have WiMAX equipment, rather than all the homes in the City, is a conservative way of estimating the potential revenue.

The result was a slow build of consumer subscribers over 7 years to a point where less than 8% of all households in Folsom are subscribing to the WiMAX-based Internet service. This estimate probably understates the market potential, both in terms of maximum penetration and speed of adoption by consumers, but it provides a conservative base figure for purposes of analysis.

The price for a consumer subscription was set at $10 a month. This figure is comparable to occasional use rates at commercial WiFi hotspots, where customers pay $10 or more for just a few hours of access. It is low enough that it should be an acceptable price for a supplemental service, in an environment where DSL prices are dropping as low as $15 per month. The assumption is that few customers will want to cut their wired service, but many would be interested in supplementing it.

A similar set of assumptions was used to estimate the size and revenue potential of the commercial market. It was first assumed that Folsom businesses would adopt WiMAX technology at the same rate as consumers, and that 20% of these WiMAX-equipped businesses would subscribe to the service. This 20% "subscription rate" is based on research and experience from other municipalities. A higher price point of $20 per month (to account for a higher, "commercial" level of service) was used. Growth in this segment was assumed to continue past the 7-year point, because the value of the local networking potential of the system will continue to increase as the number of connected businesses grows.

Estimated credit card processing fees were deducted from estimated retail revenue, for both consumer and commercial customers. For the sake of simplicity, it's assumed that all such accounts would be managed via credit cards rather than by direct billing.

In 2007, the assumed first full year of operation, and continuing on, anchor customers are benchmarked to provide $100,000 per year in revenue. Vertical market revenue is estimated to grow to $150,000 by 2008, with another $27,000 per year eventually coming from hosted customers. Retail revenue would total $19,000 in 2008 and gradually grow to $272,000 by 2015, with about 80% attributable to commercial customers and the rest to consumers.

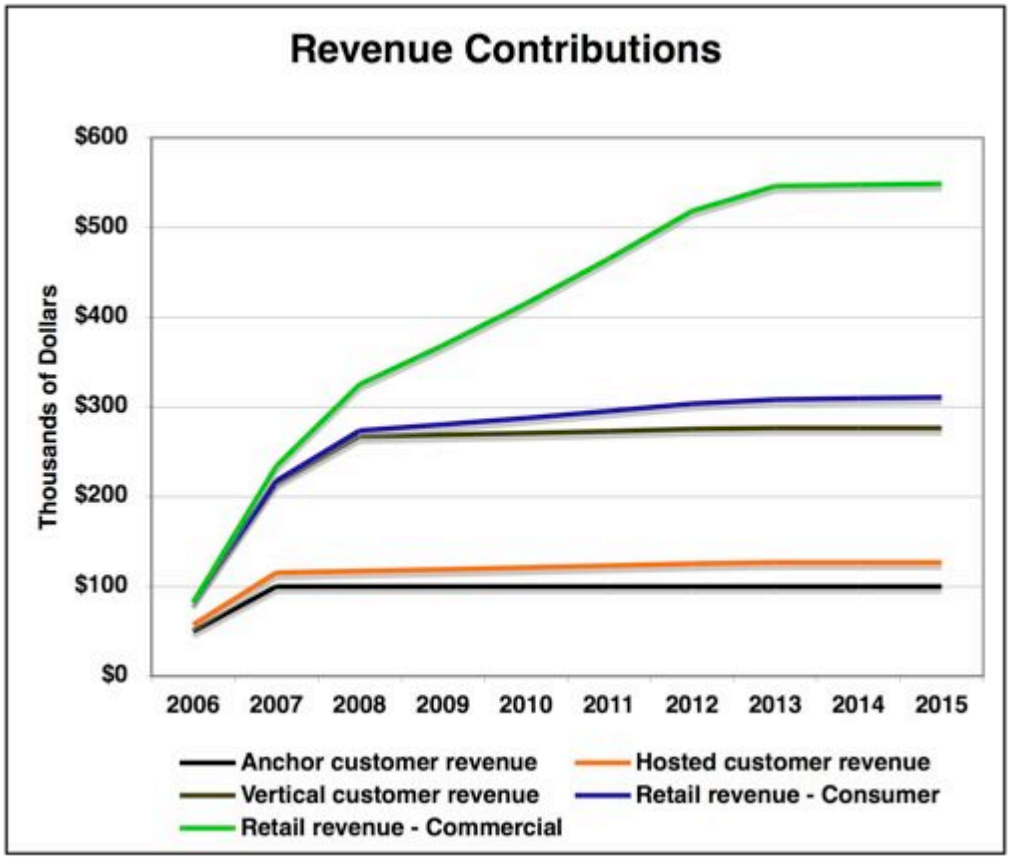


**Chart 1: Contributions of individual market segments to total revenue in the Base Business Model**

In the base business model, after allowing for bank processing fees, total revenue in 2007 should be $233,000, then grow to $534,000 annually over the next nine years. This level of revenue will cover ongoing expenses initially, and grow sufficiently to pay back the capital investment in seven years.

Revenue estimates remain the same in the ISP partner scenario, and are $50,000 per year less in the local consortium scenario due to an assumption that consortium partners would pay less on a cash basis in return for in kind contributions. In both models, all operating expenses would be paid for out of revenues in the first full year of operation, pay back the initial capital investment after four years and provide ongoing surpluses.

In the membership scenario, total revenue is set at $60,000 per year, which is sufficient to recover the initial capital investment in a few years while paying ongoing cash expenses. This scenario is essentially designed to run at a break-even level over time.

**Business Model & Cost Assumptions**

All dollar values are figured at a constant rate, with no allowance for inflation. Doing so allows for "apples to apples" comparisons between scenarios and over time, by providing a fixed point of reference. Inflation is an important consideration in planning, particularly in regards to the tendency for inflation-driven revenue growth to lag behind cost increases, however during initial analysis of contending scenarios inflation adjustments can mask critical differences. From an analytical standpoint, keeping dollar values constant allows for a cleaner first cut analysis.

Revenues and costs are assumed to be flat over time, with changes due only to customer growth, which largely ends in Year 7 after a slow ramp up. An assumption is made that the cost of WiMAX equipment will decrease from its current levels once a final standard is set and mass production begins, however all other technology costs are assumed not to drop. This approach is conservative because it understates potential revenue by making no allowance for the effect of marketing or value-added services, and it likely overstates some costs, such as information technology and telecommunications services, which very likely may come down over time.

The cost for Internet backbone service (in other words, the raw Internet bandwidth that is resold to customers) varies, and can be negotiable. Mid-range industry figures were used in the model. It's assumed that the system will initially need to buy a standard 1.5 Mbps service (commonly referred to as a "T-1" line) to support its hosted customers and for general purpose use, and will build from that point to a 45 Mbps service ("DS-3" level service) as the retail customer base grows.

Figures for hardware maintenance, software licensing and support, tower access, and marketing, consulting and IT services are based on common industry figures. Figures for end user technical support and customer service were based on standard rates charged by leading providers. It's assumed that these services will be outsourced.

In-house expenses include salary, benefits and overhead for one employee, plus an allowance for administrative, legal and office needs. A franchise fee of 5% is also included in the model.

In the ISP partner model, costs for backbone Internet access, customer service related functions and overhead items were discounted to reflect bulk rates that a large ISP would be able to negotiate and the fact that much of the overhead cost is already being absorbed. In effect, the ISP partner business model is largely based on the assumption that most operating costs would be marginal in nature.

In kind contributions, of equipment, office space, tower access and other overhead and operations related items, are assumed in the consortium model and carried over to the membership model.

Variable capital expense includes the cost of mini-base stations that would be located throughout the City to supplement coverage. It's assumed that, on the average, one mini-base station will be necessary to support each wholesale customer, up to a maximum of 12 mini-base stations.

Fixed capital expense covers the cost of the main base station, and equipment and furnishings for the network operations center. Cost figures were based on current costs for comparable installations, with an additional assumption that the cost of WiMAX equipment will drop as the standard is finalized and mass production begins.

**Base Business Model**

This base business model treats the system as a stand-alone venture. All costs would be accounted for in cash and be borne by the venture alone. The cost of capital for this scenario was benchmarked at 10%.

Cash flow would go positive in this model in Year 3, with full breakeven (calculated as a positive value for cumulative cash flow) in Year 7. After ten years, the internal rate of return (IRR) would be about 22% with a net present value (NPV) of $131,000, while at the five-year mark the venture would still be in the red, with an IRR of -16%, and an NPV of -$92,000.

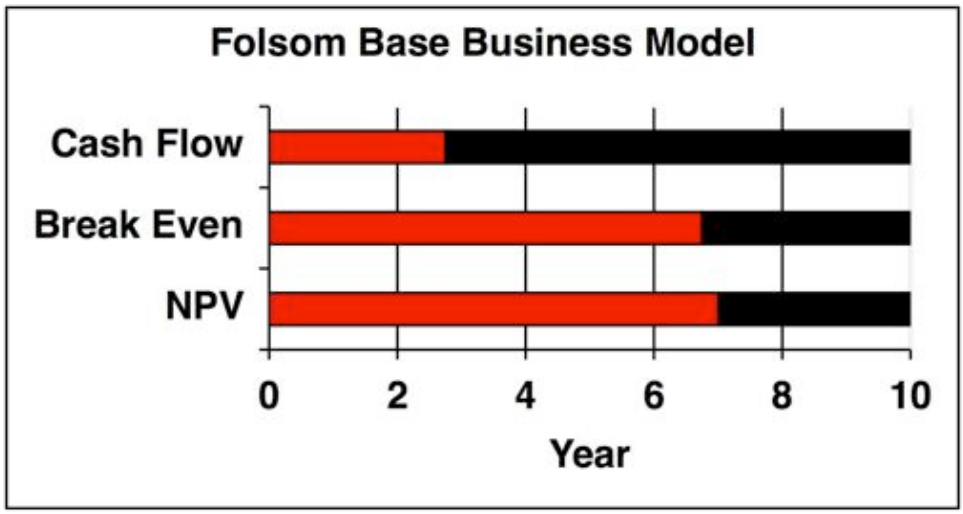


**Chart 2: Base business model metrics**

Although benchmarks for private investment vary widely, a small-scale venture that was still in the red after five years and showing an IRR of less than 30% after ten years would not be generally considered sufficiently rewarding to justify the risk. The total amount of capital required, for equipment and working capital, would be about $175,000. That's a relatively small amount, and investors with a strategic interest in the project might be convinced to participate. However, of the four scenarios considered, the base model scenario is the least attractive.

**ISP Partner Scenario**

A scenario where a large Internet service provider is brought in as a partner to operate the system is more attractive. Positive cash flow would come in the second year and full breakeven would come in four years. By Year 5, the internal rate of return would be 47%, with an NPV of $133,000. These metrics make the venture a much more attractive prospect for investors, with the added security and, potentially, capital of an established player. Primarily because of the lower operating costs, the total capital requirement is reduced to about $130,000.

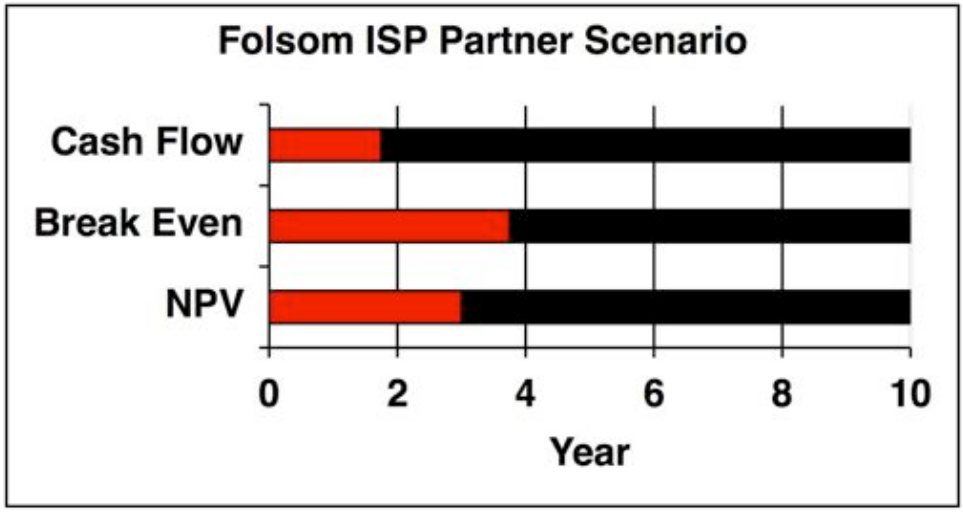


**Chart 3: ISP partner business model metrics**

The improvements in the metrics, over the base business model, are also derived from lower operating costs. While a standalone venture would have to pay all its own overhead, a large ISP would already be bearing much of those costs. Although the system would increase overhead loading for a large operator, it would be a relatively small increase, and largely marginal in nature. Participating in the venture would be viewed by a larger player as a way to leverage that existing overhead. Additionally, a large operator would be able to take advantage of an existing brand image and customer relationships.

Based on current activity and interest, DirecTv, Earthlink, Google and Verizon have already been identified as prospective partners in the system. More can certainly be found.

**Local Consortium Scenario**

If a group of public and private organizations with a need for citywide wireless networking capability were to come together and back the system with in-kind contributions of office and tower space, and some labor and equipment, the result would be very similar to the ISP partner scenario. The venture would likewise go cash flow positive in two years, with breakeven in four years and a five year return of 29% and an NPV of $74,000. Capital requirements would be even lower, at about $110,000.

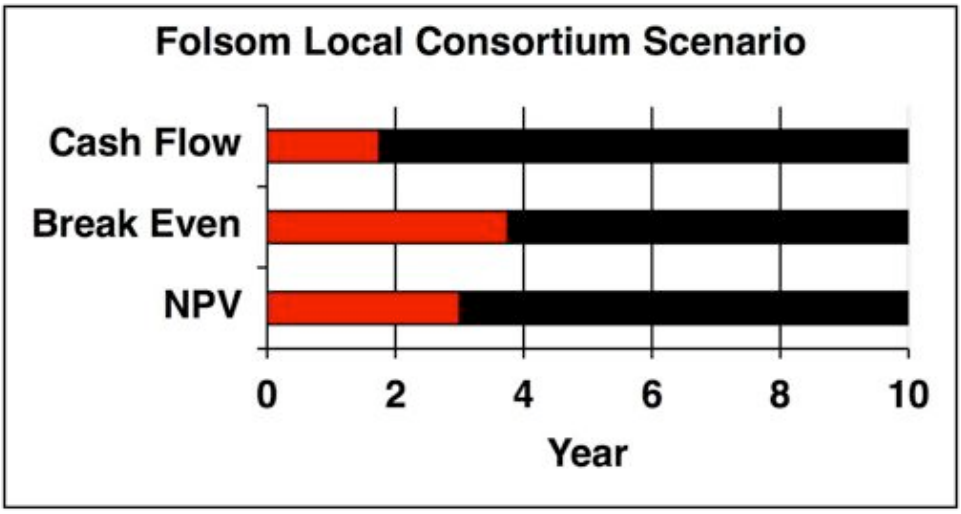


**Chart 4: Local consortium business model metrics.**

One of the assumptions made in this scenario is that the venture would have access to lower cost capital through its public sector participants, and that all members of the consortium would see some early returns on their participation via reduced service rates. Additional returns would come either from the appreciating value of the system or via operating surpluses. An attribute of this "local consortium" scenario is that, as investors, early users would be fully committed to the system and could largely shape its architecture.

On the other hand, consumers and other commercial users would pay market rates to access the system.

**Membership Model**

A membership-oriented model is a much more restricted enterprise than the first three models considered above. For the sake of this analysis, four members are assumed, although the primary impact of decreasing or moderately increasing that number would be on how the cost of running it is divided up. The sole source of revenue for the venture would be the service fees or dues paid by the members.

Costs are far less than for a system that aims to serve the general public. No marketing would be needed, the complexity of the system would be low, and the members themselves could absorb much of the overhead. In effect, the system would be an "enterprise" class facility, suitable for serving internal institutional needs, but not sufficiently robust and elaborate to serve the "carrier" class needs of the general public[1].

"Carrier class" is term usually used to distinguish networks intended for tough and basic public utility type service, for example the residential service typically delivered by major telephone companies, from internal "enterprise" class networks, for example a corporate computer network, that is intended to serve the specific needs of a limited group of users.

Setting the annual cost to members at $15,000 (versus $25,000 for anchor customers in the base model) would make operating results come out about even. The ongoing cost of running the business would be about the same as the total income generated by charging members $15,000 each per year, but there would be nothing left over to repay the initial capital investment. Charging members a higher rate of $20,000 each per year would increase the operating surplus to about $20,000 annually, with full payback of the initial capital investment coming by Year 5.

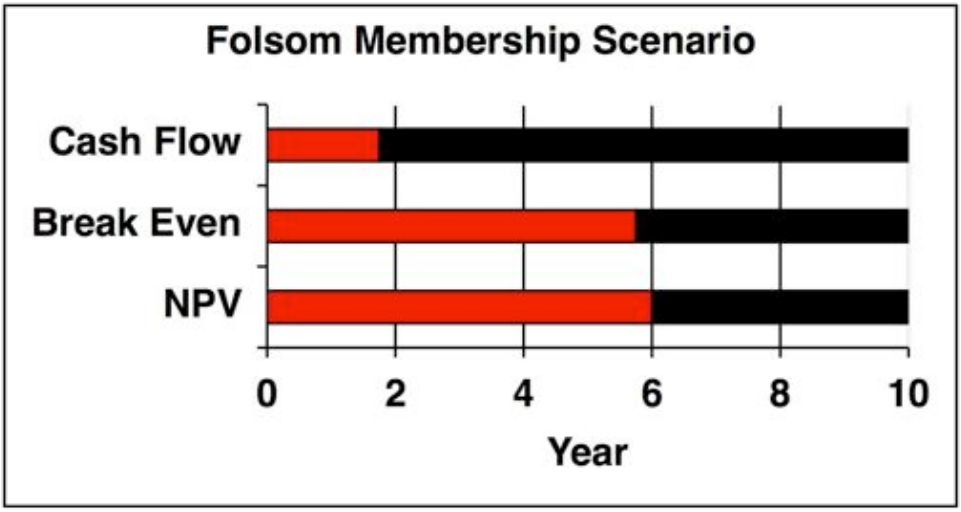


**Chart 5: Membership business model metrics, at $15,000 annual dues.**

Total start up capital required, assuming as in the Local Consortium scenario that some costs will be eliminated through in-kind contributions by members, is less than $60,000. If no in-kind equipment contributions are made, the capital requirement increases to about $85,000. With the modest operating surplus projected, the return on investment after ten years would be 17% with an NPV of $46,000. At these levels, lease financing could be an attractive option, and if public safety uses were included, Homeland Security grants might be available to further offset capital costs.

**Summary**

If the goal of the system is to provide widespread public access, on a wholesale and retail basis, then partnering with an established industry player is the best option. Such a partner would bring operating efficiencies, marketing heft and instant, market-oriented expertise to the table, eliminating many of the start-up challenges faced by new ventures as management climbs the learning curve.

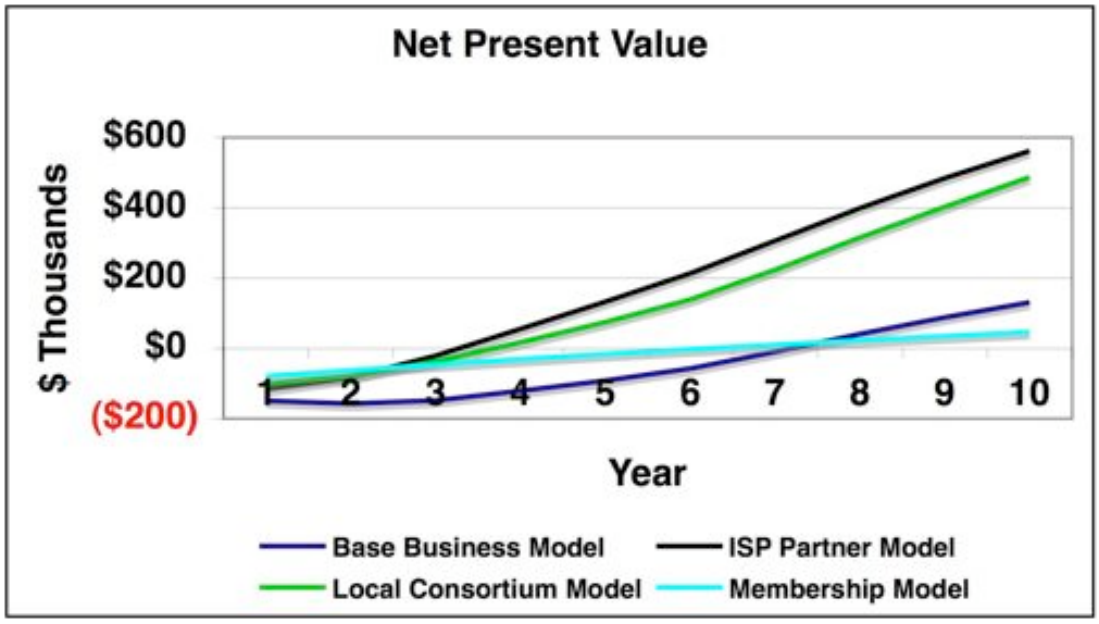


**Chart 6: Folsom wireless broadband system business models, net present value comparison.**

A local public/private consortium could provide an identical service, but would have the twin disadvantages of potentially conflicting needs and relative inexperience. Such an organization, however, would be perfectly positioned to spearhead the creation of the system on a "members only" basis and quickly claim the available spectrum, while keeping open the options of bringing in an operational partner and expanding service to the general public. Community-based ownership and management has the advantage of keeping the enterprise focused on meeting all the needs of the City of Folsom.

