Focus

On Broadband Wireless Internet Access

Steve Stroh, Editor

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***Focus** On Broadband Wireless Internet Access* is founded upon the following tenets:

1. Internet technology is becoming the foundation for nearly all communications, commerce, and entertainment services;
2. For Internet access to be truly usable, always-on Broadband Internet access is required;
3. By the end of the first decade of the 21st century, Internet access will be ubiquitous;
4. In the "last mile", wireline-based technologies and systems will generally prove to be insufficient or not cost-effective to provide ubiquitous, always-on, Broadband Internet to most homes and businesses;
5. In the near term, Broadband Wireless Internet Access in all its forms – Sub 11 GHz, Above 11 GHz, Free Space Optics, Ultra Wideband, Licensed, License-exempt has emerged as *the most likely technology* to provide cost-effective, ubiquitous, always-on Broadband Internet Access.

Focus** on Broadband Wireless Internet Access* is written in an informal, easy-to-read style, with an emphasis on clear explanations of why a particular company, product, or development in the Broadband Wireless Internet Access industry is significant. Each issue contains a number of *original*, in-depth articles and news stories. ***Focus is a just-in-time, short-lead-time publication, using Adobe Acrobat (.pdf) format, and email distribution. ***Focus** On Broadband Wireless Internet Access* is published by:

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From The Editor

My Perspective On The WCA

The "center of gravity" for industries that deal with Radio Frequency (RF) issues such as television and radio broadcasting, mobile telephony, satellite communications, etc. is Washington, DC, where the Federal Communications Commission (FCC) is headquartered. Because so much is at stake… large amounts of money, advancement of various industries, and the future and fate of whole companies, RF issues are, at times, highly politicized. In such a climate, the only effective way to work through such issues is "the process" – face to face contact, shaking hands, and being introduced by familiar faces is the most effective way of getting your viewpoint across to those that have the power to influence key decisions.

That's why the Wireless Communications Association International (WCA) is located in Washington, DC, where it can effectively monitor what happens at the FCC, meet with members of Congress, and be available for hastily convened meetings and hearings relating to RF issues. The WCA's mission is sometimes a study in conflicts, balanced between what is technical feasible and

A Note on the Format of *Focus*:

While ***Focus*** is delivered electronically (via email), in electronic (Adobe Acrobat .pdf) format, the *layout* of Focus is optimized for hardcopy- it is assumed that ***Focus*** will be printed out for reading. In essence, ***Focus*** is a monthly print newsletter, delivered electronically, and as such, columns and other "print" layout techniques are used. My research to date has indicated that a "print" format for ***Focus*** would be most popular. If you have a strong preference for a "linear" layout for electronic-only reading, please let me know. If there is sufficient demand, ***Focus*** could be made available in "print reading" and "electronic reading" versions. Also, if your preference is for text-only (no .pdf), please let me know that also.

***Focus On Broadband Wireless Internet Access*:**

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desirable in spectrum issues, and what is actually achievable in a particular political climate. The FCC and Congress prefer that industries speak with one voice, and doing so with a membership as diverse as the WCA's is no small challenge.

Such industry groups try to speak with one voice from long practice to offer a unified front to Congress and other legislative groups. The WCA does not have that luxury, because it represents an industry undergoing rapid technological evolution. In order to remain relevant to its membership and its audience, the WCA must be, to some extent, in constant internal turmoil as it tries to balance the interests of its more entrenched and established members… and the "disruptive" effect of newer members and their less established but more advanced technology.

I've come to know the work that the WCA does to some degree, and in turn very much respect that work. The WCA appears to capably represent the overall interests of its members to the varied constituencies and audiences in Washington DC. Doing so requires incredible amounts of hard work, constant human interaction with regulators, an intimate understanding of the intricacies of politics, and the usual stresses of maintaining sufficient funding to be effective and finding and retaining skilled, experienced staff. Add to this mix a membership that wants "results" but is sometimes not tolerant of the labyrinth methods which such results sometimes require. All in all, it's a difficult mission.

The WCA Technical Symposium

Techies who visit Washington, DC are heard to remark that during their time there, they were affected by the intense "reality distortion field", which is described as the tendency to view all issues, including issues largely confined to the purely technical, as political issues to be dealt with in a political manner.

To its credit, the WCA attempts to combat this by regularly "escaping Washington DC" en masse, and this is most notable in its decision to convene its annual Technical Symposium in the heart US technical innovation- Silicon Valley and San Jose, CA.

I consider the WCA Technical Symposium particularly significant to the audience of ***Focus*** because it is the most concentrated gathering of technical personnel in the Broadband Wireless Internet Access industry. Marketing, impressive booths, and the usual distractions are, if not completely absent, at least "attenuated several dB", allowing one to largely concentrate on the technical aspects and advancements in this industry.

This issue of ***Focus*** is devoted to covering the Wireless Communications Association International's (WCA) 8th Annual Technical Symposium, held January 14-16, 2002. On a personal level, attending the TS was a wonderful catharsis for the lingering effects of terrible events September 11, 2001. Now, the words are flowing again in Focus, and that's a wonderful feeling.

As always, I would like to take a moment to ask that, if you find ***Focus*** to be useful and insightful, please take a moment to recommend it to colleagues.

Thanks!

Steve

The Top Two Trends In Broadband Wireless Internet Access

2001's Top Trend – NLOS

At the various Broadband Wireless conferences I attended in 2001, the most notable trend was Near, or Non (depending on the technology involved) Line Of Sight (NLOS). NLOS is loosely defined as the ability of a Broadband Wireless Internet Access system to provide service to customers with something other than an "optical quality" path between the customer antenna to the base station antenna.

NLOS took many forms; for some vendors it was an enhanced capability to provide service through trees. For others it was the ability to not require an external antenna and work through walls in a typical home. Other systems made use of multipath (reflections) signals to "bounce around" an obstacle between the customer antenna and the base station. Still others offered "smart antennas" that would electronically focus most of the Radio Frequency (RF) energy directly at the base station instead of spreading the energy over a wider pattern.

NLOS solutions were definitely part of what the service providers were asking for. It was very much a detriment to Broadband Wireless Internet Access providers to sign up a customer in response to a marketing push, only to have to tell that customer that after a brief site survey, that they could not be served because there was a dense stand of trees in the path between the customer and the nearest base station.

But NLOS didn't "finish the job". There were still numerous cases where the new NLOS systems couldn't reach the desired customers. One example is a hill between a customer and a base station some miles away. The hill is a very effective barrier to RF signals. No improvement in modulation techniques, antenna systems, or making use of multipath (assuming there are no reflective surfaces to make use of) will be able to provide service to customer in that situation.

Repeaters – An Old Wireless Technology

Into this situation comes an old technology with a new twist – repeaters. A repeater's function is to "repeat"- or more technically, to re-transmit what is received – from a better location, using higher transmit power in order to enhance coverage areas. In the case cited above (the hill between a base station and an intended customer), a good location for a repeater would be on top of this hill, where it could see both the base station and the customer. When a transmission from the base station is sent to the customer, the repeater receives the transmission, and then re-transmits the signal, which the customer can then receive.

Repeaters are typically far simpler devices than a base station, and therefore easier to put in remote locations. They're also more cost-effective than base stations, and simpler (therefore more reliable).

However, repeaters are hardly a panacea. To operate in realtime (near simultaneous receive and transmit), separate receive and transmit frequencies are required. Repeaters require good (expensive) sites also, but you can't always put a site where you need it… nor relocate it when the requirements of a customer base dictate doing so.

2002 WCA Technical Symposium

Top Trend #1 – Wireless Mesh Networking

Wireless mesh, (or meshed) networking can be thought of as repeating a signal that has already been repeated. As the name implies, the repeated signal can take multiple paths through a mesh network. The concept of mesh networking is by no means new; a cruder form is redundant paths from multiple hubs (cruder, because the routing is not dynamic- all communications is funneled to primary routes, and the routing changes only when the primary route fails). The best illustration of mesh networking is the Internet, where each individual packet can be routed along multiple paths before finally reaching a destination.

For certain applications, wireless mesh networking has widespread appeal. For example, in battlefields, a repeater located on a fixed structure would quickly be detected, targeted, and destroyed by the enemy. A mesh network could theoretically require far fewer expensive base stations. But the most attractive feature of mesh networking is that it may be possible to provide seamless coverage of an area using mesh networking. With the combination of NLOS and mesh networking, service providers may finally be to offer coverage of an area approaching 99%.

