SMART LIGHTPOLES

The next logical step in the evolution of cell sites

With approximately 14 U.S. cities testing the waters of municipal Wi-Fi, the next icon of communication may very well be the humble corner lightpost.

BY SEAN HEATH

Small "microcell" antennas, some no larger than a pack of cards, are mounted to lightposts as a means of offering municipal wireless-broadband service. These "smart" poles would be used in a "mesh" fashion, with wireless signals passing from pole to pole until it reaches a conventional monopole or lattice tower. Then, the signal would be relayed to a transmitter with a backbone connection (fiberoptic, satellite, or cable), where it would be sent out to its final destination. Users of these "smart" poles could include residential customers, public parks, emergency service providers or city workers. Flash memory installed inside the poles could store information on local retailers, and blueprints of buildings accessible by firefighters in the event of an emergency.

One San Jose-based company, NextG Networks, works with municipalities to build microcell networks that would fill in coverage gaps created by existing wireless networks — either because of terrain challenges or competition between carriers. NextG's technology allows them to sublease the same microcell to more than one carrier (think T-Mobile or Sprint), through the use of a special type of software known as an operations-support service (OSS) that allows traffic at each site to be prioritized and billed to different parties.

Instead of thinking about OSS as a type of software, think of it like a universal translator, with the communications standards used by each carrier (GSM or CDMA) as languages, as different from each other as French is from Russian. Just as a Parisian could not communicate with a Muscovite without the aid of an intermediary, so too a T-Mobile cell site could not process a call made from a Verizon subscriber. With OSS playing the role of a translator, now any microcell can handle any call, regardless of the call's language.

Kurt Mackie, Managing Editor of Broadband Wireless Business, states that mesh networks offered by companies like NextG or EarthLink offer a greater amount of flexibility than conventional wireless networks—both in installation cost and ease of use.

"In metro areas, the [appeal] of using fixed wireless is that it can be less expensive than digging trenches and planting fiber," said Mackie. "However, it is possible to oversell the capacity of [a Wi-Fi] network. For instance, businesses may use the connection only during the day, while consumers may use the connection mostly at night. So, through OSS, network operators can prioritize the traffic. Premium business customers may get high priority on the network, while consumers may pay less for less bandwidth. Typically, oversubscription falls under the category of a network's quality of service. Quality of service is a technical network-management term. The actual agreement between the buyer and seller of the connection service is called a 'service level agreement.' Cities should have a service level agreement in place so that their bandwidth is not degraded as more users get added to the network."

Because of their small size, microcells can be enclosed inside virtually any cylindrical enclosure at a cost of less than $1,000 per pole (versus an average cost of $30,000 to $50,000 to construct a typical 30' to 40' tall monopole). The power requirements for these smaller wireless sites are also a fraction of their larger single-tenant cousins along highways and interchanges. In fact, a Scottish university is currently testing solar panels that could be used to power a streetlight and a Wi-Fi or Wi-Max antenna array enclosed inside.

NextG node located on decorative light (between flags) with antenna mounted on top of pole

NextG node located inside traffic light (external antenna on top)

NextG node located midway up pole, over white car (external omni-directional antenna on top)

Intel, with support from Cisco, Dell, IBM and other companies, has begun an initiative called "Digital Communities," created to educate city leaders on ways they can use their Wi-Fi networks as a commercial service by selling access. City officials could also gain additional revenue by charging roaming fees to non-city employee visitors.

Readers interested in viewing an online presentation of a program tailored to Digital Communities (called UniFi Grid), can visit: www.prontonetworks.com/UniFi_Grid_Presentation.html

In another C-Net article written by Michael Singer, JupiterResearch analyst Julie Ask offers this suggestion.

"Cities can use Intel's investments to save money," said Ask, "because support services for city employees in the field can be provided more efficiently using wireless communication."

City employees can wirelessly roam to locations in other cities for free, simply by entering a pre-established username and password. This innovation would allow municipal employees to be more effective and productive, while encouraging cooperation between cities.

Cities have the potential of pulling more revenue out of their Wi-Fi networks by charging visitors an access fee. Once a city makes the initial decision to charge visitors or not, their access could be handled by a simple three-step process.