## Timeline

The wireless broadband industry in general and the municipal sector in particular is rapidly evolving. A pilot project, described in the recommendations and conclusions above, is envisioned as a first step. Rapidly deploying this small scale pilot project and relying on existing resources and in-kind contributions minimizes the financial risk while positioning the City of Folsom to take advantage of new ideas, technologies, methods and partnerships as each is developed and proven. The end result will be a community-focused enterprise built on real, sustainable revenue that can serve current needs while remaining flexible enough to respond to future needs and opportunities.

By moving fast with a low-cost pilot project, risks and benefits can be minimized and properly assessed by all concerned. At the appropriate time, when the technology and the market is ripe, this pilot project can be converted into a community-focused enterprise built on revenue and other assets committed in advance by early stakeholders.

This timeline envisions a blend of the individual business models and scenarios described below. The balance of 2005 would be spent identifying resources, recruiting R&D and potential operating partners, and securing commitments for a pilot project. Early in 2006, the pilot project will commence operation using existing City of Folsom facilities and prototype equipment contributed by research and development partners. The initial focus of the pilot project will be to evaluate the technology and service it provides, in light of what is expected to be a finalized WiMAX standard, as well as the needs of prospective community users.

| Step | 4Q05 | 1Q06 | 2Q06 | 3Q06 | 4Q06 | 1Q07 | 2Q07 | 3Q07 |
|---|---|---|---|---|---|---|---|---|
| Identify potential City facilities | • | | | | | | | |
| Recruit local R&D resources | • | | | | | | | |
| Involve ISPs | • | | | | | | | |
| Install prototype facility | | • | | | | | | |
| Finalization of WiMAX standard | | • | | | | | | |
| Community-based evaluation | | • | | | | | | |
| Form core stakeholder group | | | • | | | | | |
| Self-funded pilot project expansion | | | • | | | | | |
| DSL resale ruling takes effect | | | | • | | | | |
| Determine design & organization of city-wide broadband enterprise | | | | • | | | | |
| Fund enterprise | | | | | • | | | |
| Issue RFPs | | | | | | • | | |
| Launch full city-wide service | | | | | | | | • |

**Table 4: Timeline (in Calendar Years) to launch citywide wireless broadband system in the City of Folsom.**

In the second quarter of 2006, as early WiMAX standard equipment begins to become available, a group of interested parties will be organized as the core stakeholders of the eventual citywide system. If these stakeholders so desire, they can participate in expanding the pilot project, at their own cost. This initial expansion could form the basis of an enterprise built around the local consortium or membership scenarios described below.

By August 2006, midway through the third quarter, the FCC's ruling that potentially ends DSL resales takes effect. If an existing ISP has been brought in as one of the core group of stakeholders, and desires to fund an aggressive early start to the project, this point would be an opportunity to do so. The operational organization and financial structure of the venture that will ultimately create a citywide broadband system will be finalized during this time period as well.

The fourth quarter of 2006 will be spent obtaining funding, presumably through private capital sources, although grants or other public funding might also be considered. Once the financing has been secured, requests for proposals (RFPs) would be issued, probably in early 2007, with completion and the launch of publicly available service targeted for third quarter of 2007.

Depending on technology developments, changes in the needs of consumers, small businesses, and large corporations and institutions, interest by prospective partners and a broad range of other considerations, this conceptual timeline could be compressed or drawn out in order to take maximum advantage of opportunities or to minimize risk. Cash expenditures are minimized until funding, either from investors or users, is secured.

## Conceptual Design for the City of Folsom: 802.16e WiMAX "Warm Zone"

To establish a wireless network design for the City of Folsom that can be implemented within a six to nine month time frame, it is necessary to take into account the evolving WiMAX standards and the evolving manufacturers' solutions for licensed and license exempt bands, as well as other technical considerations as detailed in Appendix D.

A single WiMAX "warm zone" can serve the City of Folsom. One advantage enjoyed by Folsom is its proximity to Carpenter Hill, the highest point in Sacramento County. Figure 2 demonstrates the citywide coverage of a WiMAX network operating in the 5.8 GHz unlicensed band. A single cell WiMAX network covering the City of Folsom would be possible with the proper engineering of the base station and obtaining the maximum effective radiated isotropic power (EIRP).

**Figure 2. 5.8 GHz WiMAX overlay for the City of Folsom, using a single base station on Carpenter Hill.**

Unlicensed spectrum is recommended because it allows a system to be quickly deployed and, in the future it will be compatible with mass produced WiMAX standard equipment. Because the unlicensed frequencies that are suitable for WiMAX deployment are virtually unused in Folsom, there is an immediate opportunity to stake a claim by quickly making use of those bands. Although doing so won't prevent someone else from also trying to use those frequencies, the fact that someone is already there will make it less attractive to potential competitors. The first user of a given piece of unlicensed spectrum gains a significant advantage over subsequent users.

On the other hand, licensed spectrum also has its advantages. By obtaining a Federal Communications Commission license, a user has exclusive use of a frequency range and is protected against encroachment by other users. The disadvantage is that obtaining licensed spectrum is time consuming and potentially expensive. It is possible to design a system that makes use of both licensed and unlicensed spectrum, and if the initial system operating in the unlicensed bands were successful, a natural expansion path would be to extend it into licensed bands.

Our survey of the radio frequency spectrum in Folsom, as well as published accounts and directories, shows that wireless networking technology is particularly popular.

The results of this survey of available frequencies in the City of Folsom, and a discussion of WiMAX technology as it relates to the findings contained in this report can be found in Appendix C. The survey identified three unlicensed bands of frequencies (4.9 Gigahertz, 5.3 GHz and 5.8 GHz) that are technically suited to the WiMAX standard, and are effectively unused. These bands could be used to deploy a WiMAX-based wireless broadband system throughout the City of Folsom.

The band (2.4 GHz) used for the current generation of WiFi-based wireless Internet service (e.g. coffee shop access) and home networking is already heavily used in Folsom. Although a well-designed network could make good use of this band in specific situations, using it for general, citywide coverage would be problematic.

The City of Folsom is not completely on flat terrain. Some parts of the City are hilly and some parts of the City may be blocked from direct line of sight to Carpenter Hill. The WiMAX technical standard supports near and non line-of-sight links (in contrast to the older WiFi standard which does not). WiMAX technology is indeed better suited to Folsom's terrain and, in practice, should require far fewer base stations than a WiFi network using current generation equipment.

Areas of the City where coverage may be blocked by terrain or on the "fringe" of the single, primary cell, could be serviced by using secondary "mini-base stations" to fill in any coverage gaps, as shown in Figure 3. Although a single base station can provide widespread coverage by itself, six to twelve base stations will be necessary to completely cover the City. Additional base stations might be required to support the needs of high volume users or specialized applications.

Such a network could provide connectivity between fixed points throughout the City of Folsom, either on a permanent or ad hoc basis. It would be easy to maintain, as there would only be the base station on Carpenter Hill and a handful of mini-base stations. The subscriber units would be incorporated into PCs or appliances, or otherwise provided by the user.

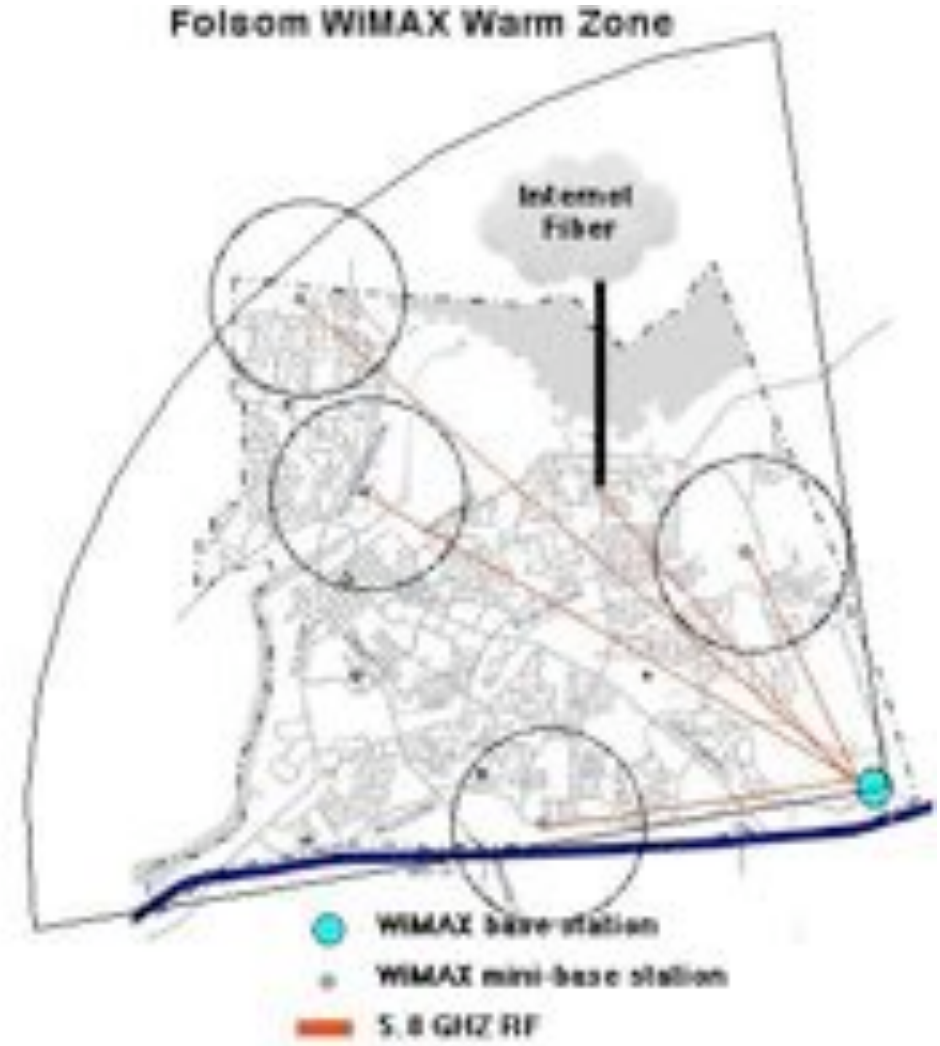


**Figure 3. Conceptual WiMAX "Warm Zone" for the City of Folsom, with mini-base stations to provide Internet connectivity, fill in hilly terrain and/or serve the needs of particular users.**

As the WiMAX standard is further developed and equipment is brought to market, mobile users will be better positioned to use the system. At first, the cost of subscriber terminals will tilt use towards enterprise-level customers. However, mass production of consumer-grade equipment will begin to ramp up in the 2007 time frame, and make the system increasingly accessible to the entire community. In the meantime existing consumer-grade technologies, based on standards such as WiFi, could allow everyone to share in the benefits. Such a hybrid network is further described in Appendix D.

# Appendix A
# Pro Formas

**Folsom Wireless System - Base Business Model**

| Proforma ($000) | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Revenue** | | | | | | | | | | |
| Anchor customer revenue | $50 | $100 | $100 | $100 | $100 | $100 | $100 | $100 | $100 | $100 |
| Hosted customer revenue | $7 | $15 | $17 | $19 | $21 | $23 | $25 | $27 | $27 | $27 |
| Vertical customer revenue | $25 | $100 | $150 | $150 | $150 | $150 | $150 | $150 | $150 | $150 |
| Retail revenue - Consumer | $0 | $2 | $7 | $12 | $17 | $22 | $28 | $32 | $33 | $34 |
| Retail revenue - Commercial | $0 | $17 | $51 | $88 | $128 | $170 | $215 | $238 | $238 | $238 |
| Misc. revenue & deductions | $0 | ($1) | ($3) | ($5) | ($8) | ($10) | ($13) | ($14) | ($14) | ($14) |
| **Total Revenue** | $82 | $233 | $322 | $363 | $408 | $455 | $505 | $532 | $533 | $534 |
| | | | | | | | | | | |
| **Operating Expense** | | | | | | | | | | |
| Cost of services provided (Internet) | $10 | $10 | $37 | $57 | $79 | $95 | $95 | $95 | $95 | $95 |
| Outsourced costs | $68 | $100 | $134 | $147 | $161 | $176 | $192 | $200 | $201 | $201 |
| In house costs | $51 | $101 | $101 | $101 | $101 | $101 | $101 | $101 | $101 | $101 |
| Franchise fee | $4 | $12 | $16 | $18 | $20 | $23 | $25 | $27 | $27 | $27 |
| **Total Expense** | $132 | $223 | $288 | $323 | $361 | $394 | $413 | $423 | $423 | $423 |
| | | | | | | | | | | |
| **Operating Income** | ($50) | $11 | $34 | $40 | $46 | $61 | $93 | $109 | $110 | $111 |
| | | | | | | | | | | |
| **Operating Margin** | (60%) | 5% | 10% | 11% | 11% | 13% | 18% | 21% | 21% | 21% |
| | | | | | | | | | | |
| Depreciation | $11 | $14 | $16 | $16 | $16 | $16 | $16 | $16 | $16 | $16 |
| **EBIT** | ($61) | ($3) | $18 | $24 | $31 | $45 | $77 | $94 | $95 | $96 |
| | | | | | | | | | | |
| **Capital** | | | | | | | | | | |
| Variable capital expense | $63 | $21 | $21 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Fixed capital expense | $51 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| **Total capital expense** | $114 | $21 | $21 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |

**Folsom Wireless System - Base Business Model**

| Cash Flow Analysis ($000) | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Operating Income** | | | | | | | | | | |
| Total revenue | $82 | $233 | $322 | $363 | $408 | $455 | $505 | $532 | $533 | $534 |
| Total expense | ($132) | ($223) | ($288) | ($323) | ($361) | ($394) | ($413) | ($423) | ($423) | ($423) |
| Operating Profit/(Loss) | ($50) | $11 | $34 | $40 | $46 | $61 | $93 | $109 | $110 | $111 |
| Capital expenditures | ($114) | ($21) | ($21) | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Total | ($164) | ($10) | $13 | $40 | $46 | $61 | $93 | $109 | $110 | $111 |
| **Cumulative Cash** | ($164) | ($174) | ($161) | ($121) | ($75) | ($14) | $78 | $188 | $298 | $409 |
| **Net Present Value** | ($149) | ($157) | ($148) | ($121) | ($92) | ($57) | ($10) | $41 | $88 | $131 |
| **Internal Rate of Return** | | | | (35.6%) | (15.6%) | (2.2%) | 8.4% | 15.1% | 19.2% | 21.8% |

| **Key Indicators** | |
|---|---|
| Years to positive cash flow | 3 |
| Years to break even | 7 |
| NPV - Year 10 | $131 |
| NPV - Year 15 | $297 |
| IRR - Year 10 | 21.8% |
| IRR - Year 15 | 26.7% |
| Cost of Capital | 10.0% |

**Folsom Wireless System - ISP Partner Scenario**

| Proforma ($000) | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Revenue** | | | | | | | | | | |
| Anchor customer revenue | $50 | $100 | $100 | $100 | $100 | $100 | $100 | $100 | $100 | $100 |
| Hosted customer revenue | $7 | $15 | $17 | $19 | $21 | $23 | $25 | $27 | $27 | $27 |
| Vertical customer revenue | $25 | $100 | $150 | $150 | $150 | $150 | $150 | $150 | $150 | $150 |
| Retail revenue - Consumer | $0 | $2 | $7 | $12 | $17 | $22 | $28 | $32 | $33 | $34 |
| Retail revenue - Commercial | $0 | $17 | $51 | $88 | $128 | $170 | $215 | $238 | $238 | $238 |
| Misc. revenue & deductions | $0 | ($1) | ($3) | ($5) | ($8) | ($10) | ($13) | ($14) | ($14) | ($14) |
| **Total Revenue** | $82 | $233 | $322 | $363 | $408 | $455 | $505 | $532 | $533 | $534 |
| | | | | | | | | | | |
| **Operating Expense** | | | | | | | | | | |
| Cost of services provided (Internet) | $10 | $10 | $37 | $57 | $79 | $95 | $95 | $95 | $95 | $95 |
| Outsourced costs | $51 | $89 | $105 | $114 | $123 | $133 | $144 | $150 | $150 | $150 |
| In house costs | $31 | $61 | $61 | $61 | $61 | $61 | $61 | $61 | $61 | $61 |
| Franchise fee | $4 | $12 | $16 | $18 | $20 | $23 | $25 | $27 | $27 | $27 |
| **Total Expense** | $96 | $172 | $220 | $251 | $284 | $312 | $325 | $332 | $332 | $332 |
| | | | | | | | | | | |
| **Operating Income** | ($13) | $62 | $102 | $113 | $124 | $143 | $180 | $200 | $201 | $202 |
| | | | | | | | | | | |
| **Operating Margin** | (16%) | 26% | 32% | 31% | 30% | 31% | 36% | 38% | 38% | 38% |
| | | | | | | | | | | |
| Depreciation | $11 | $14 | $16 | $16 | $16 | $16 | $16 | $16 | $16 | $16 |
| **EBIT** | ($25) | $48 | $87 | $97 | $108 | $128 | $165 | $184 | $185 | $186 |
| | | | | | | | | | | |
| **Capital** | | | | | | | | | | |
| Variable capital expense | $63 | $21 | $21 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Fixed capital expense | $51 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| **Total capital expense** | $114 | $21 | $21 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |

**Folsom Wireless System - ISP Partner Scenario**

| Cash Flow Analysis ($000) | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Operating Income** | | | | | | | | | | |
| Total revenue | $82 | $233 | $322 | $363 | $408 | $455 | $505 | $532 | $533 | $534 |
| Total expense | ($96) | ($172) | ($220) | ($251) | ($284) | ($312) | ($325) | ($332) | ($332) | ($332) |
| Operating Profit/(Loss) | ($13) | $62 | $102 | $113 | $124 | $143 | $180 | $200 | $201 | $202 |
| Capital expenditures | ($114) | ($21) | ($21) | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Total | ($128) | $41 | $81 | $113 | $124 | $143 | $180 | $200 | $201 | $202 |
| **Cumulative Cash** | ($128) | ($87) | ($6) | $107 | $231 | $374 | $555 | $754 | $955 | $1,157 |
| **Net Present Value** | ($116) | ($82) | ($21) | $56 | $133 | $213 | $306 | $399 | $484 | $562 |
| **Internal Rate of Return** | | (68.1%) | (2.6%) | 31.5% | 46.9% | 55.1% | 60.2% | 63.1% | 64.6% | 65.5% |

| **Key Indicators** | |
|---|---|
| Years to positive cash flow | 2 |
| Years to break even | 4 |
| NPV - Year 10 | $562 |
| NPV - Year 15 | $861 |
| IRR - Year 10 | 65.5% |
| IRR - Year 15 | 66.6% |
| Cost of Capital | 10.0% |

**Folsom Wireless System - Local Consortium Scenario**

| Proforma ($000) | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Revenue** | | | | | | | | | | |
| Anchor customer revenue | $25 | $50 | $50 | $50 | $50 | $50 | $50 | $50 | $50 | $50 |
| Hosted customer revenue | $7 | $15 | $17 | $19 | $21 | $23 | $25 | $27 | $27 | $27 |
| Vertical customer revenue | $25 | $100 | $150 | $150 | $150 | $150 | $150 | $150 | $150 | $150 |
| Retail revenue - Consumer | $0 | $2 | $7 | $12 | $17 | $22 | $28 | $32 | $33 | $34 |
| Retail revenue - Commercial | $0 | $17 | $51 | $88 | $128 | $170 | $215 | $238 | $238 | $238 |
| Misc. revenue & deductions | $0 | ($1) | ($3) | ($5) | ($8) | ($10) | ($13) | ($14) | ($14) | ($14) |
| **Total Revenue** | $57 | $183 | $272 | $313 | $358 | $405 | $455 | $482 | $483 | $484 |
| | | | | | | | | | | |
| **Operating Expense** | | | | | | | | | | |
| Cost of services provided (Internet) | $10 | $10 | $37 | $57 | $79 | $95 | $95 | $95 | $95 | $95 |
| Outsourced costs | $60 | $83 | $114 | $127 | $141 | $156 | $172 | $181 | $181 | $181 |
| In house costs | $24 | $47 | $47 | $47 | $47 | $47 | $47 | $47 | $47 | $47 |
| Franchise fee | $3 | $9 | $14 | $16 | $18 | $20 | $23 | $24 | $24 | $24 |
| **Total Expense** | $96 | $149 | $212 | $247 | $285 | $318 | $337 | $346 | $347 | $347 |
| | | | | | | | | | | |
| **Operating Income** | ($39) | $34 | $60 | $66 | $72 | $87 | $119 | $135 | $136 | $137 |
| | | | | | | | | | | |
| **Operating Margin** | (68%) | 19% | 22% | 21% | 20% | 21% | 26% | 28% | 28% | 28% |
| | | | | | | | | | | |
| Depreciation | $7 | $8 | $9 | $9 | $9 | $9 | $9 | $9 | $9 | $9 |
| **EBIT** | ($46) | $26 | $51 | $57 | $64 | $78 | $110 | $127 | $128 | $128 |
| | | | | | | | | | | |
| **Capital** | | | | | | | | | | |
| Variable capital expense | $32 | $11 | $11 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Fixed capital expense | $36 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| **Total capital expense** | $67 | $11 | $11 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |

**Folsom Wireless System - Local Consortium Scenario**

| Cash Flow Analysis ($000) | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Operating Income** | | | | | | | | | | |
| Total revenue | $57 | $183 | $272 | $313 | $358 | $405 | $455 | $482 | $483 | $484 |
| Total expense | ($96) | ($149) | ($212) | ($247) | ($285) | ($318) | ($337) | ($346) | ($347) | ($347) |
| Operating Profit/(Loss) | ($39) | $34 | $60 | $66 | $72 | $87 | $119 | $135 | $136 | $137 |
| Capital expenditures | ($67) | ($11) | ($11) | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Total | ($106) | $24 | $49 | $66 | $72 | $87 | $119 | $135 | $136 | $137 |
| **Cumulative Cash** | ($106) | ($82) | ($33) | $33 | $105 | $192 | $311 | $446 | $583 | $720 |
| **Net Present Value** | ($101) | ($79) | ($37) | $17 | $74 | $139 | $223 | $315 | $403 | $487 |
| **Internal Rate of Return** | | | (19.7%) | 12.7% | 28.5% | 37.8% | 44.2% | 48.1% | 50.2% | 51.5% |

| **Key Indicators** | |
|---|---|
| Years to positive cash flow | 2 |
| Years to break even | 4 |
| NPV - Year 10 | $487 |
| NPV - Year 15 | $860 |
| IRR - Year 10 | 51.5% |
| IRR - Year 15 | 53.4% |
| Cost of Capital | 5.0% |

**Folsom Wireless System - MembershipScenario**

| Proforma ($000) | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Revenue** | | | | | | | | | | |
| Anchor customer revenue | $30 | $60 | $60 | $60 | $60 | $60 | $60 | $60 | $60 | $60 |
| Hosted customer revenue | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Vertical customer revenue | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Retail revenue - Consumer | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Retail revenue - Commercial | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Misc. revenue & deductions | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| **Total Revenue** | $30 | $60 | $60 | $60 | $60 | $60 | $60 | $60 | $60 | $60 |
| | | | | | | | | | | |
| **Operating Expense** | | | | | | | | | | |
| Cost of services provided (Internet) | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Outsourced costs | $27 | $36 | $36 | $36 | $36 | $36 | $36 | $36 | $36 | $36 |
| In house costs | $3 | $5 | $5 | $5 | $5 | $5 | $5 | $5 | $5 | $5 |
| Franchise fee | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| **Total Expense** | $29 | $41 | $41 | $41 | $41 | $41 | $41 | $41 | $41 | $41 |
| | | | | | | | | | | |
| **Operating Income** | $1 | $19 | $19 | $19 | $19 | $19 | $19 | $19 | $19 | $19 |
| | | | | | | | | | | |
| **Operating Margin** | 3% | 31% | 31% | 31% | 31% | 31% | 31% | 31% | 31% | 31% |
| | | | | | | | | | | |
| Depreciation | $8 | $8 | $8 | $8 | $8 | $8 | $8 | $8 | $8 | $8 |
| **EBIT** | ($8) | $10 | $10 | $10 | $10 | $10 | $10 | $10 | $10 | $10 |
| | | | | | | | | | | |
| **Capital** | | | | | | | | | | |
| Variable capital expense | $42 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Fixed capital expense | $42 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| **Total capital expense** | $84 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |

**Folsom Wireless System - MembershipScenario**

| Cash Flow Analysis ($000) | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Operating Income** | | | | | | | | | | |
| Total revenue | $30 | $60 | $60 | $60 | $60 | $60 | $60 | $60 | $60 | $60 |
| Total expense | ($29) | ($41) | ($41) | ($41) | ($41) | ($41) | ($41) | ($41) | ($41) | ($41) |
| Operating Profit/(Loss) | $1 | $19 | $19 | $19 | $19 | $19 | $19 | $19 | $19 | $19 |
| Capital expenditures | ($84) | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Total | ($83) | $19 | $19 | $19 | $19 | $19 | $19 | $19 | $19 | $19 |
| **Cumulative Cash** | ($83) | ($65) | ($46) | ($28) | ($9) | $9 | $28 | $47 | $65 | $84 |
| **Net Present Value** | ($79) | ($63) | ($47) | ($31) | ($17) | ($3) | $10 | $23 | $35 | $46 |
| **Internal Rate of Return** | | | (40.4%) | (17.8%) | (4.5%) | 3.7% | 8.9% | 12.5% | 15.0% | 16.7% |

| **Key Indicators** | |
|---|---|
| Years to positive cash flow | 2 |
| Years to break even | 6 |
| NPV - Year 10 | $46 |
| NPV - Year 15 | $96 |
| IRR - Year 10 | 16.7% |
| IRR - Year 15 | 20.6% |
| Cost of Capital | 5.0% |
| Annual membership dues | $15 |

# Appendix B
# Full Base Business Model

## Folsom Wireless System - Base Business Model

| | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Wholesale Market & Revenue ($000)** | | | | | | | | | | |
| **Anchor Customers** | | | | | | | | | | |
| Number of anchor customers | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| Annual revenue | $50 | $100 | $100 | $100 | $100 | $100 | $100 | $100 | $100 | $100 |
| **Hosted Customers** | | | | | | | | | | |
| Bandwidth revenue | $6 | $12 | $12 | $12 | $12 | $12 | $12 | $12 | $12 | $12 |
| Aggregator revenue share | $1 | $2 | $2 | $2 | $2 | $2 | $2 | $2 | $2 | $2 |
| Value added revenue share | $0 | $1 | $3 | $4 | $7 | $9 | $11 | $12 | $12 | $12 |
| **Vertical Market Customers** | | | | | | | | | | |
| Number of vertical market customers | 2 | 4 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 |
| Annual revenue | $25 | $100 | $150 | $150 | $150 | $150 | $150 | $150 | $150 | $150 |
| **Consumer Retail Market** | | | | | | | | | | |
| Folsom HHs | 20,227 | 20,940 | 21,679 | 22,443 | 23,234 | 24,053 | 24,901 | 24,901 | 24,901 | 24,901 |
| WiMax technology penetration rate | 0% | 4% | 8% | 12% | 15% | 19% | 23% | 23% | 23% | 23% |
| **Service profile (year end)** | | | | | | | | | | |
| WiMax Internet subs | 0 | 265 | 548 | 852 | 1,176 | 1,521 | 1,890 | 1,890 | 1,890 | 1,890 |
| **Service profile (average)** | | | | | | | | | | |
| WiMax Internet subs | 0 | 132 | 407 | 700 | 1,014 | 1,349 | 1,706 | 1,890 | 1,890 | 1,890 |
| **Activation profile** | | | | | | | | | | |
| Net new consumer Internet subs | 0 | 265 | 284 | 303 | 324 | 346 | 369 | 0 | 0 | 0 |
| Gross new consumer Internet subs | 0 | 313 | 382 | 457 | 536 | 620 | 709 | 340 | 340 | 340 |
| Disconnecting consumer Internet subs | 0 | 48 | 99 | 153 | 212 | 274 | 340 | 340 | 340 | 340 |
| **Consumer market summary** | | | | | | | | | | |
| Consumer subscribers (year end) | 0 | 265 | 548 | 852 | 1,176 | 1,521 | 1,890 | 1,890 | 1,890 | 1,890 |
| Consumer subscribers (average) | 0 | 132 | 407 | 700 | 1,014 | 1,349 | 1,706 | 1,890 | 1,890 | 1,890 |

**Folsom Wireless System - Base Business Model**

| | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Consumer Retail Revenue ($000)** | | | | | | | | | | |
| Assumed revenue growth | | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| Compounded revenue growth | | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| Standard Internet service revenue | $0 | $16 | $49 | $84 | $122 | $162 | $204 | $227 | $227 | $227 |
| Daily subscriptions | $0 | $1 | $2 | $4 | $6 | $8 | $10 | $11 | $11 | $11 |
| Service & support revenue | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Total consumer revenue | $0 | $17 | $51 | $88 | $128 | $170 | $215 | $238 | $238 | $238 |
| **Commercial Retail Market** | | | | | | | | | | |
| Folsom medium/small businesses | 1,842 | 1,907 | 1,974 | 2,043 | 2,115 | 2,190 | 2,267 | 2,347 | 2,430 | 2,515 |
| Folsom large businesses | 460 | 477 | 493 | 511 | 529 | 547 | 567 | 587 | 607 | 629 |
| WiMax technology penetration rate | 0% | 4% | 8% | 12% | 15% | 19% | 23% | 23% | 23% | 23% |
| **Service profile (year end)** | | | | | | | | | | |
| Standard Internet | 0 | 18 | 38 | 59 | 81 | 105 | 130 | 135 | 140 | 145 |
| **Service profile (average)** | | | | | | | | | | |
| Standard Internet | 0 | 9 | 28 | 48 | 70 | 93 | 118 | 133 | 137 | 142 |
| **Activation profile** | | | | | | | | | | |
| Net new standard Internet subs | 0 | 18 | 20 | 21 | 22 | 24 | 25 | 5 | 5 | 5 |
| Gross new standard Internet subs | 0 | 18 | 21 | 25 | 28 | 32 | 36 | 18 | 18 | 19 |
| Disconnecting standard Internet subs | 0 | 0 | 2 | 4 | 6 | 8 | 10 | 13 | 13 | 14 |
| **Commercial Retail Revenue ($000)** | | | | | | | | | | |
| Assumed revenue growth | | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| Compounded revenue growth | | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| Standard Internet | $0 | $2 | $7 | $12 | $17 | $22 | $28 | $32 | $33 | $34 |
| Commercial subscription revenue | $0 | $2 | $7 | $12 | $17 | $22 | $28 | $32 | $33 | $34 |
| Service & support revenue | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Total commercial revenue | $0 | $2 | $7 | $12 | $17 | $22 | $28 | $32 | $33 | $34 |

## Folsom Wireless System - Base Business Model

| | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Market & Revenue Recap ($000)** | | | | | | | | | | |
| **Wholesale networking customers** | | | | | | | | | | |
| Anchor customer revenue | $50 | $100 | $100 | $100 | $100 | $100 | $100 | $100 | $100 | $100 |
| Hosted customer revenue | $7 | $15 | $17 | $19 | $21 | $23 | $25 | $27 | $27 | $27 |
| Vertical customer revenue | $25 | $100 | $150 | $150 | $150 | $150 | $150 | $150 | $150 | $150 |
| Total wholesale revenue | $82 | $215 | $267 | $269 | $271 | $273 | $275 | $277 | $277 | $277 |
| **Retail networking & access customers** | | | | | | | | | | |
| Total subscribers (year end) | 0 | 283 | 586 | 910 | 1,257 | 1,626 | 2,020 | 2,025 | 2,030 | 2,035 |
| Total subscribers (average) | 0 | 142 | 435 | 748 | 1,084 | 1,442 | 1,823 | 2,023 | 2,027 | 2,032 |
| Commercial Internet service revenue | $0 | $2 | $7 | $12 | $17 | $22 | $28 | $32 | $33 | $34 |
| Consumer Internet service revenue | $0 | $17 | $51 | $88 | $128 | $170 | $215 | $238 | $238 | $238 |
| Retail Internet service revenue | $0 | $19 | $58 | $100 | $144 | $192 | $243 | $270 | $271 | $272 |
| Misc. revenue | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Processing fees | $0 | $0 | ($0) | ($1) | ($1) | ($1) | ($2) | ($2) | ($2) | ($2) |
| Internet merchant account fees | ($0) | ($1) | ($3) | ($5) | ($7) | ($9) | ($11) | ($12) | ($12) | ($12) |
| Total retail revenue | $0 | $18 | $55 | $94 | $137 | $182 | $230 | $255 | $257 | $258 |
| **Total revenue** | $82 | $233 | $322 | $363 | $408 | $455 | $505 | $532 | $533 | $534 |

**Folsom Wireless System - Base Business Model**

| | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Cost of Services Provided ($000)** | | | | | | | | | | |
| **Internet connect & support cost** | | | | | | | | | | |
| Internet bandwidth cost - wholesale customers | $10 | $10 | $10 | $10 | $10 | $10 | $10 | $10 | $10 | $10 |
| Internet bandwidth cost - retail customers | $0 | $0 | $28 | $48 | $69 | $85 | $85 | $85 | $85 | $85 |
| Total Internet bandwidth cost | $10 | $10 | $37 | $57 | $79 | $95 | $95 | $95 | $95 | $95 |
| **Operating Expense ($000)** | | | | | | | | | | |
| **Outsourced costs** | | | | | | | | | | |
| Software upgrades & licensing | $2 | $4 | $4 | $4 | $4 | $4 | $4 | $4 | $4 | $4 |
| Outsourced system maintenance | $3 | $5 | $5 | $5 | $5 | $5 | $5 | $5 | $5 | $5 |
| Provisioning & CRM/CA per sub | $7 | $13 | $22 | $30 | $38 | $47 | $56 | $61 | $61 | $61 |
| Technical support | $6 | $10 | $17 | $22 | $29 | $35 | $42 | $45 | $45 | $46 |
| IT support services | $3 | $5 | $5 | $5 | $5 | $5 | $5 | $5 | $5 | $5 |
| Tower rental & power - Carpenter Peak | $4 | $8 | $8 | $8 | $8 | $8 | $8 | $8 | $8 | $8 |
| Tower rental & power - mini-base units | $7 | $19 | $24 | $24 | $24 | $24 | $24 | $24 | $24 | $24 |
| Marketing | $12 | $12 | $24 | $24 | $24 | $24 | $24 | $24 | $24 | $24 |
| Management & engineering support | $24 | $24 | $24 | $24 | $24 | $24 | $24 | $24 | $24 | $24 |
| Other | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Total outsourced costs | $68 | $100 | $134 | $147 | $161 | $176 | $192 | $200 | $201 | $201 |
| **In-house costs** | | | | | | | | | | |
| Salaries & benefits | $42 | $84 | $84 | $84 | $84 | $84 | $84 | $84 | $84 | $84 |
| Office expense | $6 | $12 | $12 | $12 | $12 | $12 | $12 | $12 | $12 | $12 |
| Legal and administrative | $3 | $5 | $5 | $5 | $5 | $5 | $5 | $5 | $5 | $5 |
| Total in-house costs | $51 | $101 | $101 | $101 | $101 | $101 | $101 | $101 | $101 | $101 |
| Franchise fee | $4 | $12 | $16 | $18 | $20 | $23 | $25 | $27 | $27 | $27 |
| **Operating expense summary** | | | | | | | | | | |
| Outsourced costs | $68 | $100 | $134 | $147 | $161 | $176 | $192 | $200 | $201 | $201 |
| In house costs | $51 | $101 | $101 | $101 | $101 | $101 | $101 | $101 | $101 | $101 |
| Franchise fee | $4 | $12 | $16 | $18 | $20 | $23 | $25 | $27 | $27 | $27 |
| Total operating expense | $122 | $213 | $251 | $266 | $282 | $300 | $318 | $328 | $328 | $328 |
| **Cash flow from operations** | ($50) | $11 | $34 | $40 | $46 | $61 | $93 | $109 | $110 | $111 |

**Folsom Wireless System - Base Business Model**

| Capital Expense ($000) | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Variable capital expense** | | | | | | | | | | |
| Incremental mini-base units required | 6 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Incremental mini-base unit cost | $60 | $20 | $20 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Furnish and install | $3 | $1 | $1 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Variable capital expense | $63 | $21 | $21 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| **Fixed capital expense** | | | | | | | | | | |
| WiMax base station | $8 | | | | | | | | | |
| Controller | $5 | | | | | | | | | |
| NOC equipment | $5 | | | | | | | | | |
| Server | $5 | | | | | | | | | |
| NOC interconnect & telecomm | $1 | | | | | | | | | |
| Misc. IT equipment | $10 | | | | | | | | | |
| Furnish and install | $2 | | | | | | | | | |
| Engineering design | $15 | | | | | | | | | |
| Total fixed capital expense | $51 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Annual capital expense | $114 | $21 | $21 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Cumulative capital expense | $114 | $135 | $156 | $156 | $156 | $156 | $156 | $156 | $156 | $156 |

**Folsom Wireless System - Base Business Model**

| Proforma ($000) | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Revenue** | | | | | | | | | | |
| Anchor customer revenue | $50 | $100 | $100 | $100 | $100 | $100 | $100 | $100 | $100 | $100 |
| Hosted customer revenue | $7 | $15 | $17 | $19 | $21 | $23 | $25 | $27 | $27 | $27 |
| Vertical customer revenue | $25 | $100 | $150 | $150 | $150 | $150 | $150 | $150 | $150 | $150 |
| Retail revenue - Consumer | $0 | $2 | $7 | $12 | $17 | $22 | $28 | $32 | $33 | $34 |
| Retail revenue - Commercial | $0 | $17 | $51 | $88 | $128 | $170 | $215 | $238 | $238 | $238 |
| Misc. revenue & deductions | $0 | ($1) | ($3) | ($5) | ($8) | ($10) | ($13) | ($14) | ($14) | ($14) |
| **Total Revenue** | $82 | $233 | $322 | $363 | $408 | $455 | $505 | $532 | $533 | $534 |
| | | | | | | | | | | |
| **Operating Expense** | | | | | | | | | | |
| Cost of services provided (Internet) | $10 | $10 | $37 | $57 | $79 | $95 | $95 | $95 | $95 | $95 |
| Outsourced costs | $68 | $100 | $134 | $147 | $161 | $176 | $192 | $200 | $201 | $201 |
| In house costs | $51 | $101 | $101 | $101 | $101 | $101 | $101 | $101 | $101 | $101 |
| Franchise fee | $4 | $12 | $16 | $18 | $20 | $23 | $25 | $27 | $27 | $27 |
| **Total Expense** | $132 | $223 | $288 | $323 | $361 | $394 | $413 | $423 | $423 | $423 |
| | | | | | | | | | | |
| **Operating Income** | ($50) | $11 | $34 | $40 | $46 | $61 | $93 | $109 | $110 | $111 |
| | | | | | | | | | | |
| **Operating Margin** | (60%) | 5% | 10% | 11% | 11% | 13% | 18% | 21% | 21% | 21% |
| | | | | | | | | | | |
| Depreciation | $11 | $14 | $16 | $16 | $16 | $16 | $16 | $16 | $16 | $16 |
| **EBIT** | ($61) | ($3) | $18 | $24 | $31 | $45 | $77 | $94 | $95 | $96 |
| | | | | | | | | | | |
| **Capital** | | | | | | | | | | |
| Variable capital expense | $63 | $21 | $21 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Fixed capital expense | $51 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| **Total capital expense** | $114 | $21 | $21 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |

**Folsom Wireless System - Base Business Model**

| Cash Flow Analysis ($000) | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Operating Income** | | | | | | | | | | |
| Total revenue | $82 | $233 | $322 | $363 | $408 | $455 | $505 | $532 | $533 | $534 |
| Total expense | ($132) | ($223) | ($288) | ($323) | ($361) | ($394) | ($413) | ($423) | ($423) | ($423) |
| Operating Profit/(Loss) | ($50) | $11 | $34 | $40 | $46 | $61 | $93 | $109 | $110 | $111 |
| Capital expenditures | ($114) | ($21) | ($21) | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Total | ($164) | ($10) | $13 | $40 | $46 | $61 | $93 | $109 | $110 | $111 |
| **Cumulative Cash** | ($164) | ($174) | ($161) | ($121) | ($75) | ($14) | $78 | $188 | $298 | $409 |
| **Net Present Value** | ($149) | ($157) | ($148) | ($121) | ($92) | ($57) | ($10) | $41 | $88 | $131 |
| **Internal Rate of Return** | | | | (35.6%) | (15.6%) | (2.2%) | 8.4% | 15.1% | 19.2% | 21.8% |

| **Key Indicators** | |
|---|---|
| Years to positive cash flow | 3 |
| Years to break even | 7 |
| NPV - Year 10 | $131 |
| NPV - Year 15 | $297 |
| IRR - Year 10 | 21.8% |
| IRR - Year 15 | 26.7% |
| Cost of Capital | 10.0% |

# Appendix C
# Spectrum Survey

## City of Folsom RF Spectrum and Noise Floor Analysis

A radio frequency (RF) spectrum and noise floor analysis was conducted during the week of July 11, 2005 in the City of Folsom. The purpose of the analysis was to study the unlicensed radio bands used for data communications, specifically the Industrial, Scientific and Medical (ISM) bands: ISM-900 (902-928 MHz), ISM-2.4 (2400 -2483.5 MHz) and ISM-5.8 (5.725 GHz to 5.850 GHz) and the Unlicensed National Information Infrastructure (UNII) bands: (5.250 -5350 MHz) and to observe channel activity and channel loading. A licensed band, 200 MHz, was also studied for use on a secondary licensed basis for radio telemetry using software defined radios. Research on licensed radio emitters in other radio bands that authorize broadband datacom was also conducted.

A "Grid Square" map that was produced by the Cities GIS Manager was used to locate fifteen representative geographic areas within the City's boundaries for the RF sampling.