Mesh networking, while appealing, is challenging to implement well. The biggest challenges in mesh networking are:

- Latency (the time delay between when a signal is received, and when it is retransmitted)
- Routing
- Inter-node interference

If these challenges can be overcome, wireless mesh networking will likely play a pivotal role in the expansion of Broadband Wireless Internet Access.

Wireless mesh networking was well represented at the Technical Symposium, and in other articles in this issue I'll discuss several examples of companies employing wireless mesh networking in products to provide Broadband Wireless Internet Access.

2002 WCA Technical Symposium Top Trend #2 – The Last 100 Feet of *Any* Broadband Connection Will Be 802.11b (Wi-Fi)

It is abundantly clear to me from the trends I am observing that 802.11b will become sufficiently ubiquitous that people will rapidly depend on it to be the de facto connection method for their device, regardless of the device or the type of Internet connection.

For example, a laptop user will "wander" from home (cable modem connected to an Access Point [AP]), to work (AP's installed in all corporate buildings), to public (coffee shops while on sales calls, hotels and airports when traveling). To such a user, 802.11b *is* the Internet.

> Beginning in 2003, 802.11b will begin to give way to "dual mode"- combined 802.11g (54 Mbps in the 2.4 GHz band, using Orthogonal Frequency Division Multiplexing [OFDM] modulation) and 802.11a (54 Mbps, in the 5 GHz band using OFDM modulation.) The 802.11g specification requires full backwards compatibility with 802.11b.

There are several reasons for this trend towards 802.11b ubiquity:

- 802.11b is now sufficiently inexpensive that cost is no longer a barrier
- 802.11b devices are sufficiently well supported in Windows (and all but standard on Apple Macintosh computers) that it is completely user-installable- or built-in.
- Having 802.11 in the user's computer provides physical isolation from the broadband system and provides the function of a "demarcation" point, thus defusing the incredibly time consuming and aggravating problem of users claiming "my computer just hasn't worked right since you set it up for the high speed
- 802.11b is nearly universal, usable worldwide.

Digital Atlantic - Winner Of My "Out Of Nowhere" Award For WCA TS 2002

Several years ago, when I began attending telecommunications, Internet, and wireless conferences regularly, I made the mistake of getting a bit smug in my ability to assess which companies were worth paying attention to at such events. At one particular conference, I had carefully allocated my time to the "name brands" who had the usual interesting announcements of new products. With that mindset, I had declined an initial invitation from a startup who wanted me to come and see their new product. The Public Relations representative for the startup was unusually persistent, and insisted that I would really be interested what the startup was unveiling… but they didn't want to be too specific. Sensing that this PR representative wasn't going to give up, I reluctantly agreed to visit the startup's booth and grant them a scarce interview slot.

The startup's product was amazing… easily the most interesting (to me) announcement at the show, and it had come out of "nowhere", from a company I didn't know existed. My near-miss of learning about the startup's product was a humbling experience and a valuable lesson not to ignore anyone that really wanted to talk to me. Since that lesson, I've not turned down any interview requests from small companies that I've never heard of (that have anything to do with my specialization of Broadband Wireless Internet Access). To my amazement, the "out of nowhere" experience has been repeated at *every* conference I have attended; there's always at least one company that I've not heard of, with a compelling product or service that I wouldn't have otherwise known about.

The winner of my "Out of Nowhere Award" for WCA Technical Symposium 2002 is Digital Atlantic of Poolesville, MD.

I encountered Digital Atlantic (www.digitalatlantic.com) during lunchtime conversation; it appeared to be serendipity that they and I were at the same table; they didn't know who I was, and I certainly didn't know who they were. We had a short conversation at lunch, and a longer discussion later, and I came away quite impressed. I'll disclaim that I was not shown *anything* ; no PowerPoint pitch, no marketing materials, no photographs, etc. Digital Atlantic may well be nothing more than a than a concept in search of

Scintillion: A Next Generation Ricochet?

In examining Scintillion, it's instructive to draw a few comparisons to, and highlight some differences with, Metricom's Ricochet network, the first Broadband Wireless Internet Access network to make use of poletops. I've previously written that many of the concepts pioneered with Ricochet would show up in other systems, and that is at least somewhat the case with Scintillion:

- Both systems used poletops as infrastructure. Metricom's failure was, in part, due to high prices paid in the late 1990's for poletop access rights. Scintillion deployments should be much easier and less expensive due to a recent Supreme Court ruling.
- For power, Ricochet replaced a streetlight's photocell with a photocell with a power tap, and optionally drew power directly from power lines in areas without streetlights. Scintillion avoids tapping into power lines or streetlights by using solar panels or fuel cells.
- Ricochet used 2.4 GHz and optionally 2.3 GHz Wireless Communications Service (WCS) spectrum for inter-node communication. Scintillion uses Free Space Optics (FSO) for inter-node communication.
- Ricochet's user access speed was 128 Kbps (a software upgrade that was in development at the time of Metricom's bankruptcy would likely double user access speeds to 256 Kbps). Scintillion will make use of 2.4 GHz, 5 GHz, and possibly Ultra Wideband for user access, resulting in much greater speeds than were possible with Ricochet.
- To minimize latency and maximize throughput for a minimum of 128 Kbps to each user, Ricochet kept RF hops to a minimum and used numerous "Wireless Access Points" (WAPs). Node-to-WAP RF backhaul throughput was approx. 1 Mbps. Scintillion's FSO backhaul will be 1 Gbps (arguably 2 Gbps).
- Ricochet's WAP sites and associated T-1 circuits were expensive. Digital Atlantic claims that bandwidth in a Scintillion network can be "sourced" on the edge, and propagated node-to-node.

funding. DA's web page is sparse, with virtually no detail. Those who briefed me answered my questions with sufficient detail and frankness that I was reasonably impressed that their concept could work. But, to date, I've not been presented with any evidence that Digital Atlantic (DA) is "real", that its system as described actually exists or could actually work as described. I was told that "no hard info available" was deliberate, in part because they are an early stage startup and that they were willing to talk to me on the record as part of a "soft intro" of their concept. Hopefully that's sufficient disclaimer. Now to the fun part…

Cheap FSO DA plans to manufacture poletop nodes, which they call Scintillion, that use a combination of inexpensive Free Space Optics (FSO) and Radio Frequency (RF) to deliver very high speed Internet access to business and residential customers. Each node is the size of a soda can. DA is an equipment manufacturer and will sell its equipment to all comers; it will not be a service provider.

Scintillion inter-node (FSO) links run at 1 Gbps (bidirectional, which DA claims to be 2 Gbps) at a maximum range of 250 feet between nodes. The "standard" (most commonly used) Scintillion node has repeat-only capability. Another type of Scintillion node includes a switch/router, for building more complex networks. Both functions are done in silicon, enabling very low inter-node latency, making it possible that a Scintillion network comprised of many node-to-node "hops" could indeed be feasible. DA's name for the hop-to-hop FSO backbone is called Cascaded-Line-of-Sight (CLS).

With the ability to do switch/routing at any node, a Service Provider using Scintillion / CLS can construct any network architecture- mesh, grid, etc.

The cost of a Scintillion node is kept relatively low by the range limitation (expensive high-power components and precision optics aren't needed) and a lack of active tracking and automatic setup. The installer need only mount the node on the poletop and roughly orient it in the right direction. A remote network administrator connects to the node and aligns the optics. (Presumably this is done on a node-by-node-by node.)

Backbone connectivity for a Scintillion network is done wherever it is cost-effective to provide a fiber connection.

Commodity Wireless Scintillion nodes will optionally (presumably, some nodes will be "connectivity only" nodes) include an RF subsystem for user access. In 2002 the RF will be 802.11b, in 2003 and beyond the RF will be 802.11g / 802.11a. Scintillion is largely RF agnostic – the RF portion of the node is intended to be completely commoditized to allow economies of scale and rapid evolution. Scintillion will be able to make use of whatever RF system can be put into a PC Card form factor with an external antenna jack. In the case of a business (or demanding residential) customer that requires more bandwidth than can be delivered over RF, or just wants a non-shared connection, a third Scintillion node can be added to the nearest poletop and a companion Scintillion node is added to the customer premise.

