

Telecom Technology



Welcome to the first issue of Dan Sweeney's Telecom Technology—the new monthly newsletter about technology trends and futures for the telecom sector. Dan is one of North America's leading technology writers, having been extensively published in technology, business and science journals such as Lightwave, America's Network, Interactive Week, Electronic Business, Forbes High Technology, Wireless Week, Multichannel News, Broadband Wireless Business, Wireless World, Wireless Integration, Telecom Asia, Satellite Communications, CIO, Mobile Office, Electronic House, Sound & Communications, Sound & Vision, Audio, Stereo Review, Twice, Video Review, and Home Theater.

In this charter introductory issue:

Wi-Fi's sobriety test

Taking stock of the hotspot phenomenon

- Is Wi-Fi hype merely a reprise of the late 1990s dotcom and telecom bubbles?
- Why did industry innovator MobileStar suffer a commercial failure?
- Are Wi-Fi hotspots nothing more than the payphones of the 21st century?
- Is the ideology behind the open spectrum movement driving Wi-Fi hype?
- Do freenets negatively impact the business model for Wi-Fi?
- What are the technical and logistical issues in deploying a Wi-Fi network

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New developments in tunable lasers, fiber throughput and Ultra Wideband

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ANALYSIS: The science (and the art) behind technology market forecasting

Editor's note: Welcome to our debut issue

Few basic industries have seen the degree of radical technological innovation and advancement that has characterized telecom over the past forty years. The pace of innovation intensified sharply through the nineties and the beginning of the current century, and in spite of the severe economic problems endured by service providers and infrastructure creators alike during the past two years, the sheer volume of research activity relating to telecommunications is still extraordinary, and still likely to bring about continuing structural changes in the networks as well as a spate of new service offerings enabled by infrastructure developments.

As has been the case in the recent past, telecom will become yet more deeply interrelated with general computing and other areas of electronic communications including television and multimedia, private data networking, digital imaging, data compression, digital signal processing, and speech synthesis and natural language processing. For this reason, technology initially developed for applications remote from telecommunications may yet be of the utmost significance to its future.

The aim of this publication, very simply, will be to track all technological developments and experiments that we deem of special relevance to the evolution of the industry. The emphasis will generally be on trends rather than solitary innovations, but where an individual invention does exhibit the potential of effecting epochal changes, as did the transistor and, coincidentally, information theory, at mid-century, or, to a lesser extent, did the erbium doped fiber optical amplifier a decade ago, then that solitary device or design concept will be accorded extended treatment. The innovation in question need not be an actual object or system of objects.

For example, a new development in mathematics, such as fractals and wavelet theory, could be just as momentous as a new type of electronic or optical component, as could a revolutionary approach to data manipulation like grid computing or object oriented computing. Even a technology trend based largely on ideology, such as the open source or open spectrum movements, might be worthy of coverage. What is important is that what is being covered is important, that is, likely to affect the industry in some fundamental way.

Whatever the innovation being scrutinized, it should always be put into a practical context, one involving such various contingencies as manufacturing issues, pre-emption by competing technologies, legal and regulatory constraints, standards activities, arbitrary barriers to adoption such as unattractive licensing

arrangements, and most significantly embodiment within a plausible business strategy. For my part, I shall strive assiduously to avoid ideological and metaphysical bents in my reporting *a la* Gilder, Dyson, and Negroponte, and focus instead on the pragmatic, though I cannot avoid taking an historical view of technology.

Finally, this is to be useful information to executives and investors, real business intelligence, as it were, and it is to be scrupulously nonpartisan. It goes without saying that I or anyone else associated with producing the content to fill this journal will not and cannot accept honoraria, stock options, consulting fees or any other form of financial attachment or equity in any organization under consideration. Unquestionably we will be wrong about some issues, but we will not be willfully wrong due to undisclosed conflicts of interest.

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Wi-Fi's Sobriety Test: Taking the measure of the hotspot phenomenon

"Billions in revenue will be generated by mobile Internet users. Want some of it?"

That is the question posed on the San Francisco based Boingo's Website, and a lot of people are answering it in the affirmative. People from companies such as Singtel, Korea Telecom, NT DoCoMo, Deutsche Telecom, British Telecom, Telia, Sonera, Telenor, Microsoft, Intel, Cisco, HP, Toshiba, Sharp, Sony, Samsung, Texas Instruments—in fact, too many major service providers and manufacturers to enumerate here.

In addition to these stalwarts, a boisterous throng of startups has arisen to address the mobile Internet market, specifically that segment devoted to using unlicensed wireless LAN equipment for public access, and, manifestly, they want some of those billions as well.

Apart from the aforementioned Boingo, arguably the best publicized of the lot, the startup contingent includes such still relatively obscure entities as Joltage, Bluengine, NetNearU, Airpath Wireless, FatPort, Nomadix, Air Portal, Airbone Access, Birdstep Technology, Palette Multimedia, Sputnik, SurfandSip, and Pronto Networks, as well as many, many others, with new entrants appearing almost weekly. Furthermore, as distinct from most areas of telecom, this new type of high speed access has enlisted the enthusiastic support of the venture community. One prominent high tech investment firm, namely Intel Capital Investment, has funded no fewer than ten new companies involved in this space.

1998 all over again?

"It's like 1998 all over again," muses Iain Gillott, a Texas-based consultant and analyst who covers the unlicensed scene regularly and has recently produced a study that purports to show the actual usage level in North America (Gillott pegs it at a mere 750,000 transmissions for all of 2002). And he's right--the funny names, the extravagant growth projection, the sheer hype—is reminiscent of those telecom boom days. The jive circus is clearly back in town, and the mood within the unlicensed sector could scarcely be more ebullient.

I, myself, have been covering unlicensed microcellular public wireless

networks, often referred to as “hotspots”, since 1998, and while early entrants such as MobileStar (now owned by T-Mobile, a subsidiary of Deutsche Telecom) and Wayport succeeded in attracting a good deal of attention, the recent upsurge in the number of hotspot companies is unprecedented, and, as Gillott indicates, recalls the dotcom phenomenon, though the level of investment, the number of companies involved, and the user numbers are as yet scarcely comparable.

Still, the level of visibility enjoyed by this very young industry is indisputably very high, and when such an arbiter of high tech trendiness as Wired devotes a cover story to the business, as it did in its October 2002 edition, there’s obviously something going on.