Vertical 3 dBi gain antennas manufactured by Radiall-Larsen, one each for the 5.8 GHz, 4.9-5.3 GHz, 2.4 GHz, 900 MHz and 200 MHz mounted into a car rooftop magnetic mount base, connected by a 3 meter coaxial cable and a low-loss N connector to a Rohde-Swartz FHS-6 Spectrum Analyzer. A Dell Latitude D500 laptop PC was used for the RF sampling and recording of spectral displays. Spectral displays were recorded at specific grid squares.

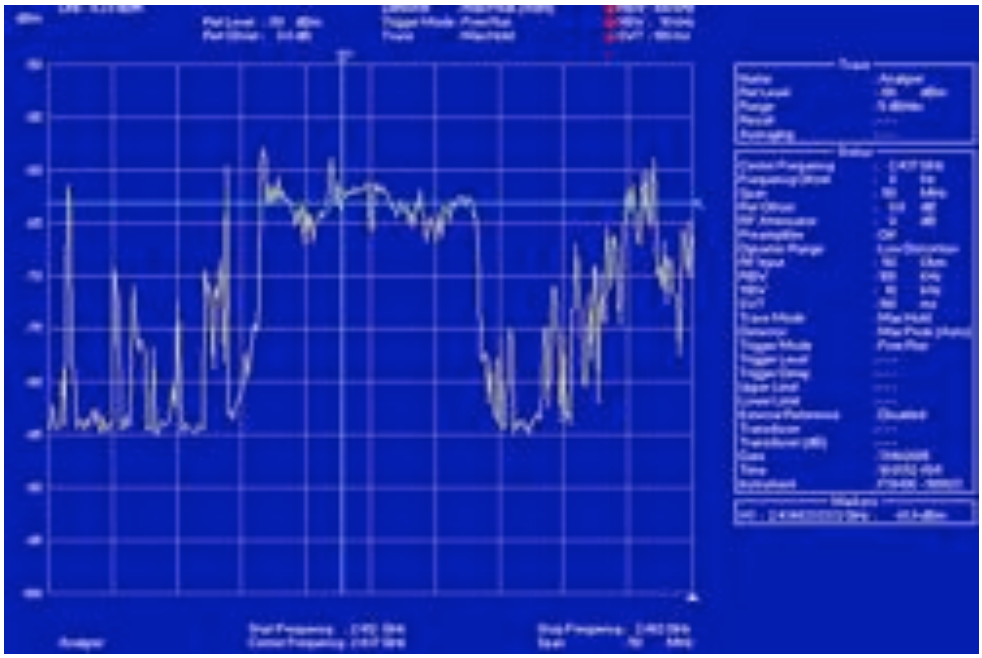

**Figure C1. Example Spectral Display 2.4 GHz in City Grid Square 58 B2**

This example of the spectral displays indicates WiFi traffic in a residential neighborhood, which was typical in the City of Folsom.

## Wireless Interference Issues

Under the FCC, Title 47, Part 15 regulations governing unlicensed point-to-point and point-to-multi-point radio links using low power of 1 watt and gain antennas are subject to interference as no user has a priority assigned frequency (as is the case in a FCC licensed service). Under Part 15, operators have no priority over or parity with any of the other users and must not cause harmful interference to all licensed and legally operating Part 15 users and must accept interference from all licensed and legally operating Part 15 users. [Part 15.5 (b) and (c)].

These Part 15 bands include unlicensed devices like cordless phones, home video surveillance cameras, microwave ovens and wireless local area networks (WLANs) that support the widely used Institute of Electrical and Electronic Engineers (IEEE) 802.11 WiFi data protocol standards. The key to deploying "robust" radio links in these ISM and UNII bands is to avoid interference through radio link planning (selecting non-interfering channels) and to utilize modulation techniques that help mitigate radio wave propagation issues (such as multi-path fading). A new IEEE standard 802.16 called WiMAX incorporates advanced modulation and multiplexing techniques to enable greater path lengths to be achieved while maintaining a high-data throughput (broadband) over greater distances extending coverage areas of the radio emitter.

## City of Folsom RF Geography

The City of Folsom is situated at the foot of Carpenter Hill, an 858 foot ridgeline, and a continuation of the ridge on the south side of Highway 50 called White Rock Peak, both of which are the highest geographic points in Sacramento County. Carpenter and White Rock Peaks are a major RF source as both broadcast, cellular telephone, microwave radio and 2-way radio installations are installed there.

**Carpenter Hill** **White Rock Peak**

**Figure C2 Sacramento County High Point East of City of Folsom**

Sacramento County is responsible for the management of the Carpenter Hill radio sites. The City is spread over 22 square miles, bordered by Highway 50, Carpenter Hill and Folsom Lake, and bisected by the American River. The topography consists of hills and valleys. Most of the City has line-of-sight (LOS) or near line-of sight (NLOS) to the radio emitters located on Carpenter Hill.

## WiFi 802.11 Hot Spots

Along the major avenues in the City, many of the retail establishments have installed WiFi 802.11 "Hot Spots" in the 2.4 GHz ISM band providing internet access to patrons. Other businesses have WiFi installations to service their own office IP data communications.

Residential neighborhoods also have numerous home WiFi installations as was observed during the RF analysis.

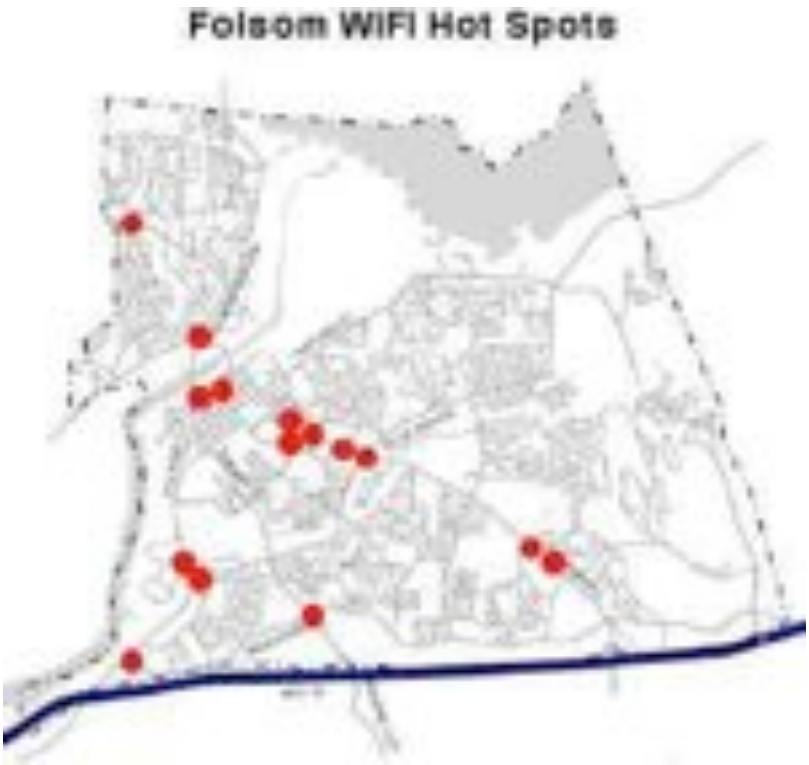


**Figure C3. WiFi Hot Spots in the City of Folsom**

## RF Band Assessment

The 5.8 GHz, 4.9 to 5.3 GHz, 2.4 GHz, 900 MHz and 200 MHz radio frequency bands were analyzed at 15 survey points around the City of Folsom on July 13 and July 14. Survey points in key grid squares were selected.

The 5.8 GHz and the 4.9 to 5.3 GHz bands appear to be without RF carriers, indicating no RF activity above the noise floor. The 2.4 GHz band appeared to have multiple RF carriers in both business and residential neighborhoods indicating that WiFi local area networks (WLANs) are fairly widely deployed in the City of Folsom. The 900 MHz ISM Band was occupied with several RF carriers, with the same RF carriers observable in nearly all of the sampled grid square locations. This observation is consistent with point-to-point radio links in the 900 MHz band, which is used for radio telemetry and WLAN "back haul". The 200 MHz licensed band also had several consistent RF carriers observable in most of the sampling locations that also appear to be point-to-point radio links, possibly used for telemetry.

## Radio Band Identification

Based on the RF analysis the 5.8, 4.9 or 5.3 GHz bands would be suitable for the development of a wireless network in the City of Folsom. Currently, pre-WiMAX networks are being deployed in the US in these bands as they are generally "unoccupied", as is the case in the City of Folsom.

2.4 GHz is also a possibility for a City wide wireless network where "hot spots" could be interconnected via 900 MHz links to one or more Internet gateways located on towers on Carpenter Hill. This approach of using 2.4 GHz 802.11 offers a more ubiquitous coverage since many consumer devices are equipped with WLAN modems that operate in this frequency.

A radio band that is being "re-farmed" by the FCC is the 700 MHz band, which is currently assigned mainly to television broadcast services and partially to public safety 2-way radio networks. The FCC is considering allocating 20 MHz of this spectrum to UNII for broadband wireless. This would be an ideal band for coverage of the City of Folsom as ultra high frequency (UHF) links do not require line-of-sight connections and are less attenuated by foliage and structures allowing the RF signals to penetrate inside buildings. The FCC is expected to issue a notice of proposed rulemaking (NPRM) sometime later this year as to how the re-farming of the 700 MHz band will take place.

# Appendix D
# Technology Analysis & Alternatives

## The WiMAX Network System – Going Beyond WiFi

WiMAX (Worldwide Interoperability for Microwave Access) wireless technology is rapidly becoming the preferred standardized data communications system to provide over-the-air broadband Internet access for both urban and rural communities.

To overcome the coverage area restrictions of the standardized 802.11 Wireless Fidelity (WiFi), the IEEE has developed a new standard, 802.16d for Metropolitan Area Networks (MANS). WiMAX is viewed as the next step to extending broadband wireless access over longer distances, as well as significantly reducing the cost of bringing broadband connectivity to urban and rural areas. Today, tens of thousands of WiFi hot spots provide data speeds of a few megabits per second over distances of a few hundred feet. Wireless LANs (WLAN) can reach speeds of more than 50 Mbps, but their reach is still limited because of transmitter power and modulation limitations.

WiMAX technology goes much further than WiFi by supporting data transmission speeds of 70 Mbps, which is enough bandwidth to simultaneously support 60 businesses with T1-type connectivity and hundreds of residences with DSL-type connectivity. Providing up to 30 miles of linear service area range, WiMAX allows users to obtain broadband connectivity wirelessly. Within a typical cell radius deployment of three to five miles, users do not require line-of-sight (LOS) providing an important solution to the "last-mile" problem (the expense and time of connecting the Internet to a customer premises).

The use of Orthogonal Frequency Division Multiplexing (OFDM) enables WiMAX radio paths to be Non line-of-sight (NLOS), a great advantage over WiFi, which requires line-of-sight (LOS) links. 802.16d standards were finalized in mid-2005 with standards based and interoperable WiMAX base station and subscriber units expected to be on the market in the US by late 2005 or early 2006.

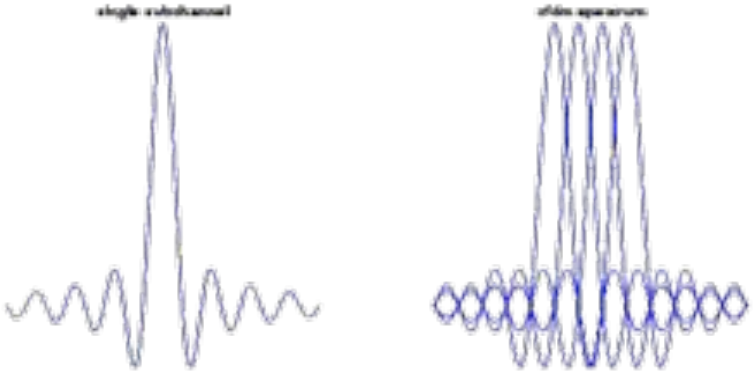

*Figure 1. MCM and OFDM spectra.*

Even more compelling for end-users is the 802.16e WiMAX standard that enables full portability/mobility of PCs, wireless phones and other devices. Intel Corporation, a strong proponent of WiMAX, will be mass-producing "chip sets" for installation in laptops by 2007.

A WiMAX network system consists of two parts:

- WiMAX Base Station Unit: The Base Station Unit (BSU) is similar in concept to a cell phone tower except that the BSU is connected to a high speed Internet facility by wire, fiber optic or microwave link. The BSU microwave radio will operate in the 5.8 GHz unlicensed band (UNII) and the radio will use directional antennas to facilitate "beaming" the radio signals to the intended coverage area.

- WiMAX Subscriber Unit - The Subscriber Unit (SU) is a small equipment package that contains a directional flat plate antenna, radio transceiver and a modem that has an Ethernet port. The SU can be mounted in a window, on a wall or on a rooftop. Future 802.11e standards for mobile application will see the integration of WiMAX on PC cards and built into a laptop in the same way WiFi is today.


**Figure D2: WiMAX Network**

The added benefit that remote WiMAX users need less, or even no on-site installation assistance, significantly reduces the cost and set-up time of delivering the service, allowing it to favorably compete with existing cable or other wired solutions. With the 802.16e standard adoption, personal computers, automobiles, appliances and devices of all kinds will be WiMAX enabled.

Perhaps the greatest attribute of WiMAX is that it can be integrated with an existing WLAN infrastructure to enable coverage for an entire campus and metropolitan area, enabling a WiMAX "warm zone" servicing the entire community of users and supporting a mobile lifestyle. For educators and businesses this means that the classroom or office can be virtually extended to any place within a WiMAX coverage area and the forthcoming 802.16e mobility standard means that students can be connected while on the school bus or in the family car and business users can access the Internet from PDA's and laptops.

The benefits realized by deploying WiMAX in a municipality range from providing high-performance network connectivity at a low per user cost, to providing Internet access and network services to locations that previously have been underserved or not served at all.

**Choosing The Radio Band for WiMAX Network Deployment**

2005 and 2006 are key years for WiMAX network developers. Three key WiMAX standards that have been or that are being ratified by the WiMAX forum are:

- The 802.16d specification ratified in 2005 for point-to-point WiMAX applications,
- 802.16e which is expected to be ratified by mid-2006, which will enable mobility. It is viewed by the fast developing WiMAX industry as the "holy grail," because Intel Corporation will be equipping millions of PC's, laptops, telephones and other computerized devices with 802.16e compatible chips.
- 802.16h, the specification for license exempt (LE) radios that can operate in the UNII and ISM radio bands in the USA. 802.16h will incorporate 802.16e.

WiMAX networks that operate in the licensed frequencies at 2.5 GHz have a substantial advantage over unlicensed networks in that power levels at the Base Station Units are substantially greater and the licensee is protected from interference. In an unlicensed network, the probability of interference from other networks operating in the same radio band is far higher and the ability to mitigate interference accomplished on a "cooperative" basis with other unlicensed operators. In practice, license exempt bands may only be able to support two or three networks operating in the same band.

Software Defined Radios (SDR) or Cognitive Radio's may offer a solution for unlicensed bands in that they "listen first" before transmitting and in a "bursty" data communications network like a WiMAX network there are many time intervals where a SDR can connect to the base station and send data. SDRs also can search out unused or underused so called "white frequencies" to communicate to the base station.

**Intel Roadmap**

Intel is one of the major backers of the WiMAX standard, and was a primary force behind the widespread adoption and success of the earlier WiFi standard. Its roadmap for wireless broadband technology has WiMAX beginning as an enabler of wide area networks, and eventually moving to consumer uses, such as mobile computing. In-home networks using ultra wideband technology, local hotspots using WiFi access points, and more specialized services employing 3G (third generation) cellular telephone systems also play a role in this vision.

As one of the few, truly global leaders in the high technology sector, Intel attracts companies and visitors to Folsom. A genuine synergy exists between the City's desire to be a magnet for blue chip, high technology employers, and Intel's goal of fostering widespread adoption of wireless broadband technology of all kinds, but particularly WiMAX.

In mid-August 2005, Intel created a "Digital Communities" initiative, which brings together a diverse group of high-tech companies with 13 pilot cities, including Corpus Christi, Philadelphia and Taipei. The project aims to "enhance government efficiency, promote economic growth, foster greater community satisfaction and bridge the digital divide." Intel's goals are directly aligned with the capabilities and benefits envisioned by the conceptual design and business model for a wireless broadband system in Folsom.

## 802.11 WiFi Hot Spots Enabled by WiMAX Infrastructure

Today, 802.11 WiFi is fairly ubiquitous within the city limits with business and residential users alike using WLANs for in-building wireless mobility. Linking to established WiFi hot spots would seem on first look to be a sensible way to implement a hybrid WiFi/WiMAX network using 802.16d for point-to-point back haul of WiFi hot spots.

Figures D3 and D4 depict an 802.16h WiMAX overlay operating in the 5.8 GHz unlicensed band, linking to 802.11 hot spots. The maximum line of sight path length from a base station with directional antennas located on Carpenter Hill to the Northwest corner of the City of Folsom is 6.5 miles. WiMAX units would be mounted on utility poles along with a WiFi Access Point and powered by an AC line voltage tap off of a street lamp.

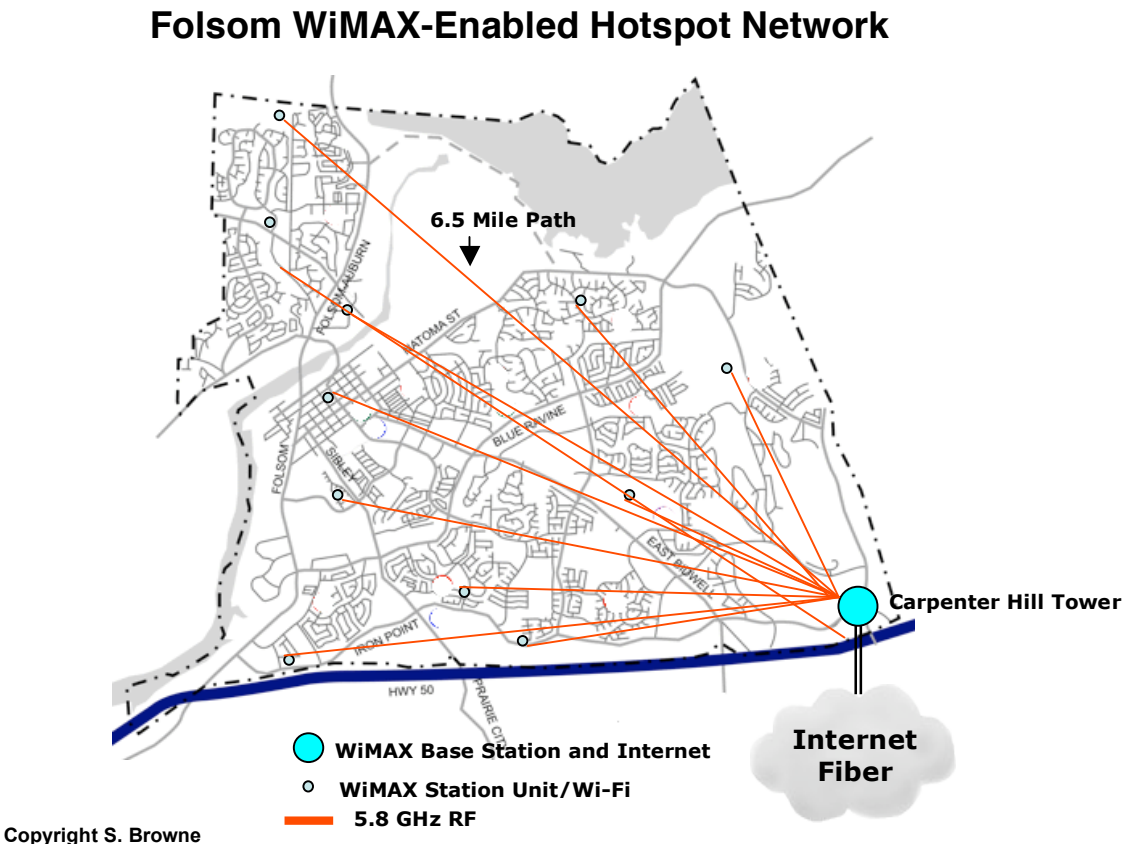


**Figure D3. WiMAX Point-to-Point Network Link WiFi Hot Spots**

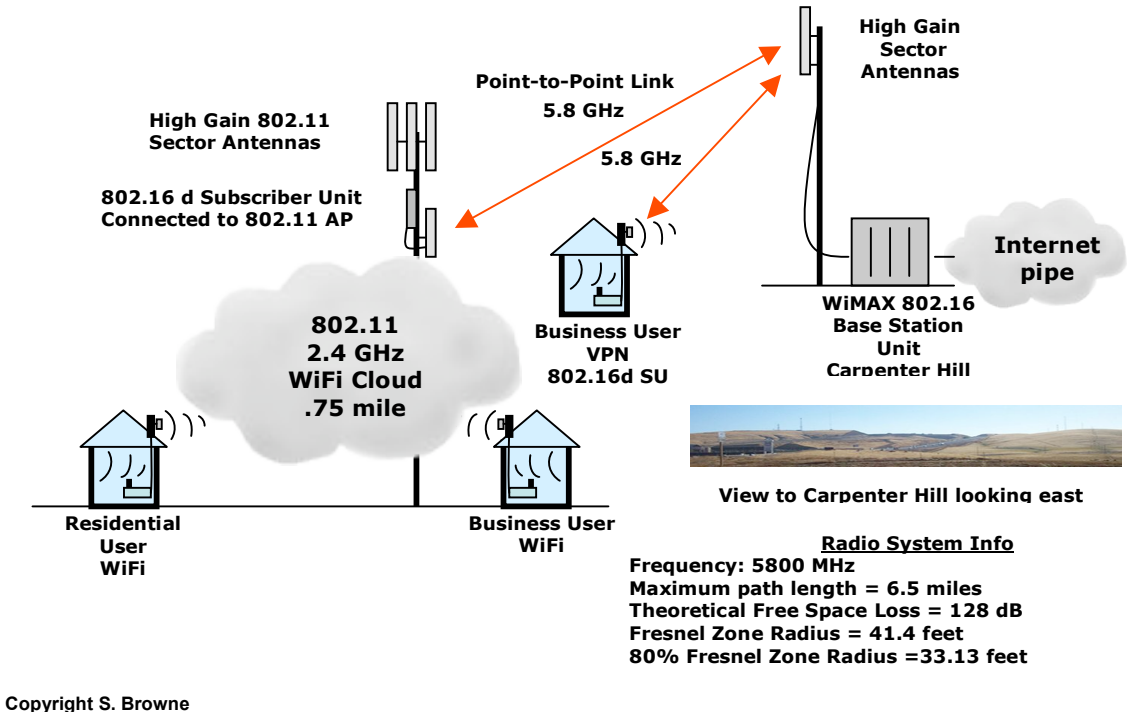


**Figure D4. City of Folsom WiMAX to WiFi Network**

WiFi hot spots operate in the 2.4 GHz band, which has eleven 22 MHz wide frequencies defined, starting at 2.412 GHz with a channel beginning every 5 MHz through to 2.462 GHz Three non-overlapping channels are available: channels 1, 6 and 11. These non-overlapping channels can be used in a three to one frequency reuse plan as depicted in Figure D5, to provide city-wide coverage if desired.