Most users will buy commodity 802.11b/g/a systems to access a Scintillion network. Off the shelf, a number of 802.11b Access Points (APs) are equipped with Universal Serial Bus (USB) connections that are especially easy for consumers to install and put the AP "up and into the clear" (avoiding the "RF Dead Zone" of an antenna connected directly to a PC card in the rear of the average "big metal box" PC). There are also numerous 802.11b APs that have Ethernet connections. Once the 802.11g specification is *finally* ratified, the use of robust Orthogonal Frequency Division Multiplexing (OFDM) modulation in 802.11g would likely provide reliable range that's more than sufficient to connect to the nearest Scintillion node on the street.

The main point is that users can buy their Customer Premise Equipment (CPE) for a Scintillion network at nearly *any* consumer electronics outlet in their area, or by mail order, and the CPE is based on *commodity* pricing.

Good Timing For Poletop Use Digital Atlantic's timing (mid January, 2002) is either fortunate or inspired, coming at the same time as a Supreme Court decision that the Federal Government is able regulate the fees that utility companies charge for use of their poles. Pole owners will no longer be able to charge discriminatory rates as had previously been the case.

Digital Atlantic avoids the issue of tapping into power lines on poles (which aren't present on many poles such as telephone poles) by powering Scintillion nodes from a small solar panel. In the rare climate where solar isn't an option year round (it's not widely known that solar power is actually feasible to use in the Seattle area even in our grey, overcast winters), Digital Atlantic claims that

compact fuel cells are available now that would put out sufficient power for a Scintillion node and need only be refueled once per year. Such a power source might even provide backup power. Powering nodes in such a manner seems at least conceptually feasible.

Most Inspiring Use To me, the most intriguing potential use for a Scintillion network is, assuming reasonable node costs, it would be possible to deploy Broadband services in secondary markets *entirely with a Scintillion network*; perhaps paid for with economic development grants. The Scintillion concept neatly bypasses many of the obstacles of deploying Broadband services in a secondary markets:

- Multiple, low power, reduced coverage RF nodes are more spectrum-efficient and appropriate for urban and other "dense deployment" situations than "base station" infrastructure
- Both the FSO and RF portions are license-exempt; no costly and time-consuming coordination or spectrum licenses are required
- Construction is relatively quick, requiring only bucket truck personnel to mount Scintillion nodes to poletops and (optionally) connect power (or alternatively solar or fuel cells.
- Given that poletop "rents" are now cost-based (per the Supreme Court decision), deployment is economical
- No dependence on telephone company infrastructure; bandwidth can be added as needed with fiber if it's economical or (long range) Free Space Optics as needed
- As with municipal fiber networks, a Scintillion network may well have sufficient bandwidth available to allow competing service providers such as AOL, MSN, or EarthLink for consumers, while businesses may well have more specialized requirements such as higher bandwidth.

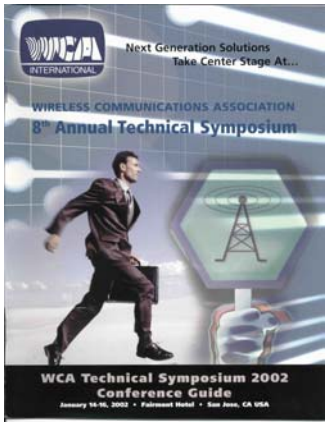
It's not widely recognized that 802.11 technology is capable of proving actual "mobility" coverage, but a number of such 802.11 mobility networks have actually been deployed. More applicable to Scintillion, it would seem quite feasible to provide "digital canopy" or "ubiquitous wireless" coverage with a Scintillion system; within reasonable range of a Scintillion node, wireless Internet access would be available.

With dense coverage of Scintillion nodes, there are numerous other amusing possibilities. I suggested to DA that with the bandwidth inherent in a Scintillion network, inexpensive low-power National Television Standards Committee (NTSC, the current analog standard) television transmitters could be added to each node. Such a network of low-power television transmitters would be the equivalent of a community low-power television station, without the expense and licensing hassles of a conventional transmitter.

I very much hope that Digital Atlantic, Scintillion, and Cascaded-Line-Of-Sight are proven to be real, and if so, I look forward to watching them evolve. Assuming that actual evidence emerges that DA is real, DA will be named to Focus' "Companies To Watch" list.

An Overview of the 2002 WCA Technical Symposium

One of the first, most noticeable things about the WCA Technical Symposium (TS) is that the exhibit area is small. Not only that, but the personnel manning the booths are not marketing personnel as would typically be found at conferences; rather the booth personnel are more typically Engineers and Chief Technical Officers.



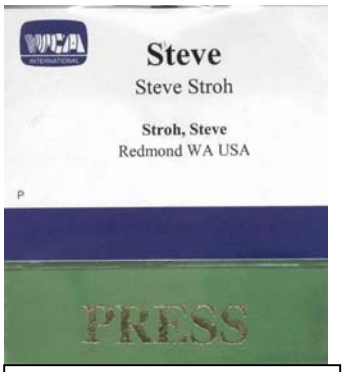
This observation is meant to help set the tone for the WCA TS- three days of technical presentations relating specifically to the Broadband Wireless Internet Access industry, held in the heart of Silicon Valley at the Fairmont Hotel in San Jose, California. The 2002 WCA TS, held on January 14 – 16, 2002, is the 8th such event, and notably (considering the brutal telecom downturn of 2001) broke previous records for attendance, presentations offered and presented, and vendor exhibits.

The WCA Technical Symposium complements the WCA's summer Business conference that is typically held on the East Coast, which places more emphasis

on exhibits, marketing, and business issues for a (somewhat) less technical audience.

One of the most notable differences of the WCA TS and other conferences is that proposed presentations are refereed by a panel of judges representing a reasonable cross-section of the Broadband Wireless industry for a limited number of presentation slots. It was refreshing to attend presentations for which the speaker(s) had no corporate (paid) presence at WCA TS.

Because the primary resource for the Broadband Wireless industry is Radio Frequency (RF) spectrum and the Federal Communications Commission (FCC) is the primary agency regulating RF spectrum issues in the US, the WCA is to be commended for attracting a number of high-profile FCC personnel to the WCA TS. It's very much "to the good" that key FCC personnel have an opportunity to meet with a wide range of companies represented at the WCA TS, some of which are just beginning to commercialize their technology and haven't yet "begun the trek" of regular visits to FCC Headquarters in Washington, DC. FCC personnel who attended WCA TS 2002 included Thomas Stanley, Chief Engineer, FCC Wireless Telecommunications Bureau and Bruce Franca, Deputy Chief, FCC Office of Engineering and Technology.



NorthStar Communications Group Sponsors Stellar Press Room at WCA Technical Symposium

As an Independent Technology Writer, I depend heavily on having access to a Press Room while attending conferences, and at many conferences I've attended, the Press Room is, at best, an afterthought.

The Press Room at WCA TS 2002, sponsored by NorthStar Communications Group was stellar; there was sufficient equipment, printers, space, quiet, and it was well-controlled. Serious Press work could get done.

Of special note were Elaine Mizzel, Business Communications Manager, Emily Holcombe, Corporate Communications of NorthStar Communications Group, and George McFadden, WCA's Director of Communications. Elaine, Emily, and George were unfailingly helpful in arranging interviews, digging up details of meetings, and otherwise assisting the Press that attended WCA TS 2002. George seemed to spend a great deal of his time arranging television coverage… think about when you last saw television coverage of the topic of Broadband Wireless Internet Access, and you begin to appreciate George's feat in generating television coverage of

A considerable amount of WCA business is done at the TS. Such "in person" meetings are a welcome chance to place faces with names and voices since most WCA business meetings are conducted virtually, by conference telephone call or email mailing list.