1) The visitor would log onto the city's Wi-Fi service as a guest

2) The visitor would then select their home city from a dropdown menu

3) Lastly, the visitor would enter their pre-established username (based on their home city) by means of a customized log-in screen.

Cities can also use Wi-Fi networks to issue real-time announcements (like Homeland Security bulletins) to every city resident tapped into the network. City officials can then tie in other services (like parking-meter control, traffic management, and utility-meter reading) into their Wi-Fi network to increase productivity, both for themselves, and for its citizens.

In the future, municipal Wi-Fi networks could be opened up to any mobile subscriber, simply by sending a text message to a dedicated phone line, known as an 80211 shortcode.

Metrofi, of MountainView, Calif., is a wireless reseller that has established broadband networks for Cupertino, Santa Clara and

Looking Under The Hood of OSS

Each time you turn your cell phone on, it locates itself within the wireless ether by broadcasting a series of codes, usually consisting of its phone number, serial number and a unique code associated with its carrier. If you are a T-Mobile subscriber, for example, your phone would transmit these codes to the closest T-Mobile cell site, which then relays this information to the nearest T-Mobile telephone switching office (also called an MTSO, for mobile telephone switching office). Most area codes have at least one MTSO, with more populated zips having more than one to better process voice and data traffic.

When you place a call to someone, your phone transmits the above series of codes plus the number you dialed to the MTSO, which logs your call and reserves a place in line for you on the public switched telephone network. If the number you dialed is a land-based phone, the MTSO connects you immediately. If you are calling another cell phone, the MTSO connects with another MTSO closer to the recipient's cell phone, which then relays your signal through another series of cell sites to the recipient's phone.

One downside of this type of transmission system is that cell phones, and the wireless networks they operate under, are carrier-specific. One reason for this is that carriers like Cingular, T-Mobile and Verizon use different standards of communication which are not compatib le with each other. Cingular and T-Mobile, for example, use a system known as GSM (short for global system for mobile communication). GSM works by breaking your call into chunks of time and assigning a code to each chunk. A cell site receiving a GSM call then places these chunks back in order based on the codes assigned to each chunk.

Verizon and Sprint on the other hand use a system known as CDMA (code division multiple access), developed by San Diego-based Qualcomm. In a CDMA network, calls are kept intact, not broken up, and are embedded with their own unique code.

A special category of microcell software known as operations support services (OSS) removes the traditional barriers between carrier networks by being able to process calls made by anyone. Since each call contains a unique carrier code, the OSS program can use these codes to discern between, say a call intended for a Cingular subscriber, or one sent by a Verizon phone. The software can also use these carrier codes to manage the call traffic, billing the carriers accordingly.

This flexibility allows a microcell network to be used by any carrier, regardless of their standard of communication.

Sunnyvale, California. Residents in these areas enjoy free Internet access from anywhere in the community.

On the state level, Michigan has wholeheartedly endorsed the possibility of municipal Wi-Fi networks. The state has targeted broadband as a crucial tool in job retraining and education.

"There's no question about it. This is a necessity," said David C. Hollister, director of the Michigan Broadband Development Authority. "We've made a commitment that we would have statewide broadband coverage and make it as affordable as possible by 2007."

In a White Paper titled, "Enabling the Future of Wi-Fi Public Access," dated February 2, 2004, the WiFi Alliance cited a survey done by Boingo Wireless to highlight the vast untapped potential of Wi-Fi.

Boingo estimates that there are as many as 2 million potential hotspot locations in the United States alone. These include:

- 212 conference centers
- 3,032 train stations
- 5,352 airports
- 53,500 hotels
- 72,720 business centers
- 202,600 gas stations
- 480,298 restaurants, bars and cafés
- 1,111,300 retail stores

At the present time, California has the greatest number of Wi-Fi sites, or "hotspots" as they're also known. By 2007, according to the WiFi Alliance (www.wi-fi.org), there will be approximately 530,000 hotspots across the country.

There are a couple of things city administrators should keep in mind when considering muni-WiFi. The first would be not to act too hastily, simply to be the first in your area to offer this technology. Most wireless resellers I spoke with strongly advise cities to do their homework before beginning negotiations.