**Figure D5. 2.4 GHz WiFi Frequency Re-Use Plan. WiFi Zone Diameter = 1.5 miles range assumes point-to-point directional antennas from Hot Spot Access Point to end-user.**

The OFDM, Time Division Duplex (TDD) and QAM modulation techniques employed in the WiMAX specification would enable the network to transport voice, data and video with a quality of service (QoS) unavailable in the 802.11 WiFi specifications, and over far greater distances. As a result, the same concept of using non-overlapping frequencies could also be applied to the 5.8 GHz band using WiMAX-only mini-base stations installed at the center of each cell, with potentially better results. In this case, two WiMAX radios would be used, one servicing the 802.16e mobile subscribers and a second radio using 802.16d standard for point to point communication. However, consumer-grade equipment complying with the 802.16e standard will not become available for several years.

Interconnecting all of the radios into a mesh network is also possible. In this case two radios could be utilized: one to service the end-user devices and the other to link the data back to the Internet gateway via multiple "hops". Alternatively, a single radio could serve both functions, alternating between modes.

# Appendix E
# Spectrum Survey Specimens

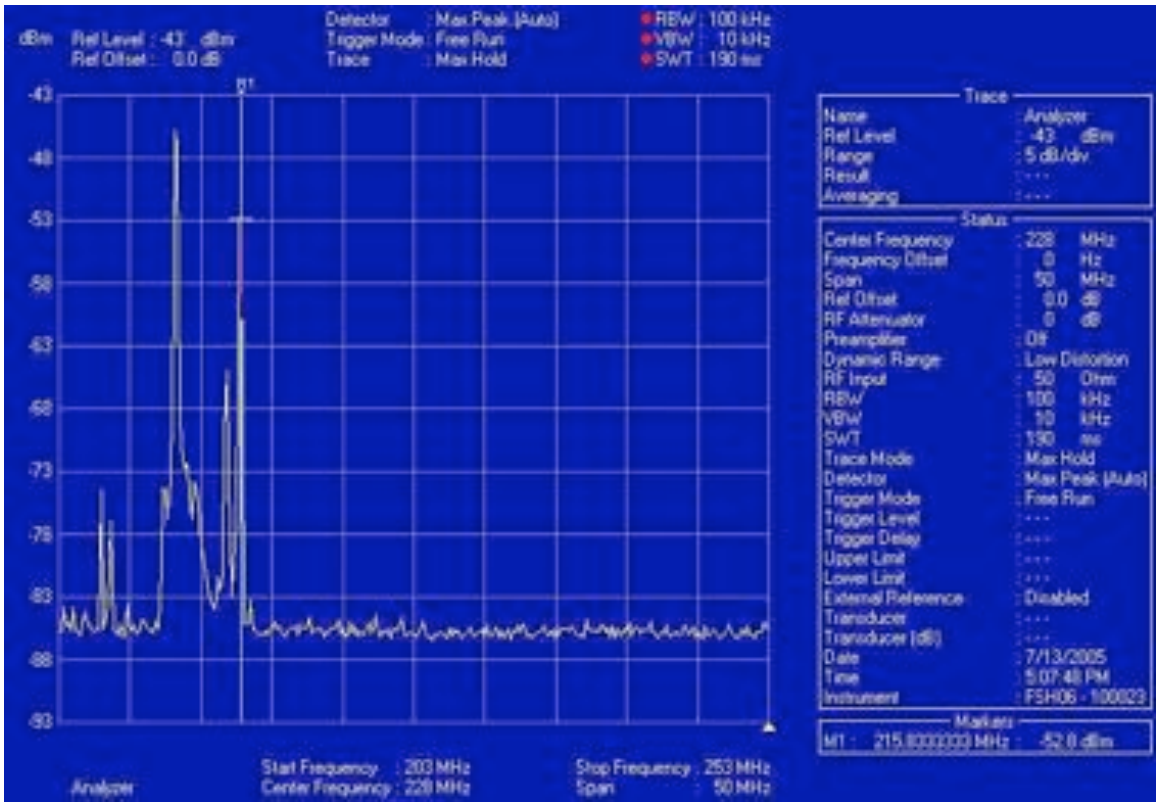


**Figure E1: Sample of spectrum usage at 200 MHz in Folsom.**

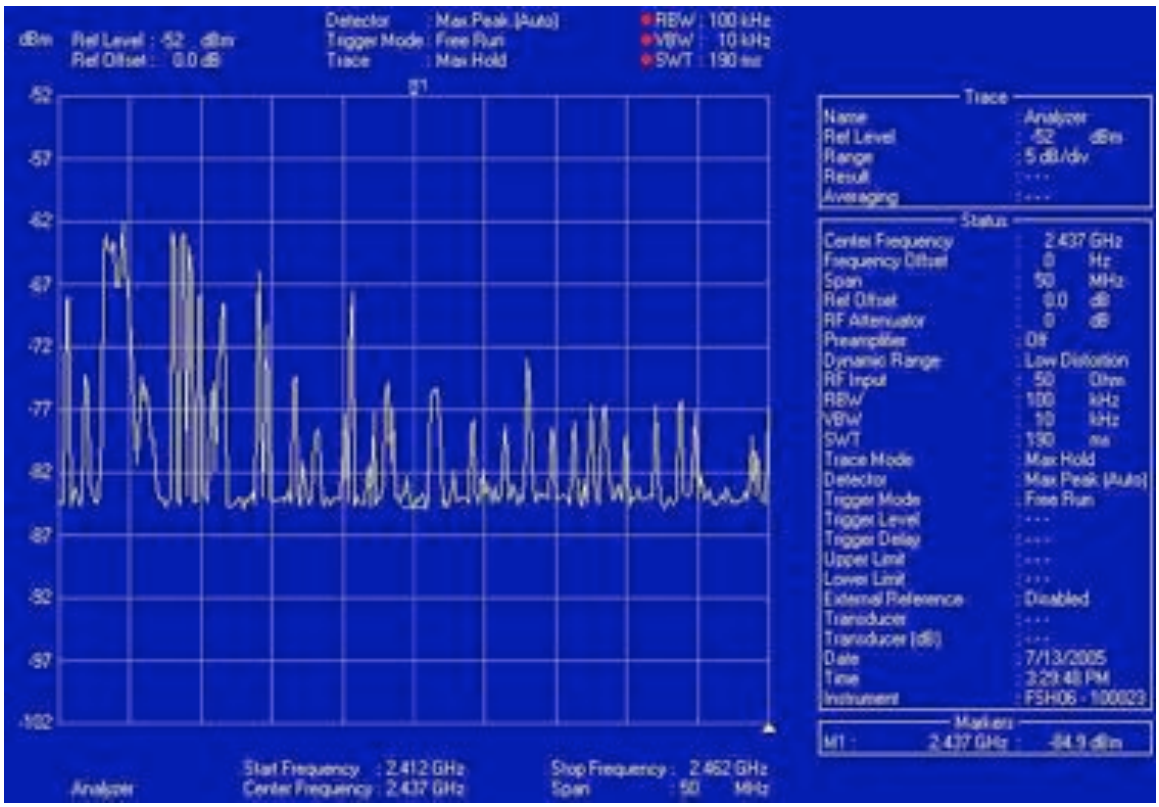


**Figure E2: Sample of spectrum usage at 2.4 GHz in Folsom.**

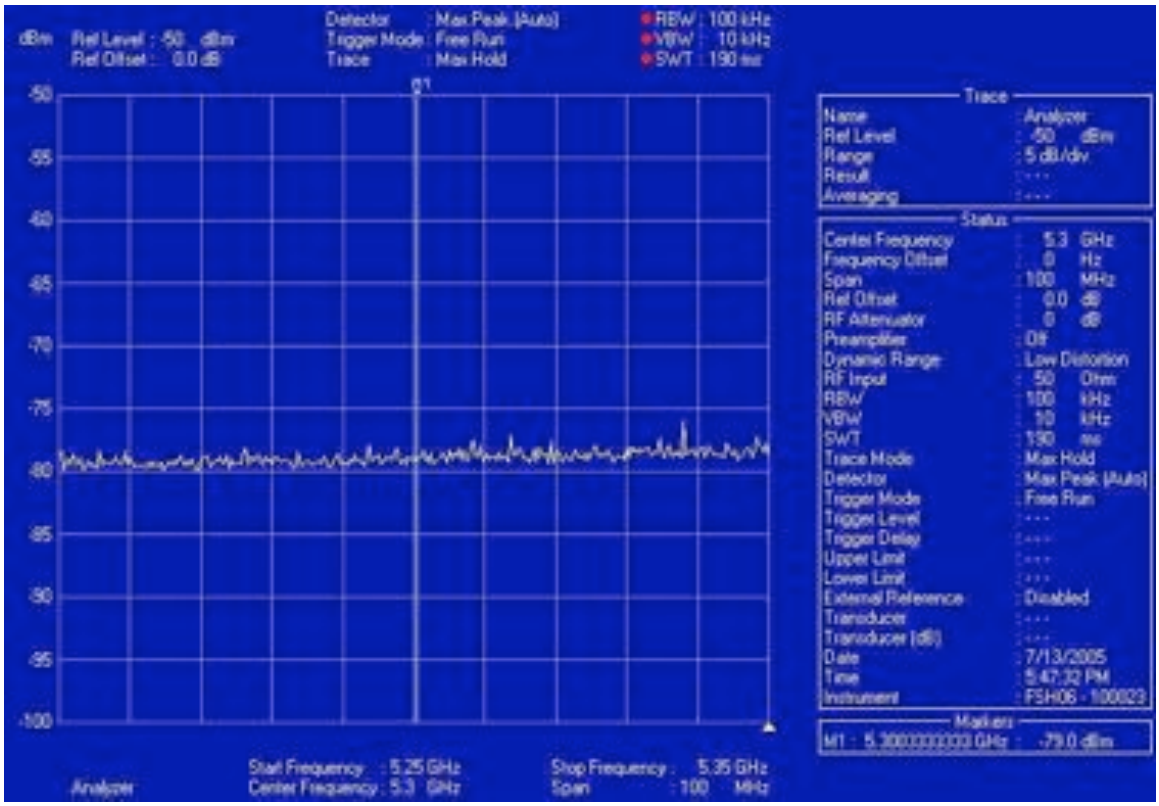


**Figure E3: Sample of spectrum usage at 5.3 GHz in Folsom.**

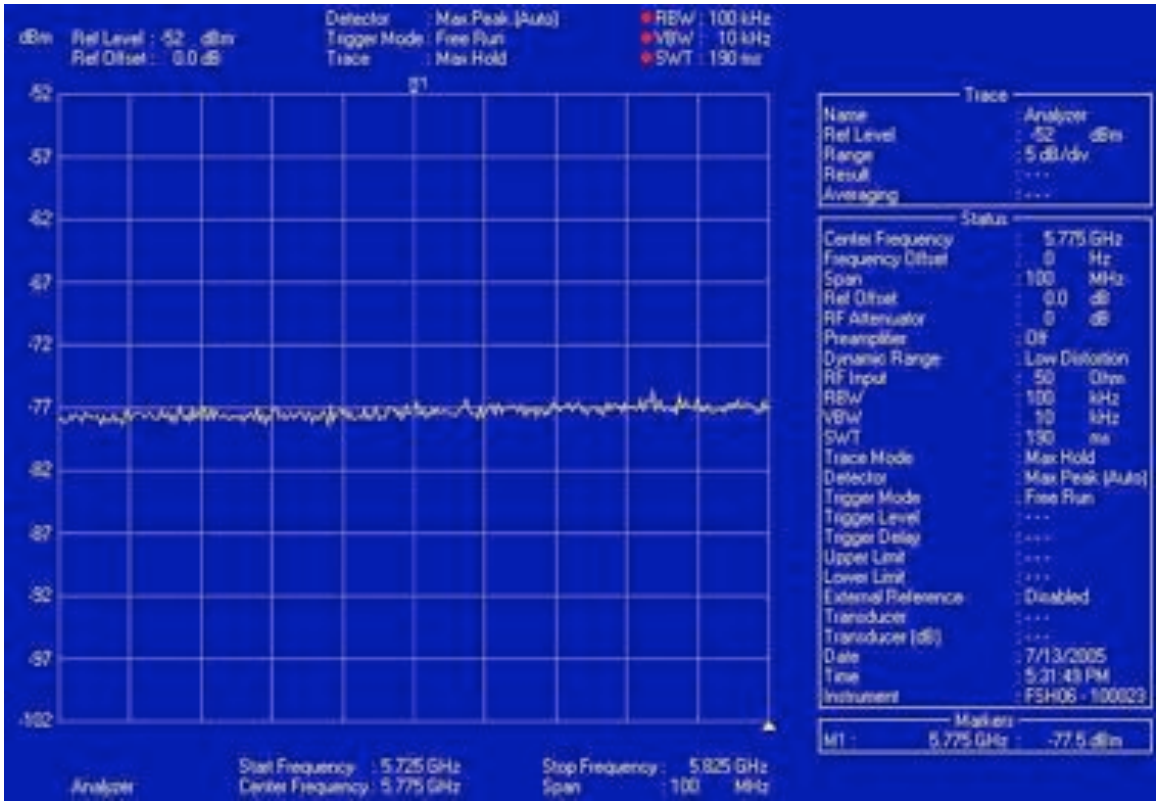


**Figure E4: Sample of spectrum usage at 5.8 GHz in Folsom.**

# Appendix F
# Sample Equipment Specifications

TROPOS networks

Metro-Scale Mesh Networking Defined™

# 5210 Outdoor MetroMesh™ Router

## FEATURES

### MetroMesh OS

- Patented, purpose-built layer 3 mesh routing intelligence
- Predictive Wireless Routing Protocol for optimized client-server throughput
- Ability to run multiple virtual networks on a single wireless mesh infrastructure
- Auto-discovery and auto-configuration on power-up
- Continuous, real-time adjustment of optimum data paths
- Redundant, self-healing network architecture
- Session-persistent roaming

### Secure Management

- User-defined traffic filters
- 802.1x/WPA
- MAC address access control lists
- AES encryption of wireless routing
- Full VPN compatibility
- Secure local and remote configuration via HTTPS
- SNMP-based element management system

### Platform

- High-performance 54 Mbps Wi-Fi
- Unrivaled link budget for superior RF propagation
- Outdoor optimized with integrated high power radio

The patented Tropos™ MetroMesh™ architecture combines the industry's most sophisticated mesh routing intelligence, designed from the ground up to optimize throughput in a dynamic metro-scale Wi-Fi mesh environment, with carrier-grade centralized element management and a purpose-built hardware platform with peerless Wi-Fi link budgets. The Tropos Networks™ MetroMesh architecture leverages Wi-Fi to enable metro-scale mesh deployments that were previously difficult or impossible. The result: the fastest, lowest-cost and simplest wireless broadband solution available anywhere.

The MetroMesh OS, including the Tropos Predictive Wireless Routing Protocol (PWRP™), is the industry's most scalable mesh routing algorithm. The Tropos 5210 outdoor MetroMesh router, utilizing the embedded PWRP, creates a self-organizing and self-healing wireless mesh, and intelligently selects the most optimum data path to the wired network. Because the MetroMesh OS and PWRP never require more than 5% of available bandwidth, networks can be easily scaled to many thousand nodes without any client throughput or network capacity degradation.

The MetroMesh architecture is key to maximizing network economics, as the software, management,and hardware combine to enable the operation of multiple independent networks on a single metro-scale Wi-Fi mesh infrastructure. Individual user communities can operate independently on the MetroMesh, segregating information access, billing, and access levels.

Tropos MetroMesh routers require only power and can be deployed anywhere it is available. Each MetroMesh router provides wireless connectivity to standard 802.11b/g clients and extends the coverage area of the metro-scale Wi-Fi network.

The ruggedized and weatherized Tropos 5210 is NRTL certified for outdoor installation. It can be mounted on external structures such as buildings or lampposts to quickly implement citywide applications such as police data communications or public wireless access.

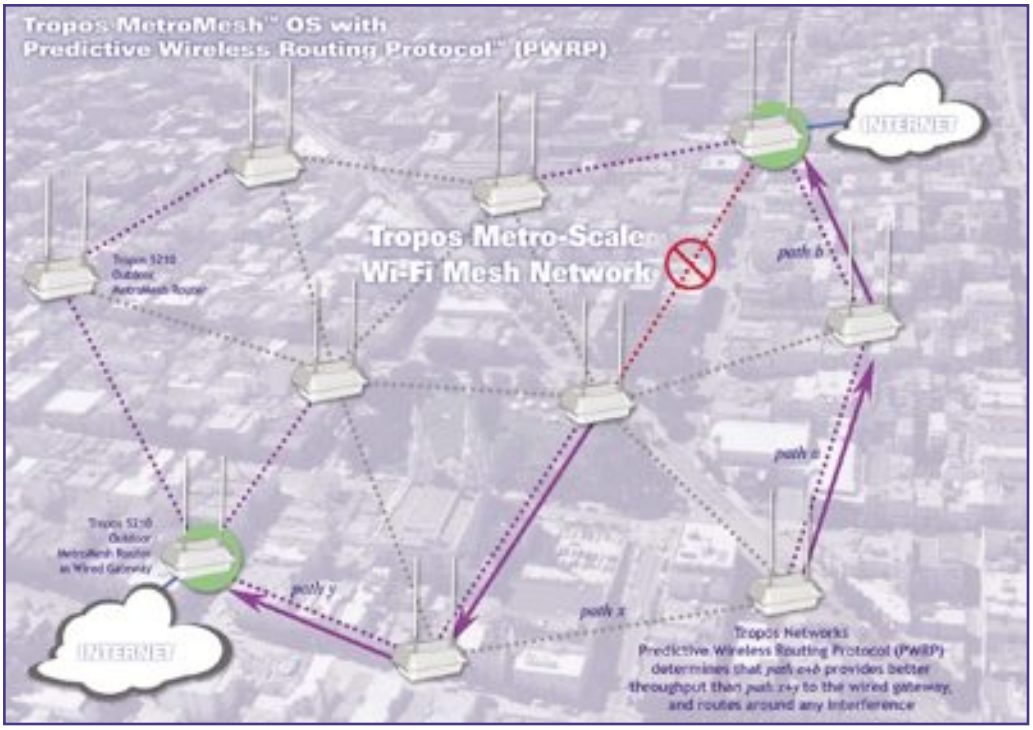


Photo courtesy of NASA Image eXchange.
Image use in no way implies endorsement by NASA of any of the products, services, or materials offered by Tropos Networks, Inc.