Given the involvement of so many leading corporations in various aspects of hotspot provisioning, it is easy assume a certain inevitability to the hotspot movement—for it is as much a movement as an industry.

But when one begins to examine the nature of the business and the many rather dubious assumptions behind the investments, one cannot but reflect that the biggest and presumably the best led companies have been wrong before in predicting the course of various technologies in the marketplace.

This is not to say that the business of hotspot networks is a chimera and that the technology will fail to find a market or possibly many markets. But such a multitude of contingencies and uncertainties surrounds the business, that it demands a good deal more reasoned analysis and considerably less zealotry than is the case today.

Defining the hotspot

A hotspot network is one serving a restricted, heavily trafficked area that is open to the public. That area could be as small as a coffee shop or the passenger section of an airplane, or as large as convention center or an entire hotel complex, but it’s basically an area that may be served by a single wireless LAN, not a MAN (metropolitan area network). Christian Gunning, director of product marketing for Boingo, one of the most visible hotspot companies, simply construes a hotspot to be a “high loiter area”, and that’s probably as good a definition as any.

Essentially what goes on in the hotspot network is that the customer establishes Internet access via a mobile wireless terminal, whether it be a radio modem equipped laptop, PDA, or smartphone, while the operator of the hotspot either derives revenue directly from the user, or else positions the hotspot as a free amenity to induce customers to linger in the hotspot area where they might be

persuaded to purchase other products and services. Hotspot networks are veritably the fast food restaurants of the broadband industry, and it's no coincidence that actual fast food franchises are frequently sought as locations.

Hotspot networks differ markedly from other forms of public broadband access in that they are generally isolated and noncontiguous, and each access point affords service to the user only over a very restricted footprint, so there's no real comparison with cellular in terms of coverage.

A network may consist of but a single access point, and that access point may be the entire extent of an individual service provider's infrastructure. The basic model is radically different from that of almost any kind of traditional public network in that generally no attempt is made to establish a comprehensive footprint within a larger service area nor to follow a public utility model of ubiquitous if not universal service. The Internet café is probably the closest analogy, though the hotspot is far less restricted as to location, and hotspot operators aim to attract a far larger clientele.

The WISP category

Hotspot networks themselves tend at some point to merge into a larger category known as the WISP (wireless ISP) where a fixed point, high speed R.F. connection is used to provide broadband access to subscribers.

The defining difference between the hotspot network and the more traditional WISP has more to do with the scope of the network itself and with the associated business models than with the equipment used to construct it, and so, not surprisingly, the two are often confused.

There are real distinctions though. A WISP is normally metropolitan in concept if not in actual reach, and aims to be competitive with more conventional broadband networks based on DSL or hybrid fiber coax. Cell size is measured in kilometers, sometimes tens of kilometers, and a single base station may serve hundreds or even thousands of simultaneous customers as opposed to the handful a hotspot can handle. WISPs may use low cost, repurposed wireless LAN equipment, or carrier grade wireless infrastructure, but typically the latter is embraced by the more serious network operators, which is never the case with hotspots.

Where WISP and hotspot tend to merge and converge is in the MDU (multi dwelling unit) market where apartment dwellers or owners are the targeted subscriber base. In such networks, wireless LAN equipment, generally based upon

the IEEE 802.11 standard, is used to provide coverage within the building or complex, while backhaul to an Internet access point may be effected through just about any physical transport medium—T1/E1, VDSL, fiber, or a point-to-point microwave connection. By most definitions, the term hotspot would tend to apply to hotels rather than apartments within this larger MDU market, though the distinction isn't hard and fast. The idea is that the hotspot will provide temporary connectivity for the casual user rather than a permanent individual link for a resident subscriber. In either case, the physical installation will be much the same, but the back office aspect of the network is likely to be quite different.

The Market Perspective - Major Segments

Hotspot networking is a relatively new industry--the first hotspots appear to have arisen in the United States in the 1998-99 time frame—but it is already considerably diversified in regard to niche markets. As well as hotels, hotspots currently occupy airports, train stations, convention centers, the lobbies of large office buildings, coffee shops and restaurants, parks, cruise ships, and soon airplanes and roadside convenience stores.

What might be termed private hotspots are even provided by certain companies for use by visitors in order to serve their needs while at the same time keeping them off the corporate LAN. In fact, the placement of a hotspot access point is limited only by the imagination of the service provider. Anywhere it's likely to draw traffic is an acceptable location.

While sometimes referred to as mobile Internet services, hotspots don't support full mobility the way cellular telephone networks do, in other words, they can't be used in moving vehicles. They should more properly be viewed as fixed point wireless networks put to temporary and intermittent use.

Communication markets are as much defined by customer base as by where an access point resides, and here, proponents of the hotspot model fall into two broad camps, those who believe that the industry should focus primarily upon the business traveler, the core market today, and those who seek an inclusive market of consumers as well as business users. The first camp appears to be dominant currently, but noisy advocacy of the consumer model increasingly characterizes the horde of startups driving the overall hotspot frenzy.

In evaluating the viability of the various niches and market orientations, especially those having to do with the key business customer, it is useful to reflect back on the origins of the industry, and on the indifferent success of the pioneers.

Texas-based MobileStar seems to have been the very first concern to espouse a recognizable hotspot business plan, and that plan was based on providing interested business travelers with Proxim's low cost HomeRF PCMCIA wireless LAN cards, and at the same time establishing an authentication scheme to control access to the networks. Billing was flat rate, and a monthly subscription permitted the subscriber to access the Internet at any airport or hotel supporting the MobileStar service.

MobileStar's primary focus was initially on airports, still considered the best niche market by many in the industry. By the late 1990s when MobileStar commenced operations, some airports already provided dialup Internet access at Internet kiosks or at special business traveler facilities such as Admiral Clubs, and MobileStar management reasoned that wireless LANs could provide for more cost effective and ubiquitous installations—in other words, could address an existing market with technology better suited to mobility. Proxim's proprietary HomeRF protocol was selected because it represented the least expensive wireless LAN solution at the time, and because 802.11 standards were not yet finalized.

"We couldn't have launched the networks any sooner than we did," recalls Dick Snyder, a former MobileStar executive now with Concourse Communications Group (Springfield, MA) which also addresses the airport hotspot market. "Proxim provided us with a solution, not an ideal solution, but acceptable."