The WCA TS is made even more interesting by a number of co-located meetings of affiliated groups, including:

- Free Space Optical Alliance (FSO Alliance)
- Millimeter Carrier Forum
- Wireless Communications Alliance
- Women's Wireless Network
- License Exempt Alliance
- TDD Coalition (Time Division Duplex Coalition)

Unique to the WCA TS is the awarding of "The Wemmies", the "Broadband Fixed Wireless Industry's Technical Awards. Space doesn't permit a detailed description, but here are some highlights:

- Individual Regulatory Vision Award - Dr. Enrique Melrose, former Technical Commissioner, Comision Federal de Telecomunicaciones (CONFETEL) [Mexico's equivalent of the FCC]
- Golden Eagle Individual Technical Vision and Industry Service Award – Anthony Klinkert, P.E., Director of Next Generation Networks, Worldcom Broadband Solutions
- Underserved Communities Awards (Service Provider and Equipment Vendor pairs):
  - Nigeria Communications and Hybrid Networks
  - TAHO and Alvarion
  - Wind Wireless and Cirronet
- Underserved Businesses Award (Service Provider and Equipment Vendor pairs):
  - Airband and Adaptive Broadband (Moseley) / Aperto Networks / Wi-LAN
  - Central Texas Communications and Ensemble Communications
  - SkyPoint and Alcatel
- NLOS (Non, or Near Line of Sight) Award:
  - NextNet
  - Nokia and Vista Broadband Networks
  - WaveRider Communications
- Plug N' Play Award:
  - IPWireless
  - WaveRider Communications
- Innovation Frontier Award:
  - IPWireless
  - Navini Networks

A well-received (but sparsely attended) seminar on the numerous wireless-related opportunities resulting from governmental Homeland Defense activities was presented by Don Dickson, publisher of the Homeland Defense Journal. Dickson's presentation and remarks offered a wealth of information on how best to take advantage of such opportunities; the presentation was well worth making time for.

All in all, the WCA Technical Symposium is one of my favorite conferences of the year. An enormous amount of information is offered, even more is learned, and the interaction between technical personnel is downright interesting to be around.

Lastly, no story about a WCA event would be complete without mentioning the incredibly hard-working headquarters Staff of the WCA. Although there is some local personnel hired for the event, the vast majority of the work at a WCA event is performed by the WCA headquarters Staff. Despite long hours, little sleep, and incredibly hectic workloads, the WCA headquarters Staff is unfailingly helpful, polite, and incredibly dedicated to seeing that WCA members and attendees get the most out of a WCA event. I commend the WCA headquarters Staff for their remarkable dedication!

First Avenue Networks Rises From The Ashes Of ART

At the same lunch that I discovered Digital Atlantic, I met Dean Johnson, President and CEO and Sandra Watson, CFO of First Avenue Networks. First Avenue Networks (FAN) is the successor to Advanced Radio Telecom (ART).

In a story that's become only too familiar, ART crashed and burned in 2001 after being starved for capital in the brutal telecom downturn. ART had, at various times during its corporate life entered, and left, the retail market for Broadband Wireless Internet Access (100 Mbps for $1000/month) and wholesale market of "wireless bandwidth for hire". ART's core asset was a number of 39 GHz spectrum licenses in a number of top US markets.

From the ART bankruptcy, FAN only bought ART's intellectual property and the spectrum licenses. All other assets, such as radios in place on buildings, were abandoned in the bankruptcy. The majority of ART's corporate functions have been relocated to FAN's offices in Charlottesville, VA.

Going forward, FAN will offer only broadband wireless transport services and not (independently) provide Internet bandwidth. FAN's two primary markets will be:

- Service provider transport / backhaul (for example, a telco customer needs a T-3, but deploying fiber will take 120 days, the customer is intolerant of such a delay, so the telco calls FAN to deploy a wireless T-3 equivalent connection on short notice).
- Private network broadband wireless connectivity (for example, a corporation has employees in two buildings, and telco charges for interconnecting the two buildings are exorbitant)

(And no, the irony isn't lost on me that the latter could easily end up as competition with the former, with the details of the link varying only in how it's terminated.)

First Avenue Networks faces some steep challenges:

- It's starting life with no deployed network infrastructure except what it is able to recover on a case-by-case basis
- All building leases will have to be renegotiated, with property owners having had to deal with the failures of *multiple* service providers in their buildings, and the aftermath of unhappy tenants, abandoned property, and unpaid leases. If it was hard for ART to get access to property, it will be *many* times harder *this* time around. Not having prearranged roof rights will significantly handicap the "quick to deploy" business.
- In its service provider transport / backhaul business, FAN will be competing with "internal" (wireline) resources of their service provider customers; FAN's only hope for winning "permanent link" business with service providers will be to price their services at a significant discount to equivalent wireline services.
- Winstar/IDT, XO Communications, and Terabeam are potential competitors, somewhat equivalent in spectrum, capacity, and markets.

- License-exempt 60 GHz and Free Space Optics (FSO) equipment make it possible for new competitors to enter FAN's key markets and provide somewhat equivalent services. Private bandwidth customers can make user of such equipment to "do it themselves".

The best news for First Avenue Networks is that demand for bandwidth is rising, especially within corporations for purposes such as Videoconferencing Over IP, Voice Over IP, and rising computer networking needs (there's a small, but growing demand for "Faster than 100 Mbps" connectivity). In addition, as a result of 9/11/2001 many more corporations are now acutely aware of the need for route and carrier diversity, and often that's difficult to achieve with wireline solutions. For high-bandwidth requirements, it's especially difficult to achieve true route and carrier diversity. Bringing fiber into a building is difficult enough, especially with tight capital markets, but it's several times tougher when the new fiber is competitive to existing fiber. The moment the second fiber is lit there is price competition, with the result that competitive fiber service to buildings is more unusual than usual.

Broadband wireless services make it possible to offer cost-effective *true* route and carrier diversity. Perhaps that market will be sufficient to allow First Avenue Networks to get a running start in providing Broadband Wireless Services.

Netro Gets A Lift From AT&T Project Angel Assets

In an article titled "**RIP, Project Angel; ATTWS Exits Fixed Wireless**" in the November/December, 2001 issue of ***Focus***, I concluded the article by saying: "*Sources have indicated that [AT&T Wireless Services] has offered the [Project Angel] technology for sale, and that there is at least one bidder seriously considering purchase of the PA technology, so it may be yet be the case that "reports of Project Angel's death are greatly exaggerated*".

On January 15, 2002, concurrent with the WCA Technical Symposium (where I was briefed by on this development), Netro Corporation announced that they had purchased the majority of the assets of AT&T Wireless' Project Angel (PA), extending Netro into the market for Wireless Local Loop (WLL) equipment. Netro's primary target markets for PA are outside North America.

Netro will retain some AT&T Fixed Wireless Services facilities in Redmond, WA including a small part of the production facilities and engineering laboratories, and has retained approximately 125 employees, most of which are engineers. The task of the Redmond staff for the next year will be to adapt the Project Angel technology from operating in 1.9 GHz Personal Communications Service (PCS) and 2.3 GHz Wireless Communications Service (WCS) spectrum to international 1.9 and 3.5 GHz spectrum allocations.

As part of the purchase, Netro acquired a license to use the relevant AT&T Wireless patents for fixed wireless use; AT&T Wireless retained ownership of the patents for mobility use.

Netro's "internationalization" effort encompasses not only spectrum changes and adaptation to international telephony standards, but also cost reduction and "designing out" a number of features that are not needed in the anticipated markets, such as demarcation and remotely controlled "cutover" circuitry for conversion from wireline service to wireless service, enhanced "switch-based" features such as call waiting, voice mail, caller ID, etc.; all features for which there is little immediate demand in Netro's target markets. Anticipated enhancements for PA include expansion from 2-4 voice lines to 6-8 voice lines and increasing Internet throughput from 512 Kbps to 1 Mbps. For the moment, Netro considers Voice Over IP (VOIP) technology "not quite mature" and so, for the near future, will continue with segregated voice and data services in PA.

Netro has no part of the shutdown of the existing Project Angel service; that is being handled entirely by AT&T Wireless. As PA equipment is removed from service, it will apparently be scrapped.

However, Netro assumes ownership of PA equipment still in stock. Though the Project Angel technology is proven to work with US PCS spectrum and PA equipment can now be sold to any qualified party, to date no other parties in North America have expressed interest in purchasing PA equipment.

To demonstrate PA systems, Netro negotiated limited use of AT&T Wireless spectrum in Redmond, WA and San Jose, CA.

UlmTech Simulight Independent FSO Atmospheric Simulation Software

One of the joys of attending conferences regularly is that you get to check in periodically with what some very talented people are up to. Such was the case when I met Maha Achour in the crowd at WCA TS 2002.

When I last saw Dr. Achour (she has a Ph.D. in Physics at Massachusetts Institute of Technology - MIT), at WCA 2001 in Boston, she had founded the Free Space Optical Alliance (FSO Alliance) and chairing its first in-person meeting held in conjunction with WCA 2001, and doing so in conjunction with her more than full-time position as Director of Systems Engineering for the Optical Access subsidiary of MRV Communications.

Since then, Dr. Achour has left Optical Access and begun a startup called UlmTech (www.ulmtech.com). UlmTech has developed a software package called Simulight which it claims to be the first commercial Free-Space Optics Atmospheric Simulation Software.