# 5210 Outdoor MetroMesh™ Router

TROPOS networks

Metro-Scale Mesh Networking Defined™

## TECHNICAL SPECIFICATIONS

### Wireless
- IEEE 802.11b/g
- Frequency band: 2.4-2.483 GHz
- Modulation: 802.11g - OFDM (64-QAM, 16-QAM, QPSK, BPSK)
  802.11b - DSSS (DBPSK, DQPSK, CCK)
- TX Power: Standard-Power 14dBm-24dBm (EIRP) factory-set in 1dB units
  High-Power 26dBm-36dBm (EIRP) factory-set in 1dB units
- 7.4dBi Omnidirectional antennas
- Media Access Protocol: CSMA/CA with ACK
- RX Sensitivity:

| | |
|---|---|
| -100dBm @ 1 Mbps | -90dBm @ 18 Mbps |
| -94dBm @ 5.5 Mbps | -87dBm @ 24 Mbps |
| -92dBm @ 11 Mbps | -84dBm @ 36 Mbps |
| -95dBm @ 6 Mbps | -79dBm @ 48 Mbps |
| -93dBm @ 12 Mbps | -77dBm @ 54 Mbps |

- Transmit and Receive diversity

### Networking
- TCP and VPN session persistent roaming
- Full 802.11b/g client compatibility
- NAT support
- Layer 2 and Layer 3 support
- DHCP Server and Relay
- Sub-interface support
- Ethernet port

### Management
- HTTPS to on-board configuration management tools
- Secure local and remote configuration via HTTPS
- SNMP V2c
- Tropos MIB
- Browser-based management tool
- Simple configuration save and restore
- Network & client monitoring and statistical capture features

### Security
- WPA - Wi-Fi Protected Access (64, 128, 152-WEP with TKIP)
- Multiple ESSIDs
- Full VPN compatibility
- VPN filtering—rejects non-VPN traffic
- MAC address access control lists
- HTTPS only to on-board management tools
- AES encryption of wireless routing
- Packet filtering
- ESSID suppression

### Environmental Specifications
- Operating temperature range: -40˚C to 55˚C
- Storage temperature range: -40˚C to 85˚C
- Weather rating: IP67 weathertight
- Wind survivability: >165 mph
- Wind loading (165 mph): <1024 Newtons
- MIL-STD-810F 509.4 Salt Fog rust resistance compliant
- Shock & vibration: ETSI 300-19-2-4 spec T41.E class 4M3
- Transportation: ISTA 2A

### Optional Battery Back-Up
- Factory Installed Li-Ion battery
- Back-up power 4-12 hours typical

### Optional Accessories
- Power Cables
  - Street light NEMA photo-electric control power tap 90-480 V AC, 2 wire 4 ft. power cable
  - Street light NEMA photo-electric control power tap 90-480 V AC, 2 wire 20 ft. power cable
  - Electrical power cord, US/Canada 120 VAC, 15 A, 3 prong 6 ft. or 30 ft.
- CAT5 building entrance data protection; network protection unit

### Package Contents
- Tropos 5210
- Mounting bracket and accessories
- Hardware Installation and Quick StartGuides

### Approvals
- FCC CFR 47 Part 15, Class B
- Industry Canada RSS 210
- Taiwan DGT LP0001/LP0002
- VCCI class B
- ARIB STD-T66
- EN 301 489-17
- EN 300 328

- EN 60 950
- IEC 950
- UL 60950-1
- CSA 22.2 No. 950

- UL 579/IEC 60529 IP67 rated for outdoor use
- UL 1449/IEC 60 664-1

- CE!

### Hardware Specifications
- Autosensing 10/100BaseT Ethernet
- Power input:
  - 90-480VAC 50/60Hz single and split-phase ANSI/IEEE C62.41 category C3 integrated branch circuit protection
  - AC power consumption: 18 W typical
- Power over Ethernet power sourcing capability: 12Vdc @ 14W, 24Vdc @12W, 48Vdc @ 10W output
- Power-on and network status lamp: Green/Red
- Dimensions (w/o mounting brackets or antennas): 13.00 in (33.02 cm) wide x 8.00 in (20.32 cm) deep x 5.3 in (13.50 cm) high
- Weight: 14 lbs (6.40 kg) max., with mounting brackets,

### Protection Circuits
- Antenna Protection: ≤ 0.5µJ for 6kV/3kA @ 8/20µS Waveform
- Electrical Protection:
  - ANSI/IEEE C62.41, UL 1449-2nd ed., 10kA @ 8/20 µS Wave form, 36kA per phase, L-L, L-N, L-PE
  - EN61000-4-5 Level 4 AC Surge Immunity
  - EN61000-4-4 Level 4 Electrical Fast Transient Burst Immunity
  - EN61000-4-3 EMC Field Immunity
- Data Protection:
  - EN61000-4-2 Level 4 ESD Immunity

### Warranty
- One (1) year on parts and labor; return to point of purchase
- *Optional* standard and premium support packages available

### Ordering Information:
Part Number: 52102501
Tropos 5210 mesh router, Japan TX; two 7.4 dBi omni antennas; bracketry
Part Number: 52102601
Tropos 5210 mesh router, Japan TX; battery backup; two 7.4 dBi omni antennas; bracketry
Part Number: 52102504
Tropos 5210 mesh router, ETSI/EU TX; two 7.4 dBi omni antennas; bracketry
Part Number: 52102604
Tropos 5210 mesh router, ETSI/EU TX; battery backup; two 7.4 dBi omni antennas; bracketry
Part Number: 52103000
Tropos 5210 mesh router, high power; two 7.4 dBi omni antennas; bracketry
Part Number: 52103100
Tropos 5210 mesh router, high power; battery backup; two 7.4 dBi omni antennas; bracketry
*For additional configuration options please contact your Tropos Representative*

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213544 rev.h


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## Specifications

### Radio

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Frequency | 5.725 - 5.850 GHz, 5.47 - 5.725 GHz, 5.15 - 5.35 GHz, 5.03 - 5.091 GHz | | | | | | | | |
| Radio Access Method | Time Division Duplex (TDD) | | | | | | | | |
| Channel | 10 MHz, 20 MHz | | | | | | | | |
| Central Frequency Resolution | 5 MHz, 10 MHz | | | | | | | | |
| Output Power (at antenna port) | AU: -10 dBm to 21 dBm, 1 dB steps<br>SU: -10 dBm to 21 dBm, automatically adjusted by ATPC | | | | | | | | |
| Max Input Power (at ant. port) | -48 dBm Typical | | | | | | | | |
| Sensitivity, typical (dBm at antenna port, @$10^{-6}$) | Modulation | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| | Level* (20 MHz) | -89 | -88 | -86 | -84 | -81 | -77 | -73 | -71 |
| | Level* (10 MHz) | -92 | -91 | -89 | -87 | -84 | -80 | -76 | -74 |
| | * Modulation Level combines modulation scheme and coding gain. | | | | | | | | |
| Modulation Scheme (Adaptive) | OFDM: BPSK, QPSK, QAM 16, QAM 64 | | | | | | | | |
| Antenna Port (AU-RE) | N-Type 50 ohm | | | | | | | | |
| Subscriber Integrated Antenna | 21 dBi, 10.5° H/V, Integrated flat panel | | | | | | | | |
| AU Antennas | 60°: 16dBi, Sector 60° horizontal, 10° vertical<br>90°: 16dBi, Sector 90° horizontal, 6° vertical<br>120°: 15dBi, Sector 120° horizontal, 6° vertical ,<br>360°: 8dBi, Sector 360° horizontal, 9° vertical (AU-SA 5.8 GHz only) | | | | | | | | |

### Data Communication

| | |
|---|---|
| VLAN support | Based on IEEE 802.1q |
| Layer-2 Traffic Prioritization | Based on IEEE 802.1p |
| Layer-3 Traffic Prioritization | IP ToS according to RFC791 |
| Security | WEP 128-bit, Authentication |

### Configuration and Management

| | |
|---|---|
| Local & Remote Management | Monitor via Telnet, SNMP and Configuration Upload/Download |
| Remote Management Access | From Wired LAN, Wireless Link |
| Management Access Protection | Multilevel Password<br>Configuration of remote direction (From Ethernet only, Wireless only, or both sides)<br>Configuration of IP addresses of authorized stations |
| Software upgrade | Via TFTP and FTP |
| Configuration Up/Download | Via TFTP and FTP |
| SNMP Agents | SNMP v1 client, MIB II, Bridge MIB, Private BreezeACCESS VL MIB |

### Physical and Electrical

| Type | | Connectors | Electrical |
|---|---|---|---|
| SU-NI, AU-NI | Ethernet | 10/100BaseT RJ-45, 2 embedded LEDs | Power consumption 25W<br>AC input: 100-240VAC, 50/60Hz |
| | Radio | 10/100BaseT Ethernet RJ-45 | |
| | AC IN | 3-pin AC power plug | |
| SU-RA, AU-RE | Indoor | 10/100Base RJ-45 with waterproof sealing assembly | 54 VDC from indoor to outdoor |
| AU-BS | Ethernet | 10/100BaseT RJ-45, 2 embedded LEDs | Power consumption 30W (module plus outdoor unit)<br>AC input: 100-240VAC, 50/60Hz<br>3.3VDC, 5.4V from power supply in backplane |
| | Radio | 10/100BaseT Ethernet RJ-45 | |
| BS-PS-AC-VL (AC power supply) | AC-IN | 3-pin power plug | Power consumption: 240W, full chassis (1 PS, 6 AU)<br>AC input: 85-265VAC, 47-65Hz<br>DC output: 5.4V, 3.3V |
| BS-PS-DC-VL (DC power supply) | -48 VDC | 3-pin DC D-Type 3 power pin plug Amphenol | Power consumption: 240W, full chassis (1 PS, 6 AU)<br>DC input: -48 VDC nominal (-34 to -72), 10 A max.<br>DC output: 5.4V, 3.3V |

### Standards Compliance

| Type | Standard | |
|---|---|---|
| EMC | FCC Part 15 class B, CE EN55022 class B | |
| Safety | UL 1950, EN 60950 | |
| Environmental | Operation | ETS 300 019 part 2-3 class 3.2E for indoor units<br>ETS 300 019 part 2-4 class 4.1E for outdoor units |
| | Storage | ETS 300 019-2-1 class 1.2E |
| | Transportation | ETS 300 019-2-2 class 2.3 |
| Lightning Protection | EN 61000-4-5, class 3 (2kV) | |
| Radio | FCC Part 15 | EN 301 753<br>EN 301 021<br>EN 301 893 |

Note: Not all options are available in all regions. Please contact your local representative for further information



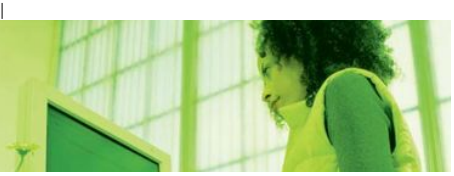
alvarion®
We're on your wavelength.

# BreezeACCESS™ VL

## Broadband Wireless Access - Beyond the Line-of-Sight

BreezeACCESS VL is the latest addition to the BreezeACCESS product family, the world's most deployed wireless broadband platform. Superior features such as non-line-of-sight (NLOS), extended reach, high capacity, encryption, QoS mechanisms and an enhanced access suite are available today by building a network based on BreezeACCESS VL, Alvarion's premier broadband wireless platform in the 5GHz frequency. Carriers, mobile operators, ISPs, enterprises and others who have already integrated BreezeACCESS VL into their network are now providing WiMAX services today!

Take advantage of the improved economics of wireless with increased subscribers and low cost infrastructure investment with future-ready capacity and rich features. With BreezeACCESS VL, operators offer a wide variety of services and applications including VoIP, wireless leased line, hotspot feeding, gaming, secure VPN, video surveillance and xDSL in urban and rural environments, even in extreme temperatures.



## Choose BreezeACCESS VL for:

- Connecting communities - for cost-effective access within communities, municipalities and educational institutions
- Hotspot feeding - for increasing speeds, capacity and reliability in hotspots
- Security and surveillance - wireless cameras transmitting heavy bandwidth requiring secure reliable services
- Last mile access - services for both residential and business users in the same area with different SLAs
- Metropolitan area networks - broadband connectivity with NLOS capabilities for all environments, even dense with buildings or foliage
- Enterprise Networks - leased line replacement for cost-effective connectivity providing VoIP and data services in enterprises and campuses

## Reasons for Choosing BreezeACCESS VL

### Technological Advantages

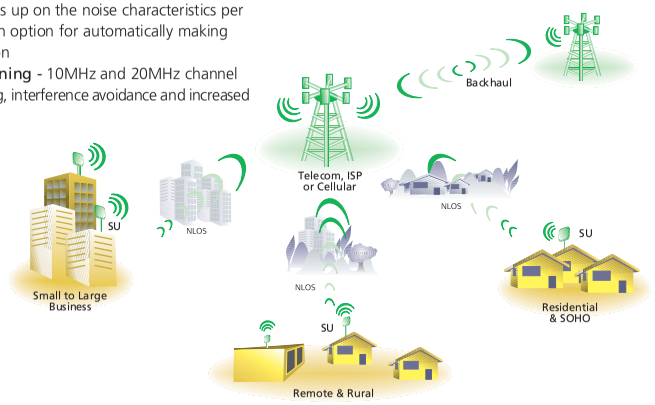
- **Expansive coverage** - serves more customers with fewer base stations
- **OFDM non-line-of-sight** (the basis of the WiMAX standard)
- **High Capacity** - more users per sector, including corporate users as well as MDU/MTU users with different levels of SLAs
- **DFS+** (dynamic frequency selection) for countries that require DFS, plus an Alvarion only algorithm to improve channel management under certain conditions of low radar activity
- **Best AU** - for fast and simple SU installation, SU scans the entire frequency band and identifies available AUs, optimizes the link with best AU selection, redundancy mechanism that automatically re-synchronizes with next AU on list
- **Automatic clear channel selection (ACCS)** - a spectrum analyzer mode that picks up on the noise characteristics per channel, and includes an option for automatically making clearest channel selection
- **Flexible network planning** - 10MHz and 20MHz channel options for radio planning, interference avoidance and increased cell capacity

### Economic Advantages

- **Less infrastructure investment today** - NLOS, high capacity, outstanding coverage, multi-subscriber profiles in same sector and network, modular and flexible "pay-as-you-grow", enables fewer base stations and site constructions
- **Lower CAPEX tomorrow** - with future investment protection due to co-location of future WiMAX with BreezeACCESS VL enabling both sets of CPEs to operate at the same time in the same sector, AlvariSTAR management tool will support all Alvarion's WiMAX platforms providing seamless management migration
- **Out-of-the-box low cost installation** -
  - 10 LEDs SNR BAR display on outdoor unit for fast antenna alignment without need for external tools or monitors, standard IDU-ODU CAT5 cable and best AU mode for fast association
  - Optimal performance and connectivity through always-on adaptive modulation and automatic transmit power control (ATPC)
  - Over-the-air software upgrade for easy, cost-saving installation and maintenance
  - Over-the-air configuration and monitoring
  - Automatic distance measuring during installation for optimization of cell performance
- **Lower OPEX** - by requiring fewer base stations, remote management, firmware and configuration download/upload, effective diagnostic tools, self-adaptive to environmental changes (automatic modulation and ATPC)

### Management Advantages

- **AlvariSTAR,** a comprehensive network management support tool with scalable architecture, topology management, configuration and monitoring, fault management, and performance monitoring
- **BreezeCONFIG** - a configuration and monitoring utility that is intuitive and simple to use and enables simultaneous firmware upgrades for multiple CPEs




### Extensive Access Suite Features

- **Bridging functionality** - simple configuration, fast installation 802.1Q VLAN support with trunk, access and hybrid modes
- **QoS** - quality of service using packet prioritization
- **SLA enforcement** - supports different user profiles in the same sector with committed information rates (CIR) and maximum information rates (MIR) per user, per direction; packet prioritization with layer 2 (802.11P) and layer 3 (IP TOS) classification, and graceful degradation in case of congested sector

### Security and Filtering Options

- AES 128 and WEP 128 **encryption** options
- **Access control** with IP address protocol and MAC based filtering, offering better control including being able to limit the number of authorized IP addresses; that can be used to create additional sources of revenue or for preventing local broadcasts from flooding the wireless link

### Flexibility and Modularity

- Flexible topology allowing stand-alone or chassis based configurations for modular and scalable solutions enabling "pay as you grow". Deployable in multiple sectors using various antenna choices
- AC and DC power supply options
- Supports CPE rates of 3Mbps, 6Mbps and 54Mbps
- Upgradeable CPE bandwidth over the air

### The Complete Spectrum™ Solution

- Covers the entire 5GHz band and easily integrates with BreezeACCESS's 900MHz, 2.4GHz, and 3.5GHz bands using the same infrastructure with a range of technologies including OFDM, frequency hopping and hybrid digital modulation
- Supports concurrent LOS, NLOS and multi-frequencies with subscriber speeds from 3 to 54Mbps
- Permits operators to customize networks for their unique market demographics, topographic environments and business model to achieve the highest revenue per cell with maximum subscribers

### Robustness and Reliability

- Adaptive modulation with 8 modulation schemes and smooth changes between rates responding to link conditions, facilitating link robustness, set at the highest per customer rate possible
- **Automatic transmit power control (ATPC)** - The access unit automatically measures and adjusts the subscriber unit's transmission power, enabling easier installation, and optimizing network performance
- Supports various redundancy options

### System Components

The BreezeACCESS VL solution consists of a base station and customer premises equipment (CPE) units. The base stations are available as either modular or stand-alone micro cell units. CPEs are available in various models for differing bandwidths and single or multiple user configurations.

### Access Units (AUs)

Installed at the base station site, the AUs communicate with the CPEs. Each AU includes indoor and outdoor units. The indoor connects to the network through a standard IEEE 802.3 Ethernet 10/100BaseT (RJ-45) interface and to the outdoor unit using a CAT-5 cable. Alvarion offers two types of base stations:

- The modular shelf base station (BS-SH-VL) 19" 3U universal chassis. Each base station shelf can hold up to six AU modules (AU-D-BS), providing reliable access to a maximum number of subscribers. Two power supply modules can be used in a BS-SH-VL chassis (either AC or DC) for fail-safe operation. The AU-D-BS kit includes a chassis based indoor unit, pole mounted outdoor unit and sector antennas.
- The stand-alone micro base station (AU-D-SA) kit includes a small indoor unit, pole-mounted outdoor unit and a sector antenna. A variety of antennas can be used with the base station: 360, 120, 90 and 60 degrees

### Subscriber Units (SUs)


Installed at the customer premises, the subscriber unit (SU) enables customer connection with the base station and supports single or multiple end users. SUs provide an efficient platform for always-on, high-speed Internet and Intranet, VoIP, VPN and other services. Each SU connects to the network through a standard IEEE 802.3 Ethernet 10/100BaseT (RJ-45) interface and connects to its outdoor part via CAT-5 cable. Each SU kit includes a small indoor unit, CAT5 indoor-outdoor cable, pole mounted outdoor unit and integrated antenna on most cases. Several CPE models are available:

- The S U-A-ff-3-1D-VL supports gross rate of up to 3 Mbps for a single user, includes integrated antenna
- The SU-A-ff-6-1D-VL supports gross rate of up to 6 Mbps for a single user, includes integrated antenna
- The SU-A-ff-6-BD-VL supports gross rate of up to 6 Mbps for multiple users, includes integrated antenna
- The SU-A-ff-54-BD-VL supports gross rate of up to 54 Mbps for multiple users, includes integrated antenna
- The SU-E-ff-54-BD-VL supports gross rate of up to 54 Mbps for multiple users, does not include antenna

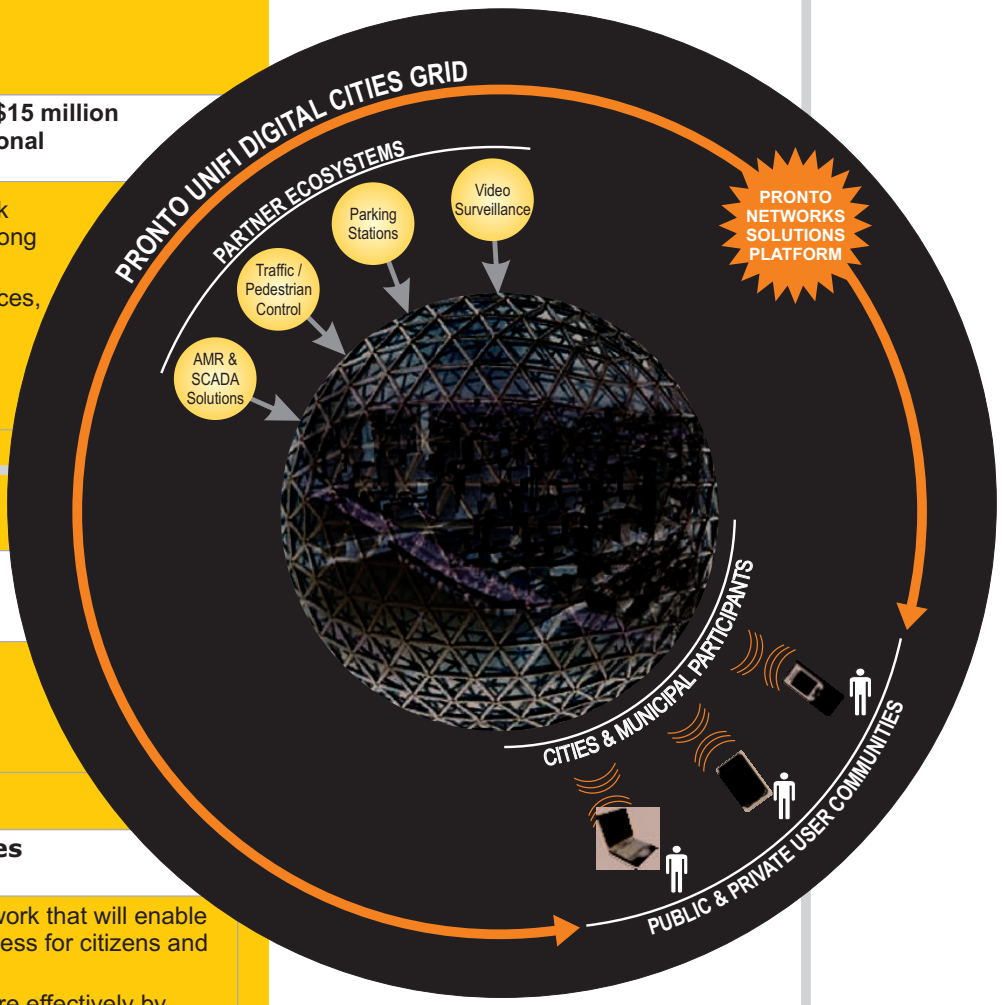
# UniFi Pronto Digital Communities Grid

## . . . A Nationwide Community Services Network

**Pronto Networks** is pleased to announce **UniFi Digital Communities Grid**, a nationwide, municipal broadband roaming network that can be leveraged for innovative applications and services,such as Amber and Homeland Defense alerts and other community-based services.