The MobileStar failure

Or so it seemed at the time. In fact, Proxim's product never achieved very widespread acceptance in the market, and thus no considerable population of users was ready at hand to embrace the MobileStar service. That put MobileStar in the position of having first to sell the notion of the wireless LAN to its potential subscribers, and then to convince them further to adopt MobileStar's specific application for wireless LAN technology. In addition, MobileStar, like many data LECs of its era, attempted, at tremendous cost, to build out a nationwide footprint, a seeming necessity given the utter lack of roaming protocols back then. Such constraints undoubtedly contributed to MobileStar's ultimate business failure.

Current providers of hotspot access in airports, including the MobileStar division of T-Mobile, can take advantage of the fact that 802.11 wireless LANs are widely accepted in both business applications and home networking and are becoming steadily more common in schools as well.

There is now, as there wasn't four years ago, a good sized and growing

population of business professionals with 802.11 cards in their laptops, indeed such cards are standard equipment in many of the newer laptops and are supported by the Microsoft Windows and the Apple operating systems as well as by various flavors of Linux. Furthermore, according to Intel representatives, 802.11 virtual radios will eventually be built right into the CPU. So no longer must a hotspot service provider sell the basic technology. It's already established.

The question then becomes will such business professionals be inclined to use their waiting time in airports to check email or access the corporate LAN. Obviously, some will, but will most? No one knows, but clearly a business traveler has a valid if not necessarily compelling reason to use an airport hotspot. Whether that reason will prove sufficient remains to be seen.

The hotel niche

MobileStar, and other hotspot progenitors such as STSN and Wayport, also targeted hotels as a primary market, and there again the business case seemed relatively sound. Business travelers were already using dialup connections routinely in hotel rooms, and some hotels were beginning to offer Ethernet ports or DSL. But there also the limited acceptance of wireless LAN technology relative to the present worked against the success of the pioneers.

Today, however, the near ubiquity of Wi-Fi in the enterprise would seem to argue strongly for the success of hotel hotspots, and eliminate the major stumbling block facing the pioneers. But things are not always as they appear, and a number of not so apparent obstacles, considered at length elsewhere in this report, have prevented hotspot operators from making a really big business of either hotels or airports. Still, airports and hotels appear to represent by far the biggest and most evolved markets to date. The highly publicized coffee shop market is by comparison much more problematic, and, incidentally, much less apt to benefit from the success of Wi-Fi in the enterprise.

“How many prime business customers do you get in coffee shops?” asks Iain Gillott, addressing this point. “I sometimes do work in Starbucks, but I'm independent. Most companies don't want their staff hanging around coffee shops all day.”

Interestingly, in certain geographic markets, Gillott's observation may not hold true, however. “A lot of insurance agents complete transactions over our network,” claims Derrick Lee, director of Singapore's Bluengine independent hotspot operator. “We even have hotspots in shipyards. Maybe it's different than in North

America, but here we've demonstrated that cafes do attract business users."

"The appeal of coffee shops is that they're a lot of them," notes Stefan Jenzowsky, head of business innovation for Siemens, whose management has taken a keen interest in the hotspot phenomenon. "We think it's a sensible market."

Jerry Kaufman, a principal at Alexander Resources (Dallas, TX) who specializes in wireless networks objects, doubting the short term market potential of restaurants for either a business or consumer clientele. "First of all, the potential business market for mobile data services has been grossly exaggerated," he states. "We did a study of over 500 occupations a few years ago, and we concluded that the percentage of employees whose jobs involve regular movement outside the worksite is single digit. And as far as consumers using these facilities, I've queried a number of Starbucks managers, and I've found that usage is extremely low. And there's a reason for that. Nonbusiness users are not going to lug around laptops, they're going to have PDAs, and the wireless Internet experience over PDAs is miserable. Most Websites simply aren't formatted for presentation on small screens."

The same, incidentally, may be said of smartphones, which will ultimately permit dual mode operation over cellular and unlicensed bands.

The Wi-Fi payphone?

In any case, at least according to Gillott's survey, restaurant installations account for only a small proportion of hotspot transmissions today in the U.S. Numbers are not available for either Asian or European markets, but John Rasmus, vice president of business and corporate development for GRIC (Milpitas, CA), a major international aggregator of wired and wireless ISPs, observes that business users in hotels and airports generally account for most of the usage worldwide as well. "But," Rasmus adds, "the heavy involvement of incumbent carriers in Asia may change that balance. A number of carriers have told us they intend to install the Wi-Fi equivalent of pay phones all over their respective territories. We see mass adoption of the technology in the future."

But what, one asks oneself, will drive such mass adoption, presumably by a consumer mass market? Will hot spots simply be an extension of existing mobile two-way messaging and 2.5G data services or something else as yet unforeseen? One hopes for the sake of the industry that it is the latter because the 2.5G model for data has not been an unqualified success.

Like the dotcom boom that preceded it, the hotspot craze is more than

simply an industry, it is to some extent part of a social movement, and a millennial one at that. And in the view of some of its more passionate participants, it is a movement that will result in nothing less than the radical restructuring of the entire telecom universe. This, as it happens, is the view of no less high tech luminary than Nicholas Negroponte, the publicity loving director of the MIT Media Lab, but, as we shall see, it is hardly original to him. Proponents of unlicensed networks have been saying essentially the same thing for years.

What is involved here is an ideology that is fundamentally opposed to the traditional natural monopoly model of telecommunications and to the traditional means of allocation of spectrum for business and governmental users. Under the proposed new dispensation, radio spectrum, at any rate, some portion of it, should be free and available for the use of anyone who desires it, and such free spectrum should be used to establish a multitude of new service networks—"micro-operators" as Negroponte like to term them—that will be independent of the entrenched incumbents."

The ideology of open spectrum

Proponents sometimes call this policy platform the Open Spectrum Initiative, but the term is somewhat misleading because the word initiative implies some degree of momentum. In fact there is no indication that any government with the possible exception of the Kingdom of Tonga (honestly) will move in this direction any time soon, if ever. Still, the concept retains its appeal among a large segment of digerati, and is often associated with the Open Source activities surrounding the Linux operating system.

In any event, such notions lay behind much of the early development work in wireless LANs. The idea was that with newly developed and highly robust spread spectrum modulation techniques, particularly direct sequence and code division multiple access, multiple users might coexist within the same bands, and therefore regulatory bodies could dispense with formal licensing and exclusive use provisions.