It is very tough for potential customers to sort out differing claims of just how well FSO systems will work in their particular application without resorting to long-term side-by-side comparisons of various systems. Of course, FSO vendors have software and models available to predict how well their particular systems will perform in a given climate or microclimate. However, such estimates are understandably suspected to be biased favorably towards the vendor's products that produced the software.

So, I feel that it's a very welcome development for the FSO industry as a whole that UlmTech, backed by Dr. Achour's impressive credentials, will offer Free-Space Optics Atmospheric Simulation software that is *independently developed, supported, and sold*. I feel that UlmTech's Simulight should, theoretically, allow potential customers of FSO systems to do direct comparisons between multiple FSO systems.

I would expect that there will be some cases where Simulight won't accurately reflect specific traits of some FSO systems. Because UlmTech is an independent (impartial) entity in the FSO industry, vendors of FSO systems should have ample incentive to be sure that their systems' performance is in fact modeled accurately in Simulight. UlmTech's independence should allow it to resist undue influence from FSO vendors.

UlmTech should have ample incentive to rapidly improve Simulight to accommodate improved weather models, add any number of specific microclimates as FSO becomes more and more popular in more regions (Afghanistan comes to mind as a fertile area for high-bandwidth secure, wireless data communications), and encompass new FSO technologies as they emerge.

Of Special Note

The WCA, the FSO Alliance and its member companies, and Dr. Achour deserve special note. Although in a strict sense of physics, FSO is a "straightforward application of free-space electromagnetic radiation"… it's notable that the WCA was able to extend its sense of mission to embrace Free Space Optics and the FSO Alliance. The FSO Alliance also had to come to grips with whether it had more in common with the WCA that to date, "did wireless, but not optical" or the fiber industry, which "did optical, but not wireless". Dr. Achour's ability to blend such divergent tendencies and begin the FSO Alliance is commendable.

CoWave Networks - Hybrid Mesh

When CoWave Networks emerged from "stealth" mode on January 7, 2002, the most interesting aspect of the company, was (for once) *not* its innovative and cost-effective Broadband Wireless Internet Access technology (have no fear – that will definitely be covered, in depth). Rather, the most interesting aspects of CoWave Networks are somewhat symbolic:

- It is a startup Broadband Wireless Internet Access equipment vendor emerging during a time when the conventional wisdom is that the market for Broadband Wireless Internet Access is all but dead (citing the failures of Metricom, ART, Winstar, Teligent, AT&T Wireless Service's Project Angel, and Sprint's "freezing" of its Sprint Broadband Direct deployments, as well as the failures of numerous equipment vendors.)
- The timing of its founding and investments; the company was founded in October, 2000 and received its funding when the brutal telecom downturn / bloodbath was *well* underway.

These two factors are, to me, very welcome evidence that there are at least a few farsighted

investors that don't have a sheepish mentality that believes that "Broadband Wireless *anything* bad, very bad". In short… there ***is*** hope for the telecommunications industry and customer expectations of lower prices and better performance for Broadband services through the use of cost-effective Broadband Wireless Internet Access systems.

The fate of an entire industry, especially one as large and as critical as Telecommunications is, admittedly, a lot to heap on the "shoulders" of one small startup company. But I liken the emergence of CoWave Networks at this time to the first green flower shoots pushing up out of the cold, frozen ground in the early Spring. The shoots are a welcome sign that Spring is indeed coming… and the emergence of new Broadband Wireless Internet Access startups like CoWave Networks are a welcome sign that perhaps the worst of the telecom downturn is behind us.

The really good news is that CoWave's technology- MeshCast, is, in my opinion, a real breakthrough. CoWave combines the performance advantages of Point to Multipoint (P-MP) systems with the cost-effectiveness of mesh networking systems.

To understand how powerful the combination is, let's first examine the strengths and weaknesses of the two component systems.

Point-Multipoint

P-MP systems are by far the most common network architecture used in Broadband Wireless Internet Access. A base station is established in a location visible to a number of customers. A backhaul connection is established to the base station (via wireless or wireline) and Customer Premise Equipment (CPE) is installed at each customer's location. It's usually necessary to use an outdoor antenna to achieve reasonable range and performance.

One major drawback of P-MP is that base stations have to be located where it's possible to site a base station; such a location may not coincide with your target customer base. Base stations are also expensive, and the cost of backhaul services can be prohibitive.

Another major drawback to P-MP is that the cost of the CPE installations (the "truck roll") becomes prohibitive (in the aggregate) as more and more customers are added to the system.

Yet another drawback to P-MP is that there will inevitably be "dead zones" where some potential customers do not have line of sight (LOS) to the base station, and therefore cannot receive service.

Mesh Networking

Mesh networking (generally) dispenses with the idea of a base station, with each CPE also being a "relay node". The backhaul connection is connected to one or more relay nodes, and each additional customer adds an additional relay node to the network.

Unfortunately, mesh networking, as currently implemented, does not scale well beyond perhaps five relay nodes. Latency, the amount of delay added at each node, is increasingly noticeable as more relaying is necessary to get packets from a customer to the backhaul connection. The solution to the latency issue is have multiple backhaul connections, but doing so somewhat defeats the cost-effectiveness of mesh networking.

CoWave MeshCast

MeshCast nodes have the capability of operating in either "mesh networking only" mode, or P-MP *plus* mesh networking mode.

The idea behind MeshCast is relatively simple… and profound.

- A Broadband Internet service provider wants to enter a new market or a new service area in an existing market.
- The service provider establishes a centrally-located base station and installs MeshCast base station equipment.
- The service provider advertises a "special deal" on Broadband Internet Access service (perhaps free for the first six months) to the first one thousand (or so) *qualified* new subscribers in the new service area.
- The qualification criteria is that these initial customers must be strategically located within the desired coverage area to form overlapping "picocells" of approximately one mile in diameter *and* have LOS to the base station.
- Those that do qualify have P-MP systems professionally installed (with external antennas) and begin receiving Broadband Wireless Internet Access.
- The "qualified" systems have now "seeded" the new service area with an interlocking mesh network *and* wireless backhaul.

- From this point, new customers are simply shipped a CPE (or the customer buys the CPE off the shelf from a nearby retailer). When the CPE is turned on, and it is able to establish a connection using mesh networking.

Vastly simplified, with MeshCast, the *first thousand* customers in a new service area require an expensive truck roll to get service, but the *next ten thousand customers* in that service area require only an inexpensive Fedex delivery to get service. The high installation cost of the former is offset, by a factor of ten, by the low installation cost of the latter, resulting in a low *average* cost and rapid Return On Investment and short ramp to profitability.

Comparison

The need to do a expensive truck roll to *every* customer, the inability to provide ubiquitous coverage, and the inability to scale bandwidth and services (at a certain point, each new customer that was added caused service to degrade for existing customers) is basically what caused Sprint Broadband Direct (SBD) to suspend the acquisition of new customers in late 2001. SBD used Hybrid Networks CPE in a "Supercell" (a single, or only a few very high profile base station(s) for an entire metropolitan area) network architecture.

Nokia Rooftop has offered a mesh network system for several years, but by its performance realistically renders it suitable only for relatively small deployment areas, and wireless backhaul is not an integral part of the system (though it can be implemented with third party products). Within such relatively small deployment areas or special situations such as challenging terrain or requiring a completely peer-to-peer wireless Internet access network, the Nokia Rooftop system works very well.

Some Details

The above "flow" is a gross oversimplification of the details of MeshCast. For example, each node is connected not only to its local P-MP "seed" node, but also to many other nodes through the mesh network. Because of this feature, MeshCast can recover from the loss of a P-MP "seed" node and customers don't lose service.

CoWave plans to implement some challenging technology into its mesh networking. Routing will be quite a challenge along with integrating power control, active beamforming, and transmission scheduling.

Markets

MeshCast could, in theory, be *at least* cost-competitive with wireline Broadband services, and will likely be significantly less expensive than wireline Broadband services. Cheaper to deploy and operate can result in lower customer prices which can then result in higher take rates for Broadband services. This MeshCast scenario is not only compelling in urban areas, where there continue to be (against all logic) significant lack of Broadband services in certain areas, but it's *especially* significant in suburban and rural areas, where Digital Subscriber Line (DSL) distance limitations severely limit service areas and there is a glaring lack of cable modem service.