Another important consideration is to make sure your proposed network is fast enough to be of practical use. In New Orleans, their Wi-Fi network (built with equipment donated from Intel and local ISPs) will operate at a 512-kilobit speed as long as the city remains under a state of emergency, and will then be reduced to 128-kilobits per second in accordance with state law, which restricts government-owned Internet service. In response to widespread outages following Hurricane Katrina in August of 2005, the city introduced their Wi-Fi network in the central business district and the French Quarter in December, and expects to be city-wide within a year. Thirteen other states have passed similar laws restricting government-owned Internet service, and other states are expected to consider similar restrictions.

The downside is that New Orleans' new WiFi network may be too slow to be of any use. For a while now, a number of ISPs have offered dial-up Internet access at speeds of approximately 392 kilobits per second as an upgrade to the old, notoriously-slow 56-kilobit conventional dial-up means of access. Yet this level of connection is neither cable or DSL, which offer 3-megabit to 5-megabit access speeds, more than 8 to 13 times faster than New Orleans' WiFi network.

Residential users of Philadelphia's Wi-Fi network, on the other hand, can reach the Internet at one-megabit per second, for approximately $16 to $20 per month. Metrofi's service also promises one-megabit access. The fastest WiFi connection tops out at 54 megabits per second. And the newest kid on the block, WiMax, promises speeds of up to 70 megabits per second.

Wi-Max, short for Worldwide Interoperability for Microwave Access, works similar to Wi-Fi, but on a much broader scale. A single Wi-Max tower could provide coverage over a 30-square-mile area, whereas Wi-Fi antennas have a very short broadcast range of a couple of blocks or so.

With Wi-Fi, a city would need to have several lightpoles installed just to cover a downtown zone. Under WiMax, a city could pay for one base station that would cover an entire financial district. The companies maintaining the base stations for the cities might offer unlimited access for a monthly fee, or a "pay as you go" plan that charges on a per-minute or per-hour basis.

In May of 2005, Seattle announced that they will be installing a WiMax antenna at the top of the Space Needle, which will provide a six-megabit wireless Internet signal over a five-square mile radius. City officials agreed that this will be a significant upgrade to the 1.2-megabit, T-1 connections currently used by most local businesses.

Critics of municipal Wi-Fi, like telecom analyst Jeff Kagan, argue that cities may not be the best entities to provide such services. In an interview with Wireless Week, Kagan suggested that "the question is should a [private] company run [the network], or should the city government run it, or should the government work with companies to run it. When governments run it, things don't normally run well."

In a recent online article about an upcoming release of 1700-Mhz spectrum later this year, Andrew M. Seybold of Outlook 4Mobility offers another opinion for wireless development in metro areas.

"What I would like to see is a consortium of companies that come together to build a true nationwide network shared by small, medium and large resellers (like Metrofi, NextG and Earthlink) offering both voice and data services," he said.

"There are two ways in which this could happen. The first would be for a group of companies to pool their bids for specific frequencies and obtain every license nationwide," said Seybold. "The other would be for the government to hold a portion of the spectrum and allow a consortium of companies to 'rent' it (as in Japan) and build out a nationwide network that could be resold to small, medium and large wireless service resellers."

Microcell Financial Model

# of sites	Base Rent/Site	Base Rent/Yr	5% Recapture	Difference	Avg PV
		Money Outgoing	Money Incoming		
5	$50	$250	$2,400	$2,150	$9,798
10	$50	$500	$4,800	$4,300	$19,596
15	$50	$750	$7,200	$6,450	$29,394
20	$50	$1,000	$9,600	$8,600	$35,882
25	$50	$1,250	$12,000	$10,750	$44,852
30	$50	$1,500	$14,400	$12,900	$53,823
35	$50	$1,750	$16,800	$15,050	$62,793
40	$50	$2,000	$19,200	$17,200	$71,764
45	$50	$2,250	$21,600	$19,350	$80,734
50	$50	$2,500	$24,000	$21,500	$89,704
55	$50	$2,750	$26,400	$23,650	$98,675
60	$50	$3,000	$28,800	$25,800	$107,645
65	$50	$3,250	$31,200	$27,950	$116,616
70	$50	$3,500	$33,600	$30,100	$125,586
75	$50	$3,750	$36,000	$32,250	$134,557
80	$50	$4,000	$38,400	$34,400	$143,527
85	$50	$4,250	$40,800	$36,550	$152,498
90	$50	$4,500	$43,200	$38,700	$161,468
95	$50	$4,750	$45,600	$40,850	$170,439

OSS software allows microcell providers like NextG or EarthLink to sublease the same network to more than one carrier, since the software has the ability to prioritize calls made over the network, organize these calls by carrier, and then bill the appropriate carrier on a usage basis.