Of course that didn't happen, but many governments did set aside some license free spectrum for data transmission, and in fact 802.11 equipment operates in just those bands. It also makes use of spread spectrum techniques, and the operation of the systems in the field does appear to demonstrate the validity of the underlying concept, though, as in so many other aspects of the hotspot, appearances can be somewhat misleading.

Ultimately, it was the establishment of the standards as much as the core

technology or the informing ideology that proved revolutionary though. Industry standards, and the WECA (Wireless Ethernet Compatibility Alliance) sponsored Wi-Fi (Wireless Fidelity) certification process for reinforcing them, led to economies of scale in manufacturing and to a drastic reduction in price for wireless LAN modems, which had typically sold for \$500 U.S. and up in the middle nineties before the standards were in place. With the coming of low cost, high performance client cards and base stations at the end of the decade, practically anyone who wished to do so could build a small broadband network and operate it largely free from government regulation. Market penetration of wireless LANs was rapid thereafter.

At this point one might be wondering just what the Open Spectrum ideology has to do with hotspots other than having inspired the equipment used in them. A good deal as it happens.

You see hotspots were not the first manifestation of the new wireless LAN technology in a public access setting. Before hotspots ever existed, small commercial WISPs began using wireless LAN gear in the U.S. and Europe. Perhaps more significantly, so did operations known variously as freenets, guerillanets, and piranhanets.

The freenet phenomena

Such freenets are not-for-profit networks where a community of users leases a broadband connection to the Internet and purchases one or more base stations, sharing the cost of the lease and other miscellaneous expenses, and, in some cases, providing free access to casual users visiting the network. In this manner they give particularly vivid expression to the Open Spectrum philosophy.

Freenets, unlike WISPs, are not commercial entities whereas most hotspots are, but as we shall in a moment, some persons within the hotspot industry, drawing upon the freenet model, actually advocate not charging the user for access.

Their reasoning is that the freenet model will eventually prevail and that businesses supporting hotspots should position them as amenities for attracting customers for other offerings, not as profit centers in an of themselves. Still others believe that freenets perform a vital role in building a base of Wi-Fi users, a base who will presumably pay for the service outside of their own homes.

Determining the number of WISPs and freenets worldwide or even in North America is a fairly hopeless undertaking. I've seen figures for U.S. WISPs ranging anywhere from a couple hundred up to nearly 10,000. Commercial WISPs have

generally proven unsustainable in the long run, and few have remained in operation for longer than two years. As Jerry Kaufman observes, “the management of a network is beyond the capabilities of most of the entrepreneurial types who’ve launched these companies.” On the other hand, new WISP entrepreneurs are never in short supply, and the overall number of such operations is probably increasing.

Freenets are probably increasing as well and are probably just as short lived. I’ve seen many come and go over the past two years. Proponents are given to vainglorious proclamations about linking up to one another and supplanting the telco incumbents, incidentally the same notion being currently advanced by Negroponte regarding hotspots, but there’s no evidence that this is happening anywhere.

In economic terms, none of the unlicensed WISP or freenet activity is important yet, but in cultural terms I believe it bears watching. The public Internet itself had similar grassroots, quasi-outlaw origins in the United States, which transmuted in time into the entrepreneurial fervor of the dotcom era. The progression from WISP and freenet to hotspot seems to suggest a similar evolutionary process, and this analogy is not lost on hotspot boosters. The idea here is that primeval anarchy and enthusiasm of the pioneers provides the necessary excitement to build a mass movement and later a mass market.

Grass-roots enterprises, not users

I do not see history repeating itself here, however. For one thing, most hotspots are not direct outgrowths of WISPs or freenets for that matter, but instead rather distantly related parallel developments. For another, the grassroots nature of the hotspot movement is not associated with the end user so much as with the hotspot operator. In other words, it’s a grass roots entrepreneurial push rather than being driven by consumer demand.

Most of the platform startups such as Boingo, Pronto, Nomadix, Bluengine, et al, subscribe to some variant of the franchising model, and are attempting to persuade countless small businesses with presumed hotspot potential to try to enrich themselves by installing an access point on the premises.

Such franchising is virtually unprecedented in the history of telecommunications, but, more curious still, there are often multiple layers of service providers involved in the process—for instance, Nomadix might offer local aggregation, roaming, and billing services to participating hotspot owners, while Boingo might layer national roaming and unified billing on top of that, and finally

GRIC might add an international dimension.

In addition, the local incumbent telco is getting money for providing backhaul. Revenue sharing of various sorts becomes the rule, and it's difficult to believe that anyone is making much money in this portion of the market. The exigencies attendant upon such arrangements have not been lost on the more astute observers of the hotspot scene.

"This franchising thing simply can't work long term," declares Seamus McAteer, a principal with the Zelos Group in San Francisco who has studied hotspots extensively. Many other respondents agree, and Roger Killion, president of RoomLinX (Rancho Murieta, CA), a hotspot expediter that does not follow this practice, goes further, declaring, "it's the characteristic of an unhealthy business climate. Everybody's trying to get a cut and milk the system for what they can get."

The converse of franchising and fragmentation is the reluctance of anyone including incumbent telcos to develop comprehensive suites of OSS software and standards for roaming and interoperability. Instead pieces of solutions are offered by various independents, and since the pieces are all proprietary, the hotspot experience doesn't approach the transparency of a cellular telephone call. The presence of so many vendors with so many incompatible offerings may make for a lot of excitement in the marketplace, but it works against the widespread acceptance of public access Wi-Fi.

Pricing practices are also somewhat problematic, and there is little consistency except that prices are rather high *vis a vis* established broadband services. Most service providers follow some kind of subscription model, but many also issue prepaid cards or allow users to pay per session with a credit card.

A lack of applications?

Another rather glaring deficiency of hotspot platforms today is lack of built-in business applications and, coincidentally, the cultivation of vertical business markets of the sort long established for the mobile data services. GRIC does offer conferencing, expense accounting, and field force automation for the hotspot user, but it is alone in doing so.

This deficiency is paralleled on the consumer side. There is almost no specialized content designed for hotspots, and, of course, no QoS that would permit any rich multimedia offerings.

Most of the many individuals interviewed for this piece are bullish on the

hotspot industry, but time and again I heard comments as to the paucity of sound business models for selling the service or for serving the independent operators. It's almost as if these individuals were speaking of the MP3 phenomenon in the music business where lots of traffic is being generated but no one is making any money.