If MeshCast has a part to play in North America, with its highly-developed wireline telecommunications infrastructure… imagine how useful MeshCast would be in a developing country. MeshCast could easily allow a developing country to completely skip over the development of wireline Broadband infrastructure.

Spectrum

CoWave's stated "spectrum of choice" is "below 6 GHz". CoWave's initial development and first production systems will operate in PCS bands at 1.9 GHz. This was surprising… the PCS bands are almost universally used for mobile telephone (and, more recently, accompanying low-speed data services). CoWave points out, correctly, that there are six "blocks" of PCS spectrum. Most urban areas have all six blocks in use. In suburban areas, and especially in rural areas, there isn't enough of a customer base to justify the buildout of six competitive PCS mobile telephony systems (not to mention two "cellular" [800] MHz) competitors, plus Nextel). When the PCS spectrum was purchased at government auction, there were "buildout" requirements attached to the purchase. Many of those buildout requirements have not been fulfilled. CoWave feels that such unused PCS spectrum is ideal for use with MeshCast. Technically, they're correct – 1.9 GHz has reasonably good foliage and building penetration characteristics.

Arguing against the use of PCS spectrum for MeshCast is the omnipresent "conservatism" that's typical of companies who currently hold unused PCS spectrum. MeshCast is something *very* new to this group- *Fixed* Broadband Wireless Internet Access, with *flat rate* pricing… a very, very different business than what such companies are used to (and comfortable with).

A further argument is the looming relaxation of mobile telephony "spectrum caps" that currently limit the amount of mobile telephony spectrum that any one company can own in a particular market. Once the spectrum caps are completely eliminated in the next several years, a surge of corporate consolidation will inevitably occur in the mobile telephony industry… with an accompanying consolidation of mobile telephony spectrum. In short, by the time CoWave has the 1.9 GHz version of MeshCast production-ready; it may well not find many customers for such a system.

CoWave also plans to offer versions of MeshCast for 2.5 – 2.7 GHz (Multichannel Multipoint Distribution Service – MMDS / Instructional Fixed Television Service – IFTS), 3.5 GHz (International) and 5.7 GHz (Unlicensed National Information Infrastructure – UNII). While the 2.5 – 2.7 GHz is very close to what MMDS/ITFS spectrum holders *claim* they need to deploy, those same spectrum holders have not placed any significant orders with new equipment vendors.

It seems to me that developing MeshCast for 3.5 GHz and UNII offers the greatest opportunities for success. 3.5 GHz is very, very popular internationally, and in North America, deployments of UNII systems are increasing as 5 GHz technology has evolved very rapidly due to volume shipments of 802.11a Wireless Local Area Network (WLAN) systems that also operate in the 5 GHz band.

Lastly… CoWave has a bit of a blind spot in its dismissal of the use of 802.11 technologies. Making use of commodity 802.11 components, and 2.4 GHz for the mesh networking may well make significant cost savings possible.

In summary, I am very impressed with CoWave's concept for MeshCast. The combination of limited, tactical truck rolls, and low-cost mesh networking deployment may finally make reasonable-cost, reasonable-performance Broadband services possible… without any reliance on wireline service providers.

***Focus On Broadband Wireless Internet Access*:**

www.strohpub.com/focus.htm

e-tenna FlexScan Phased Array Antennas For CPE

I'll have to confess that it took me a while… and considerable patience on the part of Arno Kosko to fully grasp the idea behind e-tenna's FlexScan system.

Reduced to "cut-to-the-chase" simple… FlexScan is a flat panel, Phased-Array Antenna (PAA) that is inexpensive enough to deploy as part of Customer Premise Equipment (CPE). That simple statement bespeaks something of a revolution in Broadband Wireless Internet Access.

PAA technology is more than twenty (perhaps thirty? forty?) years old. The most famous PAA system is the flat-panel Radio Detection and Ranging (RADAR) systems on United States Navy (USN) Aegis guided missile cruisers. The Aegis cruisers are a primary line of defense for USN aircraft carriers, and phased-array technology is used because mechanically-actuated RADAR can be too slow to track incoming threats- a potentially fatal flaw when you're trying to defend a carrier (which is a *very* big target) against very fast sea-skimming cruise missiles.

PAAs are a good solution to a lot of problems where physically moving an antenna system simply isn't practical. Moving parts wear out, and in high, exposed locations such as towers, mountains, and rooftops, wind resistance is an issue. But, PAAs are very, very expensive- the electronics necessary for the "phasing" to work is exacting and exotic. As a result, PAAs were only used where the their high costs could be justified.

PAAs have been used overseas for some time; they're the only way that mobile telephony can be made to work in very dense urban environments. PAAs are beginning to be used in mobile telephony systems in the US to add capacity to existing base stations less expensively than constructing additional base stations. PAAs are beginning to be used in Broadband Wireless Internet Access by, among others, ArrayComm and BeamReach Networks.

Generally, very few BWIA systems have attempted to make use of PAAs as part as the Customer Premise Equipment (CPE). That's hardly surprising considering that PAAs only just now becoming available in size, price, and performance that would be appropriate for such an application. But, more to

the point, many would question "Why is a phased-array antenna *needed* on CPE?

The answer to *that* question is "PAAs aren't "*needed*". But, that's the wrong question to ask. The real question to be asked is "What could be done if a PAA was used on CPE? The answer is, a *lot*.

One big issue of CPE installations is that when you go to the time, trouble, and expense of a CPE installation, you have to decide where to point the antenna. If you have a narrow beam (high gain) antenna, then your aim has to be pretty precise. If you have a "wide focus" antenna, then aiming isn't as critical, but you don't have as much signal margin.

But the biggest factor about a fixed antenna is… what happens if the base station fails, or more commonly, you have to move your systems to another tower? All the CPE that is connecting to that base station has to be re-aimed- a process that can take days; days that your customers won't have service.

So, at a minimum, a PAA CPE antenna is something of an insurance policy. If you have to move your antennas from an existing tower, or the tower goes down, or your equipment has a catastrophic failure, or your base station begins receiving severe interference that takes some time to track down, or …. (the scenarios are endless). Having a PAA CPE antenna that can be electronically changed may well be highly useful if you have to quickly put another base station online.

That last scenario is what I consider the biggest factor in favor of PAA CPE. When you're beginning a BWIA system, you don't really know where most of your business is going to come from. Despite what the mass marketers tell you, where your customer base will come from is highly variable. One very satisfied, very vocal customer may bring in more business than you're prepared for… or more to the point, more business than your system can handle. So, you get to the point where you need to construct another base station in an area with a proven customer base. It would be most efficient if you could service all the customers in that area from the new base station… but many of your oldest customers' antennas are still pointed at the old base station. The PAA CPE will, according to eTenna, will automatically "acquire" the new base station.

As to the "how" can e-Tenna build inexpensive PAAs, the answer is

- The "slew rate" (how fast the beam aiming changes) isn't very fast
- The electronics is largely analog, not digital

It's fascinating to me that analog technologies keep getting rediscovered every few years and it's surprisingly useful in very specific situations.

e-Tenna does not actually manufacture PAA antennas; it licenses the intellectual property to do so. This is a reasonable approach- to be optimally effective, a PAA antenna can't be added on to a system, but should be actively controlled by the CPE, and therefore has to be designed in.

I'm looking forward to further news from eTenna that they've licensed their designs to various vendors who can use it to enhance already strong products.

CALY Networks - Ultimate Mesh

I first learned of CALY Networks and its Router In The Air (RITA) at a private meeting at the WCA 2001 conference, but was embargoed from writing about it. From that brief showing, I was very impressed and intrigued (there's a lot they weren't willing to discuss then), and it's something of a relief that CALY has since uncloaked and I can write about their system.

As discussed in other articles in this issue, mesh networking is one of the most flexible and useful wireless network architectures… but one of the most difficult to "get right". My assessment of CALY is that it has thought more deeply about how to "do mesh networking right" than any other company.