The above spreadsheet illustrates the type of revenue a city might achieve if they were to have a Wi-Fi network installed. First, the city would enter into a master-lease agreement with a microcell provider at a fairly low rate (say $50 per pole per year). The microcell provider would in turn sublease this network to other carriers at a higher rate (usually between $500 to $1,000 per pole per month). Under the terms of the MLA, the city would be able to receive an annual sublease recapture of approximately 5% to 10%.

In the above example, I have assumed an MLA base rent of $50 per pole per year, and a sublease rental rate of $800 per pole per month. To be conservative, I calculated the present value of the difference in outgoing revenue (orange column) and incoming revenue (green column) over a spread of discount rates ranging from 8% to 12%. The yellow column represents the calculated average of the five present values found.

The above calculation assumes that the microcell network is only subleased to one carrier.

Assuming an average build-out of 50 microcells across the city, the following would be the estimated value of this income stream for one or more carriers.

Subleased to:

One carrier	$89,704
Two carriers	$179,409
Three carriers	$269,113
Four carriers	$358,818
Five carriers	$448,522
Six carriers	$538,227

The Realm Key by Realm Systems

Progressing in a line from lattice towers to "fake trees" to "smart lightpoles," the next logical step in the evolution of the cell site will not be a "site" at all, but instead will be something we can tuck in our pockets. Early versions of personal wireless servers can already be found on the shelves of Costco and electronics stores, in the form of 1.0-gigabyte flash drives, or "thumb drives" as they're sometimes called. In an ideal environment, a personal wireless server would offer the storage capacity of a computer-network server with the flexibility of a Wi-Fi wireless modem to offer true ubiquitous computing "anywhere, anytime."

An example of one type of USB personal server is the Realm Key by Realm Systems (www.realmsys.com). This flash drive, also called the "Mobile Microserver" by its manufacturer, works just like a stand-alone PC. Contained within its tiny package are an embedded operating system, 400-MHz processor and 256 megabytes of flash memory, with an expansion slot for another gigabyte. According to Realm Systems, the device will include e-mail software similar to Outlook, full Web browser, file backup and management tools (including firewalls and virus checkers), and a full office-productivity suite similar to Microsoft Office. There will also be slots for a Wi-Fi modem and other customized features. Once plugged into a USB port on a host PC, a software wizard will provide step-by-step instructions to sync with the host PC, as well as tying into any other networked PC, PDA or other storage device connected to the Internet. Realm Systems claims their product will be compatible with Windows, Macintosh and Linux desktops.

One could describe technological innovations like OSS or microcells as hurdles laid in the path of a metaphorical runner. Each time the runner clears a hurdle, his sight is set on the next one before him. With the adoption of these new innovations, we (as a wireless community) have also cleared a type of hurdle — the differences between our communications standards. If that is so, what will be the next barrier in our path?

We might find the answer from a seemingly unrelated source — a quote in a book about physics. In his book The Dancing Wu-Li Masters, Gary Zukav includes the following quote from physicist Henry Stapp.

"The physical world," states Stapp in Zukav's book, "is not a structure built out of independent…entities, but rather a web of relationships between elements whose meanings arise wholly from their relationships to the whole."

This is true from an information-sharing context as well. It might be easier to think of ourselves as a community of individuals sharing voice and multimedia files with other individuals in a series of isolated interactions. Instead, perhaps we could consider that the data we are sharing wirelessly becomes part of a "data cloud" enveloping all of us —as ubiquitous as the air we breathe. Then, we may be in a better position to study the web of relations we make in this wireless world, and we will be better able to "see" the next technological hurdle down the road. ■

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