And, indeed, a scenario is already beginning to play out where the hotspot operator doesn't expect to derive any direct revenues from the service. Says Ed Moura, president of SOHO Wireless (Palo Alto, CA), one of the earliest hotspot expeditors, "we do very little revenue sharing as such. We concentrate on the MDU and hotel market where the real estate owners increasingly offer Wi-Fi access free of charge. I believe that it is becoming a free utility like drinking fountains in an office building." Roger Killion of RoomLinX agrees. "More and more hotels are putting in Wi-Fi as an amenity. So what's that do to the guy in the coffee shop down the street trying to charge for the service or the mobile operator trying to do the same thing? Well, at least the guy with the coffee shop can offer it as an amenity too, but what's the mobile carrier gonna do?"

If Killion and Moura are right, ironically the most radical freenet model may be proving itself out already, and Moura admits as much. "I love freenets," he declares. "I consider them my best friends because they're helping to promote Wi-Fi, and I often provide software to them. The traditional telco approach of billing by the minute and reserving spectrum will not work in this market."

The irony here is that the free spectrum that would supposedly allow so many new network operators to participate in the marketplace simply isn't being valued by the consumer or, indeed, by many of the network operators themselves—in other words, it's free in more ways than one. One wireless equipment manufacturer, Hatim Zaghoul, president of Wi-LAN located in Calgary, Alberta, even suggests that corporations should make their enterprise access points available to the public while deriving small termination fees from network aggregators who would handle billing and Internet access. Since so many enterprise LANs are already being illicitly accessed from the street, a practice known as "war riding", Zaghoul reasons that the IT departments should simply legitimize what is common practice and make a little money into the bargain.

Convenience store hotspots

Another market development which could conceivably further devalue unlicensed spectrum and undercut network operators attempting to charge for access is the deployment of hotspots in convenience stores for the purpose of selling online content such as maps, music files, video files, etc., as well as for providing

telematic vehicle diagnostics. Many analysts predict the imminent emergence of such an application, and in this instance retailers are unlikely to charge the customer for access itself and may instead permit him to browse the Web simply as an added benefit. If this comes to pass, no one is going to be charging travelers several dollars per logon which is happening today.

The free access model is further strengthened by the simple fact that Wi-Fi networks are not and cannot be anything approaching carrier grade—not with current technology, that is. Wi-Fi networks are shared resource, contention based Ethernets that do not enable quality of service or reservation of bandwidth under existing standards, and do not support large numbers of simultaneous users accessing a single base station.

And such limitations are exacerbated in many instances by poor installation and excessive interference. How does one tariff something like that, particularly when the number of access points is steadily increasing and so is the number of individuals willing to make them available gratis?

The Coming of Major Player Involvement

Notwithstanding the lack of runaway successes among existing and past hotspot service providers, incumbent telcos all over the world are either contemplating service launches or already initiating them. I interviewed numerous wireless carriers in the U.S., which is seen by many as having the poorest potential of the major markets, and I found endorsement of the hotspot concept to be universal. “They’re like lemmings,” comments Herschel Shosteck, a well known mobile telephony analyst and consultant, and one of the few to dismiss the hotspot business out of hand. “They’re all going into it, even though absolutely no one has demonstrated a sound business plan.”

So how will incumbent carriers proceed with the rollouts, and how will they make a business of the service? The answers are elusive at present, but a period of experimentation is likely initially. Meanwhile, the deployments are proceeding apace. NTT DoCoMo in Tokyo has already established numerous hotspots making use of existing PHS basestation sites, a ploy which is fairly cost effective if nothing else, and two other companies, Yahoo! Japan and Softbank Commerce have announced a very ambitious plan to install hotspots in thousands of McDonalds restaurants throughout the Japanese archipelago.

Elsewhere in the Pacific Rim, Singtel has already blanketed Singapore with approximately a hundred hotspot access points. But no effort to date approaches

the magnitude of Korea Telecom's hotspot initiative which calls for 25,000 hotspots nation wide before the end of this calendar year. Korea Telecom's deployment strategy appears fairly indiscriminate at first glance. The carrier is placing the hotspots in almost every conceivable type of venue—airports, train stations, subways, restaurants, and the lobbies of office buildings, as well as universities which have not been traditional hotspot locales. The service is targeted at the existing DSL subscriber base and is positioned as a low cost value add. The deployment is said to be a response to a flattening of DSL demand as the Korean market becomes saturated, and is indicative of the determination of KT to find new sources of revenue. I might add that there is no evidence whatsoever that the American Open Spectrum ideology plays any part in the undertaking.

I have heard rumors that other Pacific Rim nations are contemplating similarly ambitious projects but have been unable to confirm them.

Incumbents lead Asia, Europe hotspot deployment

East Asia, in asserting its dominance within the hot-spotting arena, has done so largely without a strong independent presence, though there are a few "indies" out there such as Bluengine and Palette Multimedia in Singapore and Indonesia, and Xone, Air Portal, and Azure Wireless in Australia. As has been the case with wireline Internet services previously, Asian incumbents have largely been responsible for introducing the new technology and services.

Several European carriers are commencing hotspot deployments, including British Telecom, Deutsche Telecom, Telia, Sonera, Telenor, and others, but in Europe independents have assumed a larger role, though not so large as in North America. Megabeam in Italy and Netario in Britain are two of the better publicized examples, but there are numerous other independents with at least twenty reported in Germany alone.

Stefan Jenzowsky of Siemens notes some hesitancy on the part of incumbent carriers to roll out hotspots on a massive scale thus far, hence the early lead taken by the independents. "I think people are still trying to figure out the correct business model," he remarks.

Jenzowsky himself believes as many do that airports constitute the prime market today, though, as he hastens to add, "the number of major airports is limited. There's a little over 300 in Europe and roughly the same in the U.S. Once you've established that market, where do you go next? That's the question on everyone's mind." That's assuming that airports really are the market of choice for

carriers though, and not everyone agrees. Dick Snyder of Concourse points out that many airports don't necessarily want service providers managing hotspots and that installations are frequently complicated by the existence of internal Wi-Fi networks, often more than one.

In addition, many airports are already being served by independents such as Wayport, Aerzone (a division of San Francisco based Softnet Systems), and Airpath. Here again the business opportunities may not be as great as some industry boosters would have us believe.

One would think though that incumbents would be more vigorous in promoting hotspots currently, if for no other reason than that they prompt the sale of broadband wireline connections. But there is little evidence of outreach to independent hotspot operators, and, as indicated, direct telco involvement is still at an early stage in most areas.