**Pronto Networks has committed $15 million to create an open, IMS-ready national infrastructure that will:**

- Enable a national roaming network that allows reciprocal roaming among government employees.
- Lay the foundation for future services, such as SMS-based services and multimedia applications, by supporting Internet Multimedia Subsystem (IMS) standards.




**An Ecosystem of Technology Partners provide services that help:**

- Enhance field worker productivity.
- Reduce the cost of government.

**Communities & municipalities are able to:**

- Be part of a national wireless network that will enable easy, secure wireless Internet access for citizens and public workers.
- Manage emergency response more effectively by leveraging alert notifications to residents and first responders.
- Participate with or without currently deployed WiFi network.
- Enjoy free use for all government and city employees.
- Achieve local government objectives like:
  - Improve citizen services.
  - Boost local tourism.
  - Streamline city operations.
  - Spur economic development.
- Earn potential revenue from roaming fees and Virtual Network Operators (VNOs)

**To Join the 500 Digital Communities or for more information, call Carol Davis at 925-251-5641 or email grid@prontonetworks.com**

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pronto networks


# UniFi: Pronto Digital Communities Grid

## Frequently Asked Questions (FAQ) for City Operators

1. **What is Pronto UniFi: Digital Cities Grid Initiative?**
   The main premise behind this initiative is for 500 "Metro" cities/munis to create a nationwide infrastructure to enable effective communication in both normal and emergency conditions. Pronto Networks is making a significant investment to enable cities to be connected via a national network, on which applications and services such as nationwide Amber Alerts, Homeland Defense Alerts, Snap Surveys, and other emergency or community-based services can be broadcasted to the users of the network. Furthermore, Pronto has created a strong partner ecosystem to provide applications, services, and solutions that can be deployed on the network.

2. **What is the cost to join the Pronto UniFi Digital City Grid?**
   There is NO cost to join the Pronto UniFi Grid. It is FREE.

3. **What benefits does my community get by joining UniFi Grid?**
   There are a number of high value infrastructure and applications that your community will be able to experience including a fully functional mixed use network, emergency management and communication applications. Even though, radio coverage area for this infrastructure will be limited to 300 feet, you will still be able to utilize multi modal emergency alerts and related communication tools throughout the city.

   Included for free is one Network Service Controller which enables the city to connect and become part of the UniFi grid. Also included for free is Pronto's world-class managed services support for an unlimited number of city and government users. There is no limit to number of city and government users who can utilize this service.

4. **What if I do not have a wireless network currently?**
   That's fine. Pronto Networks' Service Controller has a fully compliant 802.11 radio as part of the device, which can be deployed as a showcase in an area, typically indoors providing 300 feet of wireless coverage. This is a large enough area to showcase the benefits of the UniFi grid for participants that do not have a larger wireless network. Pronto Networks' Service Controller has a LAN port which can support multiple access points to cost effectively extend the size of the showcase location. When you are ready to deploy a larger wireless network, Pronto Networks can provide the platform and partners to help make that deployment smooth and successful.

5. **What if I already have a wireless network?**
   That's great! Pronto Networks' Service Controller has a LAN port which can be connected to a wireless network, creating a hotzone fully supported by the Pronto UniFi Grid. The Network Service Controller can be deployed at a network location supporting up to 200 concurrent users. For much larger networks, Pronto will work with you to recommend appropriate Service Gateways and continue to extend free service to all city and government workers.

6. **Does this grid support a Wi-Fi network only or this also work with other networks such as public safety and WiMAX?**
   The UniFi Grid is a software based service enablement platform, and can support the full compliment of IP-based networks including 802.11 Wi-Fi, 802.16, WiMAX, Mesh, and Public Safety networks. Pronto Networks can help you design a future proof strategy for infrastructure, applications and services, and business models based on your objectives.

7. **Under what circumstances may there be additional fees?**
   There are NO mandatory fees to be part of Pronto UniFi grid initiative, and the support for city and government users will always be free. There may be additional costs if additional Network Service controllers, Service Gateways, or access points are requested to support large hotzones. There may also be additional costs if support for non-city/government users, such as public users, is requested.

8. **What partner solutions are available to me as part of the Pronto UniFi Grid participant?**
   Many partners are currently under evaluation and will continue to join UniFi Grid in upcoming months. At present, we have commitment from number of partners including -

   a. Cellnet provides AMR, SCADA control solutions. Cellnet currently supports over 10M devices and can support a variety of meters.

   b. Cross Current provides a number of public safety applications including Computer Aided Dispatch, criminal records database, and others.

   c. Lexis Systems provides wireless enabled parking stations and pay stations.

   d. SmartVideo provides mobile TV services for public safety official and residents.

9. **How do I engage with the Pronto UniFi Ecosystem partners?**
   Pronto Networks has arranged for business and technical contacts from each ecosystem partner company. They are ready to assist you to provide details on any applications and services that may be of interest.

10. **Why should I join now?**
    Access to real-time information is critical in today's dynamic world, both in homeland defense, security, weather, amber alert, and general communication to your city, government, and public constituents. Since there is clear and significant value by joining the Digital Grid, we expect to connect 500 Cities and Municipalities very quickly. If this initiative has value for your city or municipality, you should join now.

11. **How do I join?**
    Please contact Lee Tsao (lee.tsao@prontonetworks.com), Worldwide Solutions Director for further details, Mutual NDA, and non-binding LOI document to start the process. Once the enrollment process is complete, you will receive instructions and the Network Service Controller to become part of the Pronto UniFi Digital Cities Grid.

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pronto networks

*Enabling the Next Wave of Connectivity™*

# Pronto Hotspot OSS™

## For Public Access WLANs

A carrier-class Operations Support System (OSS) for large scale, public WLAN networks, Pronto Hotspot OSS is a complete end-to-end platform that streamlines the deployment of public hot spot networks and minimizes ongoing operation costs for service providers. Pronto Networks' Hotspot OSS provides all inclusive customer care and billing management capabilities, end user self-provisioning of services, remote network management, usage-based pricing, pre-paid and post-paid services, multiple authentications and roaming options.

Pronto Hotspot OSS is a modular, multi-tier platform that includes feature-rich components for:

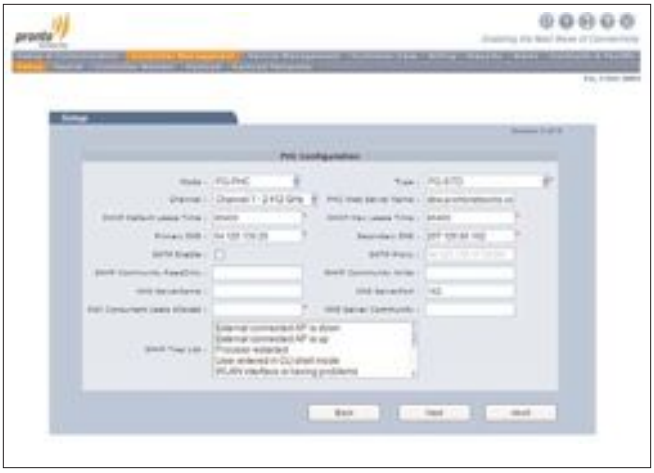
- Service creation, activation and maintenance of hot spot locations
- Network policies implementation (QoS) and monitoring capabilities
- Authentication, Authorization and Accounting (AAA) and custom authentication realms
- Multiple authentications and roaming options
- Roaming clearinghouse for network partners
- Customer care and billing management
- Payment processing and collection

### Multi-Vendor Friendly Solution

Pronto Hotspot OSS manages all operational aspects for the deployment of Pronto Hotspot Controllers™ (PHC) and provides a cost-effective access service gateway that supports multi-vendor hardware, including Proxim, Cisco, Colubris, Gemtek Systems, and upcoming WiFi switch based gateways.

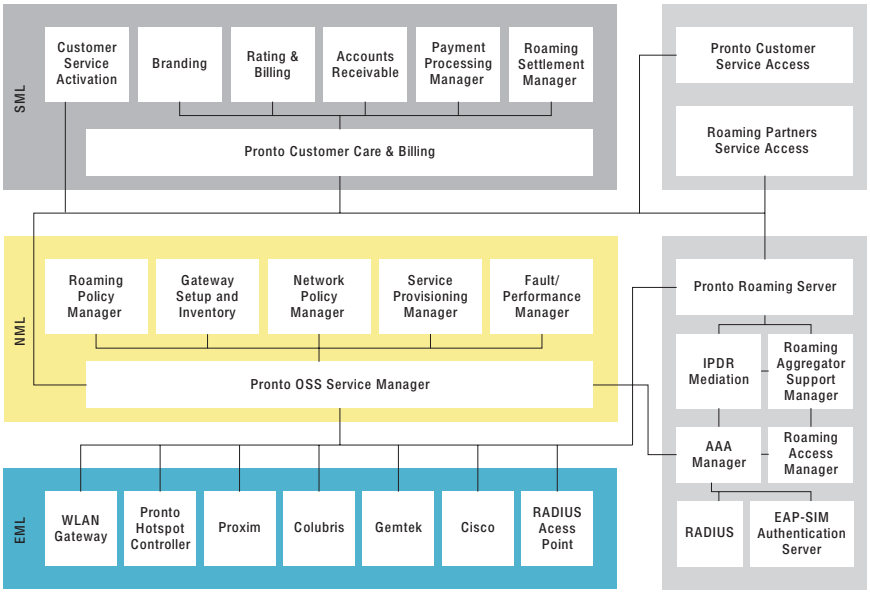
### System Integrator Friendly Platform

Pronto Hotspot OSS was designed using J2EE™ technology and supports Web services to enable development of secure, robust and interoperable business applications. Our platform provides native integration with third-party billing and CRM systems and includes TIBCO middleware integration for legacy systems support. Our platform offers flexible options to fit the unique needs of any business for customer support, branding, billing, and reporting.



Setup and Deployment of Hot Spots

Flexible Service Plans




**Pronto Hotspot OSS is a modular, highly scalable platform enabling the provisioning, management, and deployment of large scale, public WLAN networks.**

## Provisioning of Network Elements

- Web-based service management
- Provisioning of Pronto and third party gateways
- Service creation with QoS/ bandwidth management capabilities
- Monitoring, management and remote upgrades of edge elements
- SNMP support
- Customizable location-specific content and interface for ad hoc user experience (i.e., walled garden sites)
- AAA and custom authentication realms
- Support for multiple service providers on one server
- Real-time system administration and configuration ability
- Automatic e-mail alerts
- Easy integration with external NMS Product
- SOAP, Radius and EAP methods based communication

## Billing

- Internationalization and branding
- Flexible pricing, rating and discounting of usage-based and flat rates
- Multiple payment options, including credit cards, invoice and pre-paid cards
- Support for foreign currency billing, payments and taxation
- Configurable online bill formats, in multiple media options
- Native integration to third party billing and CRM systems
- TIBCO middleware for legacy systems support
- Integration to operators' billing system via IPDR

## Customer Care

- Customer self-care portal
- Credit limit management
- Incident tracking
- Account adjustment and refund

## Roaming Services

- Inter-WISP roaming
- Support for iPass, GRIC and Boingo smart clients
- Integrated billing, clearing and settlement

## Reporting & Data Mining

- Real-time reports and statistics

## Security

- SSL-encrypted HTTP traffic
- Corporate VPN compatibility
- 802.1x support

pronto networks

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Corporate Headquarters
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**For more information:**
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info@prontonetworks.com

# Appendix G
# Glossary

## Financial Terms

**assets**
Anything owned by the company having a monetary value; eg, 'fixed' assets like buildings, plant and machinery, vehicles (these are not assets if rented and not owned) and potentially including intangibles like trademarks and brand names, and 'current' assets, such as stock, debtors and cash.

**capital employed**
The value of all resources available to the company, typically comprising share capital, retained profits and reserves, long-term loans and deferred taxation. Viewed from the other side of the balance sheet, capital employed comprises fixed assets, investments and the net investment in working capital (current assets less current liabilities). In other words: the total long-term funds invested in or lent to the business and used by it in carrying out its operations.

**cash flow**
The movement of cash in and out of a business from day-to-day direct trading and other non-trading or indirect effects, such as capital expenditure, tax and dividend payments.

**cost of goods sold (COGS)**
The directly attributable costs of products or services sold, (usually materials, labour, and direct production costs). Sales less COGS = gross profit. Effectively the same as cost of sales (COS) see below for fuller explanation.

**cost of sales (COS)**
Commonly arrived at via the formula: opening stock + stock purchased - closing stock.
Cost of sales is the value, at cost, of the goods or services sold during the period in question, usually the financial year, as shown in a Profit and Loss Account (P&L). In all accounts, particularly the P&L (trading account) it's important that costs are attributed reliably to the relevant revenues, or the report is distorted and potentially meaningless. To use simply the total value of stock purchases during the period in question would not produce the correct and relevant figure, as some product sold was already held in stock before the period began, and some product bought during the period remains unsold at the end of it. Some stock held before the period often remains unsold at the end of it too. The formula is the most logical way of calculating the value at cost of all goods sold, irrespective of when the stock was purchased. The value of the stock attributable to the sales in the period (cost of sales) is the total of what we started with in stock (opening stock), and what we purchased (stock purchases), minus what stock we have left over at the end of the period (closing stock).

**depreciation**
The apportionment of cost of a (usually large) capital item over an agreed period, (based on life expectancy or obsolescence), for example, a piece of equipment costing $10k having a life of five years might be depreciated over five years at a cost of $2k per year. (In which case the P&L

would show a depreciation cost of $2k per year; the balance sheet would show an asset value of $8k at the end of year one, reducing by $2k per year; and the cash flow statement would show all $10k being used to pay for it in year one.)

**earnings before or EB…**
EBIT refers to Earnings before Interest and Taxes. EBITD refers to earnings before interest, taxes, depreciation and amortization.
There are several 'Earnings Before..' ratios and acronyms: EBT = Earnings Before Taxes; EBIT = Earnings Before Interest and Taxes; EBIAT = Earnings Before Interest after Taxes; EBITD = Earnings Before Interest, Taxes and Depreciation; and EBITDA = Earnings Before Interest, Taxes, Depreciation, and Amortization. (Earnings = operating and non-operating profits (eg interest, dividends received from other investments). Depreciation is the non-cash charge to the balance sheet which is made in writing off an asset over a period. Amortisation is the payment of a loan in instalments.

**fixed assets**
Assets held for use by the business rather than for sale or conversion into cash, eg, fixtures and fittings, equipment, buildings.

**fixed cost**
A cost which does not vary with changing sales or production volumes, eg, building lease costs, permanent staff wages, rates, depreciation of capital items.

**goodwill**
Any surplus money paid to acquire a company that exceeds its net tangible assets value.

**gross profit**
Sales less cost of goods or services sold. Also referred to as gross profit margin, or gross profit, and often abbreviated to simply 'margin'. See also 'net profit'.

**IRR or internal rate of return**
As an investment decision tool the calculated IRR is used to rate alternative investments. The investment alternative with the highest IRR is preferred. Note that placing the initial investment amount in the bank is always an alternative. Thus, any investments which do not at least match the bank's going deposit rate would not be viable. The internal rate of return (IRR) is defined as the discount rate that gives a net present value (NPV) of zero.

**liabilities**
General term for what the business owes. Liabilities are long-term loans of the type used to finance the business and short-term debts or money owing as a result of trading activities to date. Long term liabilities, along with Share Capital and Reserves make up one side of the balance sheet equation showing where the money came from. The other side of the balance sheet will show Current Liabilities along with various Assets, showing where the money is now.

**NPV or net present value**
One of the building block calculations for finance. It provides a methodology for evaluating and pricing securities and projects. It is a form of calculating discounted cash flow, in other words the value of money expected in the future discounted by either the cost of borrowing that money or the amount of interest that would have been earned if it had been kept in a bank account. For example: X corporation during capital budgeting is trying to decide whether or not to proceed with a new product line. The new product will have start-up costs, operational costs, and incoming cash flows increasing over time. X corporation's CFO has declared that all new projects must have an NPV of more than zero looking five years out and an internal rate of return of more than the weighted average cost of capital. Which just means that the project must pay the company back within five years, and must return more than its normal short-term (money market) rate of return.

**net profit**
Net profit can mean different things so it always needs clarifying. Net strictly means 'after all deductions' (as opposed to just certain deductions used to arrive at a gross profit or margin). Net profit normally refers to profit after deduction of all operating expenses, notably after deduction of fixed costs or fixed overheads. This contrasts with the term 'gross profit' which normally refers to the difference between sales and direct cost of product or service sold (also referred to as gross margin or gross profit margin) and certainly before the deduction of operating costs or overheads. Net profit normally refers to the profit figure before deduction of corporation tax, in which case the term is often extended to 'net profit before tax' or PBT.

**overhead**
An expense that cannot be attributed to any one single part of the company's activities.

**return on investment**
Another fundamental financial and business performance measure. This term means different things to different people (often depending on perspective and what is actually being judged) so it's important to clarify understanding if interpretation has serious implications. Many business managers and owners use the term in a general sense as a means of assessing the merit of an investment or business decision. 'Return' generally means profit before tax, but clarify this with the person using the term - profit depends on various circumstances, not least the accounting conventions used in the business. In this sense most CEOs and business owners regard ROI as the ultimate measure of any business or any business proposition, after all it's what most business is aimed at producing - maximum return on investment, otherwise you might as well put your money in a bank savings account. Strictly speaking Return On Investment is defined as:
Profits derived as a proportion of and directly attributable to cost or 'book value' of an asset, liability or activity, net of depreciation.
In simple terms this the profit made from an investment. The 'investment' could be the value of a whole business (in which case the value is generally regarded as the company's total assets minus intangible assets, such as goodwill, trademarks, etc and liabilities, such as debt. N.B. A company's book value might be higher or lower than its market value); or the investment could relate to a part of a business, a new product, a new factory, a new piece of plant, or any activity or asset with a cost attached to it.

The main point is that the term seeks to define the profit made from a business investment or business decision. Bear in mind that costs and profits can be ongoing and accumulating for several years, which needs to be taken into account when arriving at the correct figures.
ROA - Is the Return on Assets. It is calculated by dividing income by the total assets.
ROE - Is the Return on Equity. It is calculated by dividing income by the equity.
ROI - Is the Return on Investment. It is calculated by dividing income by the total investment.

**variable cost**
A cost which varies with sales or operational volumes, eg materials, fuel, commission payments.

**working capital**
Current assets less current liabilities, representing the required investment, continually circulating, to finance stock, debtors, and work in progress.

## Technical Terms

**3G**
Third-generation mobile communications technology, as defined by the ITU, provides a global standard for cellular networks capable of handling live video calls and data access at broadband speeds. There are several flavors of 3G, including EDGE, CDMA 2000, and WCDMA/UMTS. A handful of carriers are moving from GSM to EDGE and from CDMA to CDMA 2000, but the reigning champ for an emerging global 3G standard is WCDMA/UMTS, which has already started rolling out in Europe. Expect to see a lot of hoopla about 3G in 2004 and beyond.

**802.11**
Refers to a family of specifications developed by the IEEE for wireless LAN technology. 802.11 specifies an over-the-air interface between a wireless client and a base station or between two wireless clients. The IEEE accepted the specification in 1997.
There are several specifications in the 802.11 family:
**802.11** -- applies to wireless LANs and provides 1 or 2 Mbps transmission in the 2.4 GHz band using either frequency hopping spread spectrum (FHSS) or direct sequence spread spectrum (DSSS).
**802.11a** -- an extension to 802.11 that applies to wireless LANs and provides up to 54 Mbps in the 5 GHz band. 802.11a uses an orthogonal frequency division multiplexing encoding scheme rather than FHSS or DSSS.
**802.11b** (also referred to as *802.11 High Rate* or *WiFi*) -- an extension to 802.11 that applies to wireless LANS and provides 11 Mbps transmission (with a fallback to 5.5, 2 and 1 Mbps) in the 2.4 GHz band. 802.11b uses only DSSS. 802.11b was a 1999 ratification to the original 802.11 standard, allowing wireless functionality comparable to Ethernet.
**802.11g** -- applies to wireless LANs and provides 20+ Mbps in the 2.4 GHz band.

**802.16**
The technical name for WiMAX. 802.16 and a subset, 802.16a, are used for long-haul and backhaul connections. It is an IEEE standard designed for fixed broadband wireless access. It is used in WirelessMAN (Wireless Metropolitan Area Network) set-ups, which feature a

controlling base station that connects subscriber stations not to each other but to various public networks, such as the Internet, linked to the base station.

**access point**
The hub of a wireless network. Wireless clients connect to the access point, and traffic between two clients must travel through the access point. Access points are often abbreviated to AP in industry literature, and you may also see them referred to as "wireless routers," "wireless gateways," and "base stations." We prefer to use "access point" when discussing true access points that don't also share Internet connections or bridge between wired and wireless networks.

**ad hoc connections**
Spur-of-the-moment connections made for a specific reason and then shut down. Most uses of infrared communications are for ad hoc connections.