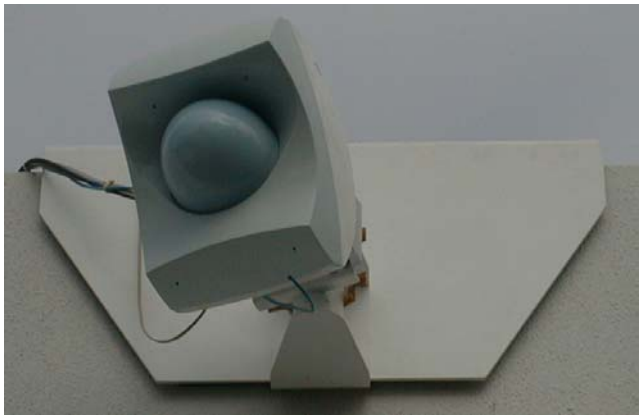
Conventionally, mesh networking "done right" manages a number of elements:

- Transmission times of each node are coordinated (scheduled) with neighbor nodes to reduce interference
- Transmission power control (only enough power is used to reach neighboring nodes)
- Efficient routing
- Inter-node latency

To those elements, CALY adds:

- Choice of RF path
- Choice of Channel
- Customer prioritization (Committed Information Rate versus Best Effort)
- Choice of Modulation based on path quality and type of traffic

As far as I'm aware, CALY is the only company to implement such *complete* control and integration of the disparate elements of mesh networking. The sum total of this thorough treatment of mesh networking parameters is that a CALY mesh network will wring about as much usable throughput from a given spectrum as is conceivably possible, with no coverage holes.



RITA - Router In The Air

CALY's system is unapologetically an Internet Protocol (IP) system, with Fiber Ethernet interface – no provision for ATM, SONET, or other legacy interfaces or protocols. CALY has licensed and implemented Nortel Networks' *Open IP Environment*, which it views as the best available, industry standard, IP routing software. It's a somewhat difficult concept to grasp, but a network of CALY nodes is, essentially, a "distributed router". Instead of a single unit with multiple connections, RITA consists of Radio Frequency (RF) links and "routing intelligence" distributed amongst the nodes. Each customer has their own connection into "RITA" via one or more CALY nodes on their roof. To the customer's internal routers, "RITA" looks like any other router, including Border Gateway Protocol (BGP) services. As necessary, the Service Provider "injects" bandwidth at multiple points in the network where it is optimally needed, convenient, and cost-effective.

Scheduling / Prioritization – Scheduling is critical in a Wireless Mesh Network (WMN) to avoid "collisions" – two transmitters transmitting simultaneously, requiring a retransmission and resulting reduction in throughput. In a CALY network, the Scheduling element has to integrate when each node transmits, what channel each transmission uses, which beam sector the transmission is transmitted from, and classes of service taking into account type of traffic and customer preferences.

Data flow is scheduled in real time based on the priority of the traffic (is it sensitive to latency, such as Voice Over IP [VOIP], or not (email). System management traffic, such as scheduling, has the highest priority in the network and in descending priority, customers paying for maximum speed or guaranteed throughput, "best effort customer time sensitive", best effort customer non-time sensitive".

Power Control / Modulation – In a CALY node, power control and choice of modulation are integrated. A CALY node will analyze the relative quality of a path (chosen by the RF Path element) and choose the optimum combination of transmit power level and modulation technique with priority given to path quality and secondarily, minimizing interference. If the link quality cannot be maintained with a higher order modulation and transmit power is at maximum, then a lower-order modulation is used. Modulations used are Quadrature Phase Shift Keying (QPSK), 16-Quadrature Amplitude Modulation (QAM), 64- QAM, and 256-QAM. The RF Path element and the Power Control / Modulation element work together to determine whether there is a usable path between two nodes, and if so, the relative quality of that path is factored in by the Routing / Latency element.

Efficient Routing / Latency – Efficient routing is devilishly hard to do well in a Wireless Mesh Network (WMN) because there are a number of variables to be taken into account such as hop count (the number of nodes on each path – 3-5 hops are the maximum recommended before latency becomes an issue), latency on each route, the relative congestion of each route (priority is given to less congested routes), and the relative throughput and quality of each route.

RF path – CALY nodes have an integrated Phased Array antenna in each node (the "ball" of the unit). The total field of view of each CALY node is 120°. Each transmission and reception is from one of sixteen 7.5° sectors communicating with any other CALY node within its 120° field of view.

Spectrum – To date, CALY's development has been focused the 28 GHz band and use of 50 MHz channels. Internally, the Radio Frequency (RF) subsystem uses an Intermediate Frequency (IF) of 2 GHz, so developing for other bands, as demand dictates, presents few issues.

Physical – Physically, a CALY node is relatively small – approximately one square foot. This makes it relatively easy to install. In contrast to conventional microwave systems, relatively unskilled (minimal RF knowledge) labor can be used to install a CALY node- no "tweaking", waveguide or coaxial cable to fuss with, and virtually no aiming or "sighting-in" is required. All that is required is for a the installation of a new CALY node is for there to be at least some "line of sight" to other CALY nodes. 100baseF fiber and power need to be provided.

Management – The usual network management elements are present in a CALY network. Simple Network Management Protocol (SNMP) is present, and the industry-standard HP OpenView Network Management System (NMS) is supported. CALY supplies its own NMS, written in Java, that allows geographic coordinates to be added to form a geographic map of a CALY network. CALY's NMS requires an Oracle database. Note that entry of geographic coordinates of each node is not required – the network is formed dynamically, which each node determining what other nodes it can "see".

Progress To Date

CALY has a trial network in place in Sunnyvale, CA. Currently the hardware is in Alpha stage testing (not feature complete), with Beta stage testing expected to commence in April, 2002 with General Availability (GA) in October, 2002. CALY does not currently have sufficient capital commitments to proceed to GA. CALY has sufficient capital to continue through 2002 in Research and Development (R&D) mode if additional investment isn't received.

CALY's primary facilities are in Silicon Valley where it can take advantage of the abundant technical talent pool for development of RF / phased array antennas, networking and routing, Application Specific Integrated Circuit (ASIC) design, Digital Signal Processing (DSP), etc. Of particular note is that CALY is developing its own Gallium Arsenide Semiconductor (GAAS) RF devices. A remote CALY facility is located in Bellingham, Washington.

Target Markets

CALY views existing wireline Service Providers as its primary customer base. In CALY's view, wireline Service Providers are have spectrum and access to capital to deploy RF networks. Wireline Service Providers would use CALY nodes to extend existing fiber networks as needed / "just in time".

A secondary customer base may be mobile telephony Service Providers that need additional Internet backhaul capacity from existing mobile telephony base stations for deployment of new (3G) services.

Geographically, CALY expects the majority of sales to be outside North America, especially in Europe.

Promising Technology, But…

CALY faces considerable skepticism in the industry and its target markets. Simply put, they're used to doing things "the old-fashioned" way – individual, low capacity, point to point links, sourced from established vendors. One of the first issues that CALY will face is its adherence to IP and Fiber Ethernet. I agree wholeheartedly with those choices, but many of CALY's hoped-for carrier and service provider customers likely won't. They're slow to change, and they *want* the choice of ATM or SONET in their network… even if such a transport system will be used for transporting IP packets. While it's true that it's far more efficient to have IP end-to-end, they haven't grasped that concept yet and or had the courage or expertise to implement it yet.

My second concern is CALY's choice of licensed spectrum. This is a result of their target customers, most of whom have (or can get) licensed spectrum, but more importantly *want* (are most comfortable with) licensed spectrum. CALY's principals have expertise in licensed spectrum and are clearly more comfortable with the idea of having control over the RF environment.

I feel that CALY's potential customer base could be *much* larger if it were to offer a product for 5 GHz license-exempt spectrum. New service providers, especially in the US, simply cannot get cost-effective access to licensed spectrum. The potential for use of 5 GHz is compelling, especially if a recent petition to the Federal Communications Commission (FCC) succeeds in adding 255 MHz of spectrum to the existing license-exempt portions of 5 GHz. CALY's unique combination of technologies seem especially applicable to license-exempt spectrum. The key to offering reliable services using license-exempt spectrum is to carefully engineer and manage the link margins of each network path; which is inherent to CALY's technology. For example, in the (for now, theoretical) 5 GHz CALY node, CALY could provide "logical separation" between the scheduling element and the routing element that would allow multiple, competitive service providers to use 5 GHz and not interfere with each other (the scheduling element would work "across all service providers",

but routing and attendant data flow would only be done within the nodes owned by specific service providers.

When it was pointed out that CALY nodes could be highly useful for providing backhaul for the burgeoning "Wireless Hot Spot" trend, CALY replied that their original mechanical design of the CALY node housing provides ample room for adding an 802.11b radio and antenna. With the throughput available in a CALY network, a better fit would be 802.11a and 802.11g at 54 Mbps.