As many respondents have suggested, few incumbents are presently in a position to fund major buildouts regardless of the hype surrounding 802.11. They may like the idea of hotspots, but they're not so eager to pay for provisioning them.

The rumored Project Rainbow

One further note: within the United States, admittedly an undeveloped market, reports have been circulating in the business press of a joint program involving many of the major mobile carriers as well as Intel and IBM for developing a nationwide network of hotspots. Dubbed Project Rainbow, its existence has not been confirmed by any of the supposed participants, but it is credited by a number of industry insiders with whom I've spoken.

Given the propensity of American carriers for working through established standards bodies in formulating interoperability protocols, and given the utter lack of evidence for the same, I am doubtful that there is much substance to Project Rainbow. As a matter of further interest, established American ISPs, with the singular exception of Earthlink, have generally not embraced hotspots. (Like Boingo with which it enjoys a partnership, Earthlink was founded by the flamboyant Sky Dayton, the current media superstar of the hotspot biz.) Perhaps most surprisingly, wireless ISPs have been particularly leery of the hotspot business.

Wi-Fi's chances of enjoying solid success in the public access space are heavily dependent upon logistics and ultimately upon the expenses of setting up and operating a wireless hotspot. For an upstart technology to prevail it has to be

notably easy to deploy or else subject to overwhelming demand. Since the latter is clearly not the case as yet with Wi-Fi, ease of deployment considerations assume overwhelming importance.

The logistical issues of Wi-Fi deployment

The actual physical installation of a hotspot's infrastructure is fairly straightforward, so long, that is, as the network is confined to a few square feet of floor space, which is what one would expect given the fact that home networks are a major market segment for Wi-Fi gear. In simplest terms, the network operator places one or more base stations on the premises, and then runs an Ethernet connection back to a gateway for a wireline broadband service, variously a T1/E1, cable data, or DSL. Alternately, a wireless bridge, also using unlicensed frequencies, could be connected with a telco operated access point, but this approach has not proven popular to date, though it can reduce recurrent costs considerably.

If the hotspot is to be operated as a no charge amenity, such a simple installation will suffice, but if it is intended to produce revenue, then a software component is required. And that's where things can get complicated.

Normally, in an office or residential setting, computers utilizing a Wi-Fi connection must be specially configured for the purpose, but how is this to be accomplished in the public space where each hotspot may have a different owner/operator and different supporting software?

Customers surely don't want to stop to reconfigure their laptops every time they decide to download email. A few of companies, notably Nomadix and SOHO Wireless, have developed browser based approaches for access where client software need not be loaded, and this represents a partial solution to the problem, but it is one that has yet to be adopted across the hotspot market.

And it is not only the customer who is challenged by the current complexities of the systems. The aspiring hotspot operator will need billing software, an authentication server, and provisions for ensuring privacy and security, all requiring continued administration as customers are added and dropped. In most cases, he will also want to be able to support common business applications such as VPNs and transparent LANs, the same sort of services offered by wireline broadband access providers.

If the hotspot operator is present in several locations, then problems multiply because he's no longer provisioning a single access point, he's running a network. And if he's primarily in the restaurant business, he's not likely to have the skill set

to do that creditably. A host of companies have arisen to help just such beleaguered individuals—Boingo, Pronto, Airath, Nomadix, and many more. What they're offering are turnkey approaches to hotspotting where in many cases the access point and the authentication and OSS server are combined in a single physical unit, what Boingo and Pronto term a "WISP-In-A-Box". Most of these platforms are intended to support private branding on the part of the individual operator, and, at the same time, to facilitate subscriber roaming and single billing.

Unfortunately, there is no roaming platform with anything close to universal acceptance, let alone a client software system for subscribers that has achieved industry dominance, so the benefits of any platform for promoting the technology at large are really pretty limited. Furthermore, since most turnkey solutions involve some form of revenue sharing, they erode what might already be a rather scanty revenue stream.

Contrast the Wi-Fi mess where multitudes of here-today-gone-tomorrow startups are trying to sell aggregation software to anyone and everyone with the well considered, and highly orderly process by which mobile carriers formulated roaming, authentication, and reciprocal billing standards during the nineteen eighties. Then ask yourself what judicious individual would want to buy a proprietary protocol knowing that its vendor may not survive a second funding round? The answer is not likely to be such as to encourage heavy investment in the hotspot industry.

It should be mentioned here that there is an industry initiative supported by some though not all hotspot platform developers called Pass-One that could result in the same kind of roaming and interoperability standards long enjoyed by the cellular carriers. Whether it will enlist full industry support is doubtful at this juncture, and if it does not, it will accomplish nothing. That the industry sorely needs this sort of thing can scarcely be doubted though.

The cost of broadband connections

The fledgling hotspot operator also faces the problem of recurring broadband connection costs. He can attempt to leverage a low priced consumer cable modem or DSL connection, but broadband wireline operators look askance at that practice and have taken legal action in the U.S. to curtail it. If, on the other hand, the hotspot impresario opts for a business class broadband connection, he'll pay a price that is multiples of that for the consumer service.

In addition, hotspot operators also face constraints that are inherent in the 802.11 standard. Because unlicensed spectrum is open, interference is a given, and

if Wi-Fi systems achieve really widespread acceptance in public spaces, the interference problem will become critical. Moreover, the direct sequence modulation scheme used in most Wi-Fi radios does not scale and only permits a handful of simultaneous users at each base station. Unlicensed spectrum also makes a mockery of quality of service provisions because they simply can't be enforced in the presence of intermittent interferers. Finally, large Wi-Fi systems with multiple access points are tricky to deploy and generally require expensive professional installation, negating the low barrier to entry argument.

Seldom mentioned in the promotional literature of the numerous hotspot platform manufacturers are the vicissitudes to which r.f. propagation is subject even in the best of circumstances. A radio airlink will usually have a very high bit error rate relative to a wireline connection, and a Wi-Fi operator really should perform an r.f. site survey before buying or leasing anything. Unfortunately, many do not.

All of this makes for a wildly inconsistent hotspot experience unless the user is confining himself to a single vendor operating in a single environment, such as Airpath with its thirty-five airport installations scattered through North America.