**aggregator**
A company that resells access to other companies' wireless networks.

**AirPort Extreme**
Apple's marketing name for its 802.11g wireless networking technology.

**authentication**
The process of identifying a user, usually by a user name and password. The next generation of WiFi security, WiFi Protected Access, or WPA, will use authentication to verify whether users have access to a particular wireless network.

**backhaul**
Connecting Internet access to a location over long or short distances. Traditionally, wired networks have been necessary for backhaul, but with 802.16, also known as WiMAX, backhaul via wireless will become even more common than it is with WiFi.

**band**
Another term for spectrum used to indicate a particular set of frequencies. Wireless networking protocols work in either the 2.4 GHz or the 5 GHz bands.

**bandwidth**
See throughput.

**Bluetooth**
A short-range wireless cable replacement technology.

**bridge**
A device that passes traffic between two networks that use different media or are physically separate, but which use similar network standards. Common uses for bridges include connecting wired and wireless networks, connecting a HomePlug network to a wireless network, and connecting distant wireless networks (with the aid of antennas).

**cable modem**
A device that hooks to your cable TV line to allow your computer to receive data at about 1.5 Mbps. The theoretical maximum for downstream transactions is 27 Mbps and 2.5 Mbps upstream, but the connection is usually much slower because the provider may be hooked to the Internet via a T-1 line.

**captive portal**
A Web page that appears automatically when you try to access any URL when first connected to some public wireless networks. On the captive portal page, you must enter login information or agree to acceptable use policies before you can use the wireless network to do anything else.

**Cat5**
The only type of twisted pair wire you should buy for Ethernet networks. Cat3 isn't rated for 100 Mbps.

**CDMA**
The type of digital cellular phone network used throughout most of the United States, but rare elsewhere in the world. CDMA stands for Code Division Multiple Access, and CDMA2000 1x is the third-generation, or 3G, extension to which CDMA cellular operators are upgrading their networks. It is a digital cellular technology that uses *spread-spectrum* techniques. Unlike competing systems, such as GSM, that use *TDMA*, CDMA does not assign a specific frequency to each user. Instead, every channel uses the full available spectrum. Individual conversations are encoded with a pseudo-random digital sequence. CDMA consistently provides better capacity for voice and data communications than other commercial mobile technologies, allowing more subscribers to connect at any given time, and it is the common platform on which 3G technologies are built.

**CDPD**
Cellular Digital Packet Data, a specification that supports wireless access to the Internet or other public networks. It uses packet switching, so a persistent link isn't needed, making it especially useful for mobile devices. CDPD is quickly being replaced by higher-speed services in 2.5G and 3G cellular networks.

**cell**
The geographic area covered by a cellular telephone transmitter. A connected group of cells form a cell system, which is what you gain access to when you sign up for cellular telephone service.

**Centrino**
A marketing name developed and promoted by Intel for laptops that use the Pentium-M processor, an Intel Pro/Wireless mini-PCI adapter, and some of Intel's support chips. Intel also requires some compatibility testing before manufacturers can use the Centrino name.

**channel**
A specific portion of the radio spectrum; for example, the channels allotted to one of the wireless networking protocols. 802.11b and 802.11g use 14 channels in the 2.4 GHz band, only 3 of

which don't overlap (1, 6, and 11). In the 5 GHz band, 802.11a uses 8 channels for indoor use and 4 others for outdoor use, and none of them overlap.

**decibels**
The unit used for measuring antenna gain. Decibels are abbreviated as dB, and you may also see dBm (decibels relative to a reference level of 1 milliwatt) and dBi (decibels relative to an isotropic radiator, or a single point antenna).

**DSL**
A common form of broadband Internet connection. DSL stands for Digital Subscriber Line.

**E911**
Enhanced 911, an emergency service that automatically sends phone number and location information to the operator. E911 comes in handy, say, when you need to get emergency help and are unable to speak or don't know your location.

**EDGE**
An upcoming cellular data technology for GSM networks. EDGE stands for Enhanced Data GSM Environment and should provide more than 100 Kbps of bandwidth.

**encryption**
The process of scrambling data to make it difficult for unauthorized parties to understand. Pretty Good Privacy is a commonly used encryption scheme employing public and private keys; a message is encrypted using the recipient's public key and decrypted with the associated private key. Without the private key, the encrypted message is gibberish.

**Ethernet**
The most common networking standard in the world, formally known as IEEE 802.3.

**Faraday cage**
An electromagnetic shield, which may be simulated in a house by chicken wire supporting plaster on the walls.

**firewall**
A network program that blocks malevolent traffic that might endanger the computers on your network.

**fixed wireless**
The operation of wireless devices in a specific location, such as an office. This term is usually reserved for devices that need to be plugged in to operate, such as a desktop computer. If it runs off a battery, it's not fixed wireless. The point-to-point signal transmissions occur through the air over a terrestrial microwave platform rather than through copper or fiber cables; therefore, fixed wireless does not require satellite feeds or local phone service. The advantages of fixed wireless include the ability to connect with users in remote areas without the need for laying new cables and the capacity for broad bandwidth that is not impeded by fiber or cable capacities.

**Fresnel zone**
Fresnel Zone: (*pronounced 'fre-nel' the "s" is silent*) The area around the visual line-of-sight that radio waves spread out into after they leave the antenna. This area must be clear or else signal strength will weaken. Fresnel Zone is an area of concern for 2.4 GHz wireless systems. Although 2.4 GHz signals pass rather well through walls, they have a tough time passing through trees. The main difference is the water content in each. Walls are very dry: trees contain high levels of moisture. Radio waves in the 2.4 GHz band absorb into water quite well. This is why microwaves -- which also use the 2.4 GHz band -- cook food. Water absorbs the waves, and heat from the energy cooks the food.

**FTP**
A common way of transferring files on the Internet, though it's primarily used for uploading these days. FTP stands for File Transfer Protocol.

**gain**
The amount by which an antenna concentrates signal strength in a wireless network.

**Gigabit Ethernet**
An up-and-coming Ethernet wiring standard that works almost exactly like 10Base-T, but increases the maximum throughput to 1000 Mbps, or roughly 1 Gbps. Gigabit Ethernet is more technically known as "1000Base-T."

**gigahertz**
A measure of electromagnetic wave frequency equal to one thousand million (1,000,000,000) hertz, often abbreviated as GHz and used to specify the radio frequency used by wireless devices. 802.11a networks operate at 5 GHz. 802.11b and g networks use 2.4 GHz, which is susceptible to interference from nearby cordless phones and microwave ovens that use the same frequency.

**GPRS**
Short for ***G****eneral* ***P****acket* ***R****adio* ***S****ervice*, a standard for wireless communications which runs at speeds up to 115 kilobits per second, compared with current GSM (Global System for Mobile Communications) systems' 9.6 kilobits. GPRS, which supports a wide range of bandwidths, is an efficient use of limited bandwidth and is particularly suited for sending and receiving small bursts of data, such as e-mail and Web browsing, as well as large volumes of data.

**GPS**
Global Positioning System, a technology that uses satellites to pinpoint a device's location on Earth. Some new cell phones include GPS capability for location-based services, such as driving directions or pinpointing your location when you call 911.

**GSM**
The primary type of digital cellular phone network used throughout most of the world outside the United States, and a growing standard in the U.S. GSM stands for Global System for Mobile Communications. GSM provides a very slow (9600 bps) cellular data service.

**HomePlug**
A networking standard that uses standard electrical wiring. HomePlug is primarily useful for bridging wireless networks across obstacles (like brick walls) that block radio waves. HomePlug runs at 14 Mbps.

**HomePNA**
A networking standard that uses standard telephone wiring. HomePNA is primarily useful for bridging wireless networks across obstacles (like brick walls) that block radio waves. HomePNA 2.0 runs at 10 Mbps, and the just-defined HomePNA 3.0 runs at 128 Mbps, in theory.

**HomeRF**
Short for ***home r****adio* ***f****requency*. A now-defunct competitor to WiFi that integrated voice, data, and streaming media into a single wireless signal. Designed specifically for wireless networks in homes - in contrast to 802.11, which was created for use in businesses. HomeRF has a range of up to 150 feet.

**hot spot**
A place where you can connect to a public wireless network.

**IEEE**
Abbreviation of ***I****nstitute of* ***E****lectrical and* ***E****lectronics* ***E****ngineers*, pronounced *I-triple-E*. Founded in 1884 as the AIEE, the IEEE was formed in 1963 when AIEE merged with IRE. IEEE is an organization composed of engineers, scientists, and students. The IEEE is best known for developing standards for the computer and electronics industry. In particular, the IEEE 802 standards for local-area networks are widely followed.

**IP**
Internet Protocol, the method by which data is sent from one computer to another on the Internet.

**Kbps**
Kilobits per second, or thousands of bits per second, a measure of bandwidth.

**LAN**
A computer network that spans a relatively small area. Most LANs are confined to a single building or group of buildings. However, one LAN can be connected to other LANs over any distance via telephone lines and radio waves. A system of LANs connected in this way is called a *wide-area network (WAN)*.
Most LANs connect workstations and personal computers. Each *node* (individual computer ) in a LAN has its own CPU with which it executes programs, but it also is able to access data and devices anywhere on the LAN. This means that many users can share expensive devices, such as laser printers, as well as data. Users can also use the LAN to communicate with each other, by sending e-mail or engaging in chat sessions.
There are many different types of LANs *Ethernets* being the most common for PCs. Older Apple Macintosh networks are based on Apple's AppleTalk network system, which is built into Macintosh computers.
The following characteristics differentiate one LAN from another:

**topology :** The geometric arrangement of devices on the network. For example, devices can be arranged in a ring or in a straight line.
**protocols :** The rules and encoding specifications for sending data. The protocols also determine whether the network uses a peer-to-peer or client/server architecture.
**media :** Devices can be connected by twisted-pair wire, coaxial cables, or fiber optic cables. Some networks do without connecting media altogether, communicating instead via radio waves. LANs are capable of transmitting data at very fast rates, much faster than data can be transmitted over a telephone line; but the distances are limited, and there is also a limit on the number of computers that can be attached to a single LAN.

**latency**
The length of time between a packet being sent and the response to that packet being returned.

**LEAP**
A Cisco security technology that builds on WiFi's WEP encryption. Basically, it changes the WEP key dynamically during a session to make it less likely that a snooper will be able to derive the key.

**line of sight**
A clear line from one antenna to another in a long-range wireless network. A line of sight is necessary for a long-range network to connect. Sometimes abbreviated as LOS.

**MAC address**
The unique address assigned to every wireless and wired Ethernet network adapter. MAC stands for Media Access Control. Despite the fact that MAC addresses are all unique, it's possible to assign one device's MAC address to another device.

**Mbps**
Megabits per second, or millions of bits per second, a measure of bandwidth.

**megahertz**
A measure of electromagnetic wave frequency equal to one million (1,000,000) hertz, often abbreviated as MHz and used to specify the radio frequency used by wireless devices.

**mesh network**
A network topology in which every device can communicate with any other device that's within range. Mesh networking is particularly interesting for bringing wireless network access to an entire neighborhood.

**modem**
Short for modulator/demodulator. A modem modulates outgoing digital data into analog signals so they can be sent over copper phone lines, and demodulates incoming analog signals into digital.

**MPEG-4**
A standard for delivering streaming multimedia content to wireless devices. An example of the technology in action might be the ability to watch movie trailers on your wireless phone.

**multiplex**
o combine multiple signals for transmission over a single channel. For example, a WiFi connection uses Orthogonal Frequency Division Multiplexing, which spreads the signal power over a large band. It breaks the signal into parts, enabling a fast transmission that is sent as several slower transmissions simultaneously, using different frequencies.

**OFDM**
Short for ***O****rthogonal* ***F****requency* ***D****ivision* ***M****ultiplexing*, an FDM modulation technique for transmitting large amounts of digital data over a radio wave. OFDM works by splitting the radio signal into multiple smaller sub-signals that are then transmitted simultaneously at different frequencies to the receiver. OFDM reduces the amount of crosstalk in signal transmissions. 802.11a WLAN, 802.16 and WiMAX technologies use OFDM.

**packet**
A discrete chunk of data, being transferred on a TCP/IP or other addressable network.

**PCS**
Personal Communications Services, a higher frequency, digital wireless phone service similar to cellular. It operates in the 1850-1900 MHz band, while traditional cellular uses 824-849 MHz.

**PGP**
A technology and set of programs for encrypting data. PGP stands for Pretty Good Privacy.

**point-to-multipoint**
A wireless network in which one point (the access point) serves multiple other points around it. Indoor wireless networks are all point-to-multipoint, and long-range wireless networks that serve multiple clients usually employ either a single omnidirectional antenna or multiple sector antennas.

**point-to-point**
A long-range wireless network between two points. Point-to-point wireless networks use directional antennas.

**private key**
The key you keep secret in public-key cryptography systems. You use your private key to decrypt encrypted data sent to you by other people, who used your public key to encrypt it. You also use your private key to sign email messages; your recipients then use your public key to verify your signature.

**public key**
The key you give out to the world in public-key cryptography systems. Other people use your public key when sending you encrypted data, which you can then decrypt with your private key.

You also use other people's public keys to verify the authenticity of mail messages they've signed with their private keys.

**receive sensitivity**
The capability of a radio transceiver to receive weak signals. The lower the receive sensitivity, the more capable the transceiver is of understanding weak signals.

**RF**
Short for ***r****adio* ***f****requency*, any frequency within the electromagnetic spectrum associated with radio wave propagation. When an RF current is supplied to an antenna, an electromagnetic field is created that then is able to propagate through space. Many wireless technologies are based on RF field propagation.
These frequencies make up part of the electromagnetic radiation spectrum:
- Ultra-low frequency (ULF) -- 0-3 Hz
- Extremely low frequency (ELF) -- 3 Hz - 3 kHz
- Very low frequency (VLF) -- 3 kHz - 30 kHz
- Low frequency (LF) -- 30 kHz - 300 kHz
- Medium frequency (MF) -- 300 kHz - 3 MHz
- High frequency (HF) -- 3 MHz - 30 MHz
- Very high frequency (VHF) -- 30 MHz - 300 MHz
- Ultra-high frequency (UHF)-- 300 MHz - 3 GHz
- Super high frequency (SHF) -- 3 GHz - 30 GHz
- Extremely high frequency (EHF) -- 30 GHz - 300 GHz

**router**
An intelligent network device that goes one step beyond bridging by converting address-based protocols that describe how packets move from one place to another. In practice, this generally comes down to translating between IP addresses and MAC addresses for data flowing between your local network and the Internet. Many people use the term interchangeably with "gateway." You must enter the IP address of your router when configuring network settings manually.

**smart card**
A card containing data about a person's identity and credentials to allow access to a network or physical site.

**SMS**
Short Message Service, a method for sending text messages of about 200 characters to GSM mobile phones. Messages are delivered at low cost and nearly instantaneously. If the recipient's phone is turned off, messages are held and re-delivered.

**sniffer**
In wireless parlance, a sniffer is software or a hardware device that searches for the presence of a wireless network. Another type of sniffer is software used to analyze or intercept wired network traffic.

**spectrum**
A range of electromagnetic frequencies.

**spread spectrum**
A form of wireless communication in which a signal's frequency is deliberately varied. This increases bandwidth and lessens the chances of interruption or interception of the transmitted signal.

**SSH**
A security system that lets you create encrypted tunnels for any Internet protocol via port forwarding. SSH stands for Secure Shell.

**SSID**
Service Set Identifier, a set of characters that give a unique name to a WLAN.

**SSL**
A security protocol that secures Internet transactions at the program level. SSL, which stands for Secure Sockets Layer, is widely used in Web browsers to protect credit card transactions, for instance. SSL is a component in EAP-TLS (Extensible Authentication Protocol-Transport Layer Security).

**T-1, T-3**
Transmission systems commonly used in the Internet. T-1 provides a continuous, dedicated transmission rate of up to 1.5 Mbps, T-3 44.7 Mbps. T-1 and T-3 lines are expensive and generally for business or science use, not consumer use.

**TDMA**
Time Division Multiple Access, a way to deliver digital wireless service. TDMA works by dividing a frequency into time slots and allocating them to multiple calls. In this way, a single frequency can support multiple, simultaneous data channels. TDMA is the standard on which GSM is based, but GSM phones will not work on TDMA networks and vice versa.

**throughput**
The amount of data that can be transmitted in a given amount of time. Throughput is commonly measured in bits per second. (Although throughput is not really a measurement of speed, most people, including us, use the word "speed" when talking about a high-throughput network.)

**Ultra Wideband**
A wireless networking approach that broadcasts millions of tiny pulses at trillionth-of-second intervals using very low power over enormous swaths of spectrum. In comparison, traditional radios broadcast continuously on tiny bits of spectrum. Ultra Wideband is commonly abbreviated to UWB.

**voice-over-IP/VoIP**
A way of making telephone calls over a packet-switched network like the Internet. Voice-over-IP requires special telephones and software. Voice-over-IP is commonly abbreviated to VoIP. Its

main advantage is that it avoids the usual phone service tolls. A few companies are offering cordless VoIP phones that work on WiFi networks.

**VPN**
A method of creating an encrypted tunnel through which all traffic passes, preventing anyone from snooping through transmitted and received data. VPN stands for virtual private network.

**WAN**
Wide Area Network, A collection of local area networks connected by a variety of physical means. The Internet is the largest and most well-known wide area network. Wide area network is generally abbreviated to WAN.

**WAP**
Wireless Application Protocol, a set of standards to enable wireless devices to access Internet services, such as the World Wide Web and email.

**warchalking**
The act of making hobo-inspired chalk marks on walls or sidewalks to indicate the presence of wireless networks. Warchalking is more media hype than reality.

**wardriving**
The act of driving around with your laptop open, looking to see if you can connect to open wireless networks as you drive. Change the mode of transportation and you get "warwalking," "warcycling," and "warflying."

**WEP**
WEP: Short for ***W****ired* ***E****quivalent* ***P****rivacy*, a security protocol for wireless local area networks (WLANs) defined in the 802.11b standard. WEP is designed to provide the same level of security as that of a wired LAN. LANs are inherently more secure than WLANs because LANs are somewhat protected by the physicalities of their structure, having some or all part of the network inside a building that can be protected from unauthorized access. WLANs, which are over radio waves, do not have the same physical structure and therefore are more vulnerable to tampering. WEP aims to provide security by encrypting data over radio waves so that it is protected as it is transmitted from one end point to another. However, it has been found that WEP is not as secure as once believed. WEP is used at the two lowest layers of the OSI model - the data link and physical layers; it therefore does not offer end-to-end security.

**WiFi**
Short for ***wi****reless* ***fi****delity* and is meant to be used generically when referring of any type of 802.11 network, whether 802.11b, 802.11a, dual-band, etc. The term is promulgated by the WiFi Alliance. Any products tested and approved as "WiFi Certified" (a registered trademark) by the WiFi Alliance are certified as interoperable with each other, even if they are from different manufacturers. A user with a "WiFi Certified" product can use any brand of access point with any other brand of client hardware that also is certified. Typically, however, any WiFi product using the same radio frequency (for example, 2.4 GHz for 802.11b or 11g, 5 GHz for 802.11a) will work with any other, even if not "WiFi Certified." Formerly, the term "WiFi" was used only

in place of the 2.4 GHz 802.11b standard, in the same way that "Ethernet" is used in place of IEEE 802.3. The Alliance expanded the generic use of the term in an attempt to stop confusion about wireless LAN interoperability.

**WiMAX**
Another name for the 802.16 wireless networking specification used for long-haul and backhaul connections.

**wireless gateway**
A somewhat generic term that we use to differentiate between an access point and a more-capable device that can share an Internet connection, serve DHCP, and bridge between wired and wireless networks. You may also see the term "wireless router," or "base station."

**wireless ISP**
A company that provides wireless Internet access. The term is often abbreviated to WISP.

**WLAN**
Wireless Local Access Network, a LAN that can be connected to via a wireless connection.

**WPA**
A modern encryption system for preventing eavesdropping on wireless network traffic that solves the problems that plagued WEP. WPA stands for WiFi Protected Access.

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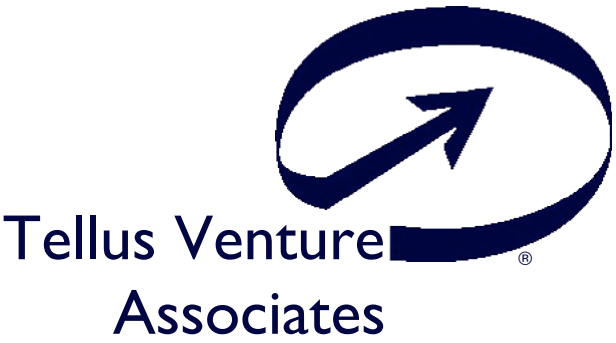
**Sources: JiWire.com, Oasismanagement.com, wi-fiplanet.com, Wikipedia.org, Tellus Venture Associates**

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Tellus Venture Associates® is a consultancy focusing on business development, market research and analysis, and new venture creation and evaluation for the broadband, digital broadcasting and satellite communications industries, with an emphasis on digital products and services delivered directly to consumers and enterprises. Located in the Monterey Bay Area, Tellus Venture Associates serves firms in the satellite, Internet and consumer electronics industries, as well as municipalities and private communities, and digital content and technology oriented start-ups in North and South America, Europe, Africa, Asia and the Pacific Rim.

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