A final consideration in regard to network management is amalgamating Wi-Fi with a mobile data service, surely the goal of many if not most mobile carriers. A number of vendors including Mobility Networks (San Jose, CA) and Boingo have developed software to that end, but no one to date has been able to run an application seamlessly across the two networks. Until this happens the involvement of mobile carriers in this marketplace is apt to be limited.

A Most Curious Industry and Where It May Be Tending

Public access Wi-Fi in North America, and, to a lesser extent in Europe, resembles a nineteenth century gold rush where adventurers flooded into a region to make their fortunes while major mining companies stood back, waiting to buy out the claims that seemed worth developing. The carriers are exactly in the position of the old time mining companies, poised to act, but biding their time to ascertain the real market potential of the business.

In Asia the hotspot industry is largely otherwise, with independents playing a minor role, and major carriers initiating the business, but there the lack of standards still attests to the immaturity of the industry, and the real extent of the revenue opportunities remains unknown.

Most of the analysts interviewed for **Telecom Technology** believe that few if any independent hotspot operators will survive long term in either the Old World or

the New, and that a natural process of consolidation will take place. But others, mostly the entrepreneurs themselves and the platform vendors who serve them, believe that low barriers to entry will continue to promote a growing horde of independents with no end in sight. My own analysis leads me to believe that attempting to pick winners is to miss the point. The issue is not whether independents or incumbents are going to own the business, but what precisely there is to own. Unfortunately that question goes largely unanswered because many of the same wrongheaded assumptions that led to the dotcom debacle seem to be operating here as well, and obscuring the real extent of the market.

Let us reflect on this point for a moment.

Much of the inflation in Internet stocks two and three years ago was based upon fallacious reports as to Internet traffic growth and by wild predictions to the effect that everyone would be more or less online 24/7 in some paradise of pervasive computing. Clearly, though, the Internet is but one information resource, and one with limited value in many mobility scenarios. It wasn't about to displace radio, television, print media, and, yes POTS, or to engage everyone continually.

Putting Wi-Fi in its place

The hyping of the Internet was understandable in view of the extraordinary early take rates for the access services, but Wi-Fi hotspot access, coming at a time when overall Internet growth rates are tapering off, seems less likely to achieve a commanding position because it is after all, just another broadband service, and, moreover, it is one that can't really account for any large percentage of Internet usage ever. It's a small subset of broadband connectivity which itself is a subset of the total universe of electronic communications. No large portion of the work force is ever going to spend any appreciable amount of time working at hotspots, and the idea that they will is simply preposterous. Business travelers will access hotspots at hotels and airports, but in the larger scheme of things, that's a small business, certainly not one to fulfill Negroponte's prediction of some successor to the PSTN. Recreational Web surfing could and probably will increase at hotspots, but it's difficult to identify emerging patterns of behavior that would place a large segment of the population in cafes and restaurants for several hours a day. If you want someone who isn't going to move, why not target problem drinkers in bars? They often do linger for hours. But no one seems to be courting the drunks.

As it begins to develop, the hotspot business really looks a lot more like the pay phone business than the wireline Internet, and pay phones are hardly the salvation of the telecom industry. Still one cannot deny the impressive growth of Wi-

Fi sui generis, nor the likelihood that Wi-Fi capabilities will soon be standard across laptops, smartphones, and PDAs alike. Won't that make for a very big business?

For Intel and Intersil it certainly will. It will also very probably make for a very big volume of Wi-Fi originated traffic, but that such traffic will be revenue producing is not assured. In the U.S. a growing number of municipalities and telephone cooperatives are building public access networks as amenities, often with Federal financial assistance. This trend coupled with the very real movement toward no charge access in hotels and the possibility of the same in certain retail establishments could undercut the potential for anyone making a thriving business of hotspots, at least where the practice of free access is permitted. Free has a way of driving out for profit. How many people are paying for Internet music downloads?

Wi-Fi Futures

Here I will consider some emerging trends that could influence the evolution of hotspots. One of the biggest problems facing the public access Wi-Fi movement is the inadequacy of the airlink itself for public access, particularly in respect to interference. Technologies exist which could mitigate this problem, though they aren't cost effective at present. Nevertheless, they will be at some point and they may figure in the future of hotspots.

Adaptive antenna arrays have been developed by a number of broadband wireless companies with the capability of rejecting interference through cancellation strategies, and permitting the use of aggressive frequency reuse within the same location—in effect eliminating Wi-Fi's biggest failing. Such technologies currently lack either cost effectiveness or a suitable form factor, but years hence their feasibility may yet be demonstrated. Software defined radios which would permit easy migration from one frequency band or from one modulation scheme to another have already been developed for base stations and could see embodiment in mobile terminals also. These too could minimize interference as well as blurring the distinction between licensed and unlicensed services.

Again, productization is probably years away as are network management systems that would permit carriers in effect to trade bandwidth across the spectrum, but such a scenario is conceivable. There are also technologies extant for transmitting over two or more unlicensed frequencies simultaneously for either higher throughput or greater redundancy or both. Finally, there is ultrawideband radio, a technology for unlicensed network operators that promises unprecedented immunity to co-interference, fiberlike-throughput speeds, and excellent building penetration.

All of the above may be seen as facilitating the ultimate realization of the Open Spectrum dream and posing a real challenge to traditional telephony. None of these approaches is close to being standardized, however, and ultrawideband has had extremely stringent power restrictions imposed upon it by the FCC, such that the technology very well may not be deployed in any public network. Indeed, powerful economic forces are arrayed against each of these innovations and may stifle their further development.

A decision on the part of Mobile carriers, however unlikely it seems at this juncture, to move ahead to multimegabit per second 4G mobile networks could also impact Wi-Fi, probably detrimentally. A ubiquitous high speed network that supports full mobility would certainly be preferable to Wi-Fi, and might even compete against essentially free Wi-Fi access.

Fundamental changes in terminal design could also alter the course of the hotspot market. Folding organic LED screens allowing for full Web graphics on PDAs could certainly promote more recreational surfing at hotspots as could the introduction of low cost, energy dense batteries such as silver zinc types, or, conversely, miniature fuel cells. Either technology would enable much longer run times and a qualitatively different computing experience. Truly powerful natural language interpretation systems could also fundamentally change the nature of mobile computing by freeing the handheld terminal from text based applications requiring large screen size and by changing the very nature of the Internet itself.

Finally, peer to peer mobile architectures where individual terminals perform routing functions have begun to appear in specialized, non-standardized software platforms for both 802.11 and Bluetooth. These could eliminate the need for the hotspot altogether while still affording many of its benefits, provided, that is, the user population were dense enough. The problems of managing and securing such a network would be very formidable though, and the appearance of such networks cannot be predicted with any certainty.

For the present however, Wi-Fi public access networks must struggle with their own persistent limitations, including lack of unique applications, true interoperability, carrier grade availability, and, most of all footprint. And that also means that they lack real credibility.

Finale: Lilypads along the Information Waterway

Nicholas Negroponte, in the same edition of Wired featuring the cover story on hotspots, advances the theory that hotspots and freenets will gradually coalesce into

a gigantic telephone collective like lily pads covering a pond. Just when we thought that the millennial vaporings of the boom period were over!

Still, Negroponte has been correct in some of his predictions, and since he isn't alone in this, his vision demands some consideration.

First of all, an all encompassing high speed wireless umbrella very probably would be revolutionary in its implications as Negroponte suggests. Getting there while making a profit along the way is the problem. It's just like fiber to the home. Everyone would like to have it at thirty dollars a month, and once in place it would certainly transform the telecommunications industry, but the short term business case for the carrier is questionable.

Which brings us to the other key question, suggested but never enunciated in our survey, and that is what is going to drive mass acceptance of Wi-Fi public access and make those lily pads sprout?

One can suggest all kinds of information services, some of them location based, such as financial news, restaurant guides, sports reports, etc. The list is long, and we've seen it before in regard to licensed mobile data networks. So far the public has not been all that receptive in most countries. As a matter of interest, the now defunct General Magic, which really was a visionary company and whose founders thought deeply about how a wireless data service should operate, took the position that wireless connectivity would flood the subscriber with enormous volumes of unwanted information and that filtering content rather than providing it was the key to success in this arena. But no one seems to have remembered that today. Instead, everyone wants to increase the flood.

What should be emphasized above all is that new media are seldom adopted quickly. When they are, like radio broadcasts in the nineteen twenties, they're often accompanied by other technological changes that alter the social order. In the twenties, modern transportation, employment outside of agriculture, and increasing leisure propelled most Americans into new kinds of social settings, settings where radio exerted a seduction impossible in traditional farm communities where the routine of work was all consuming and the consumer culture which underlay radio was profoundly alien. Such considerations had to have had a bearing on the incredibly rapid adoption of radio in America, because normally radically new behaviors, such as radio encouraged, are not readily embraced by most individuals.

Where are the social vectors urging the adoption of public access Wi-Fi? What new behaviors are likely to emerge in hotspots and encourage their spread?

How is the medium to proceed given that it lacks content or native applications? Is a pure access model, one that is proving increasingly unprofitable in other broadband offerings, going to fare any better in the Wi-Fi space?

One can imagine scenarios where an umbrella of hotspots might serve a solid consumer market. Internet radio, which has a real audience and is a real alternative to the homogenized fare on commercial stations, is currently tied to the desktop and thus simply unavailable to its listener audience much of the time. Hotspots could help it immeasurably, given the right interface. And one can go further. The lily pad model of countless physically independent network operators has analogies to the distributed virtual networks such as Kazaa and Freenet which serve to provide content to their members. Wireless freenets would make a lot of sense for devotees of peer to peer architectures, particularly in so far as many of them distrust major carriers and media conglomerates.

Visionaries seldom ponders such matters though. Viral dissemination is said by them to be sufficient for the new technology to succeed. And Negroponte is not alone here. A decade ago, before there was the *Telecosm*, George Gilder wrote a book called *Life After Television in which he predicted a fiber optic version of the lily pads, a giant self administered mesh where carrier involvement was unnecessary*. Of course it didn't happen, but the vision remains, utopian perhaps, impractical very likely, but persistently alluring.

Historically, nothing approaching the lily pad vision has ever happened—no one has designed a network intelligent enough not to require tending—and micro-operators, while they've certainly existed, have seldom if ever prevailed. America of the first two decades of the twentieth century was filled with thousands of independent local exchanges competing with the Bell system. Some remain today but they carry an insignificant amount of traffic. The closest thing to a true populist network was the CB radio craze of the seventies and the FCC killed that. Still, you never know. People forever attempt to bend technology to their own uses. Hotspots may make it after all. Just don't hold your breath.

Appendix 1

THE WI-FI STANDARDS AND SOME ALTERNATIVES

Hotspots have been made possible by the success of standards based wireless LAN products. These today are almost entirely based upon the 802.11 standards promulgated by the IEEE.

802.11 largely deals with the MAC (media access) layer of the network and is designed around the requirements for in-building and campus LANs. Operating range for the radios is deliberately restricted. A related IEEE standard, 802.16 intended for outdoor metropolitan public wireless networks, is in preparation.

The 802.11 numbering actually applies to several different wireless standards, the original 802.11 which lacked a letter designation and stipulated a data rate of only about 2mbps, 802.11b, the established standard today with a nominal 11mbps throughput, 802.11a at 50mbps, and 802.11g at approximately the same speed.

While frequency allocations for 802.11 equipment vary slightly from country to country, 802.11, 802.11b, and 802.11g all operate around 2.4GHz while 802.11a operates in the low 5GHz region. Another standard, 802.11e, is intended to provide a QoS overlay for b, a, and g as well as interoperability and roaming provisions which could be tremendously beneficial for the hotspot industry.

Wi-Fi refers to the certification given by WECA to all compliant 802.11 products. Most industry observers believe that WECA has played a key role in gaining mass acceptance for 802.11 wireless LAN products, especially among corporate IT departments.

Most hotspot platforms today only support 802.11b. 802.11a is easily impeded by walls, making it a questionable choice for hotspots, and, in any case, chipsets are few and expensive. 802.11g is not yet available in commercial products.

Other standards have been proposed for hotspots including Bluetooth, a very short-range personal networking standard primarily intended for connecting peripherals, and HiperLAN2, an ETSI standard with many built-in QoS provisions. At least two companies, Strix Communications and Netario, are operating actual hotspots using Bluetooth, but no one is employing HiperLAN2 because no PCMCIA cards built around it are on the market.

Given the very conspicuous failure of Metricom which operated an unlicensed microcellular network anticipating the hotspots of today and which did so with expensive, non-standards based subscriber units, no one is likely to attempt to build a hotspot based on standard that has failed to win mass acceptance. That means 802.11 will prevail for the foreseeable future, with Bluetooth constituting a very dark horse.