Letters

Because ***Focus*** *on Broadband Wireless Internet Access*, is a relatively new publication, we don't have any letters yet specifically directed at the contents of ***Focus***.

I'd like to explain what my policy, and hopes, are for letters. A number of other newsletters that I admire have made the reader's letters, and the editor's responses, a significant part of the content of those newsletters. This serves several purposes: 1) It makes the newsletter more interesting to read, 2) It provides something of a reality check on what's written in the newsletter, 3) the readers likely know of things that the editor doesn't.

So, Letters and Editor's replies will be an integral part of Focus. Initially, while readership is relatively low, this will be a pretty intimate exchange of ideas and points of view. As ***Focus*** grows, it may not be possible to include all letters that are submitted… but we'll do our best.

Here are the initial guidelines for Letters to ***Focus*** *on Broadband Wireless Internet Access*:

- All editorial commentary letters (including email) to ***Focus*** *on Broadband Wireless Internet Access* will be considered to be submitted for inclusion in the Letters section of ***Focus*** *unless otherwise stated*.
- Letters may be edited for space and relevance (and such edits will be noted)
- If you do not wish for your letter to be included in the Letters section of ***Focus*** *on Broadband Wireless Internet Access*, please state that in the letter.
- If you prefer to remain anonymous, but have your letter included in the Letters section of ***Focus*** *on Broadband Wireless Internet Access*, please state that in the letter and the request will be honored.
- All letters must include contact information; no anonymous communications will be published.

So, Please write! I very much look forward to exchanging ideas with ***Focus*** readers!

Focus On Broadband Wireless Internet Access
Companies To Watch

"Companies To Watch" highlights companies that I consider to be particularly innovative and therefore worthy of watching. A number of companies will be added each month, and the list will be cumulative – and dynamic. Company names in *italics* denote being added in this issue.

In future issues, each addition to Companies To Watch will be preceded by an in-depth article explaining their addition to the list. This first group of companies will be profiled together in a future article in ***Focus***.

Equipment Suppliers:

- Alvarion – www.alvarion.com
  Largest supplier of equipment to Wireless Internet Service Provider (WISP) market, formed by the merger of BreezeCOM and Floware Wireless Systems.
- Aperto Networks – www.apertonet.com
  Aperto began their design with a clean sheet of paper and effectively integrated a number of disparate wireless technologies to develop PacketWave. PacketWave is notable as one of the first to offer Non Line Of Sight (NLOS) and effective Quality Of Service (QOS) resulting in a highly effective system.
- *Cirronet* – www.cirronet.com
  One of only a few purpose-built Wireless ISP systems intended for consumers; low price point and truly self-installable.*
- Time Domain – www.timedomain.com
  Primary proponent of Ultra Wideband RF technology.
- *fSONA Communications* – www.fsona.com
  fSONA is one of the leading vendors of Free Space Optics equipment. fSONA's SONAbeam products are making significant inroads into the high-bandwidth, short-haul wireless links market previously reserved for high-bandwidth RF technologies.

Service Providers:

- *Aerie Networks* – www.aerienetworks.com
  Bought Metricom Ricochet technology out of bankruptcy; attempting to re-establish, and eventually grow Ricochet service at lower price points.
- hereUare Communications www.hereuare.com
  hereUare provides "back end" billing services for independent operators of Public Wireless Access Points (PWAPs); a notable partner is Boingo Wireless.
- *BroadLink Communications* www.broadlink.com
  BroadLink has adapted 802.11b technology to provide Small Office / Home Office (SOHO) wireless Internet access. BroadLink recently entered into a market trial with Earthlink in Atlanta.
- *Tachyon, Inc.* – www.tachyon.net
  Tachyon began by asking a fundamental question about current-generation geosynchronous satellite transponders: how much could be accomplished if a number of disparate technologies were "thrown at the problem"? Tachyon succeeded in developing a system that allows far more users and far higher speeds per transponder than were previously thought possible.

Broadband Wireless Internet Industry Events Of Interest

The events listed below are selected to likely be of interest to those involved in the Broadband Wireless Internet Access industry. Please let me know of events that will be of interest, to be featured as space permits. If I plan to attend a particular Event, it is noted.

- January 14-16, 2002, San Jose, CA – WCA Technical Symposium
  www.wcai.com/events.htm
  (I plan to attend this event.)
- January 21-25, 2002, Levi, Finland – Institute of Electrical and Electronic Engineers (IEEE) 802.16 Working Group Session 17
  grouper.ieee.org/groups/802/16/meetings/mtg17/index.html
- January 29-31, 2002, Santa Clara, CA – Wireless LAN Workshop
  www.wireless-nets.com/ws_overview.htm
- February 12-14, 2002, Anaheim, CA – Broadband Wireless World Forum
  www.scievents.com/bwwf02/default.asp
- February 12-15, 2002, Mexico City, Mexico – Expo Comm Mexico 2002
  www.expocomm.com/latin/mexico.html
- February 18-21, 2002, Tempe, Arizona – National ITFS Association (NIA) 2002 Conference
  www.itfs.org
- February 19-21, 2002, Richardson, TX – National Wireless Engineering Conference
  www.iec.org/events/2002/natlwireless/
- February 20, 2002, McLean, VA – Software Defined Radio: Future of Wireless or Bound For Extinction?
  www.wirelesswednesdays.com/events/event_detail.cfm?eventid=85
- February 24-26, 2002, San Diego, CA – Computer and Communications Industry Association (CCIA 2002 Winter Meeting
  www.ccianet.org/meetings/02winmtg.php3
- March 6-8, 2002, Washington, DC – Satellite 2002
  www.satellite2002.com
- March 10-15, 2002, St. Louis, MO – IEEE 802 LAN/MAN Standards Committee All 802 Working Groups Plenary Meeting (includes IEEE 802.11 and 802.16 Working Groups)
  http://grouper.ieee.org/groups/802/11/index.html
- March 13-15, 2002, Chicago, IL – 2002 Chicago WISP Conference
  www.primedirective.com/seminar/main.htm
- March 18-20, 2002, Orlando, FL – Wireless 2002 (CTIA)
  www.wow-com.com/events
- March 19-22, 2002, Sao Paulo , Brazil – Telexpo 2002
  www.advanstar.com.br/telexpo/english/default.htm
- March 20, 2002, Washington, DC – Federal Communications Commission (FCC), Office of Engineering and Technology (OET) Technological Advisory Council (TAC) Meeting
  www.fcc.gov/oet/tac
- March 22, 2002, West Hills (Los Angeles), CA - Deploying License-Free Wireless Internet Access in the Real World
  www.ask-wi.com/2002workshops.html
- April 29 – May 1, 2002, Santa Clara, CA – Wireless Enterprise Forum Conference and Expo Spring 2002
  seminars.internet.com/ewf/spring02
- May 5-10, 2002, Las Vegas, NV – Networld + Interop Vegas
  www.key3media.com/interop/lv2002/index.php
- May 20-24, 2002, Calgary, AB - IEEE 802.16 Working Group Session 19
  grouper.ieee.org/groups/802/16/calendar.html
- April 6-11, 2002, Las Vegas, NV – National Association of Broadcasters (NAB) 2002
  www.nab.org/conventions
- April 8-10, 2002 – Beijing, China – OFDM Forum Meeting
  www.ofdm-forum.com/index.asp?ID=8&MID=8
- April 16-18, 2002, Tokyo, Japan – Software Defined Radio (SDR) Forum General Meeting
  www.sdrforum.org/MTGS/next_meeting.html
- April 29-30, 2002, Toronto, ON – Canadian Institute's Second Annual Wireless Internet Conference
  www.canadianinstitute.com/contentframes.cfm?ID=1459
- May 14-16, 2002, Dallas, TX – Parks Associates Connections 2002
  www.connectionsconference.com/events/conn2002/conn2002.html
- May 28-31, 2002, San Francisco, CA – World Wireless Congress
  www.wirelesscongress.com
- Summer 2002 (dates to be determined), Chicago, IL, Dallas, TX, Denver, CO, Memphis, TN, Newark, NJ - Fundamentals of Unlicensed Wireless IP Network Deployment Workshop Series
  www.scievents.com/wip/
- June 2-6, 2002, Atlanta, GA – SUPERCOMM
  www.supercomm2002.com
- June 10-12, 2002, Philadelphia, PA – 802.11 Planet Convention and Expo
  seminars.internet.com/80211/spring02/index.html
- June 11-13, 2002, Boston, MA – Software Defined Radio (SDR) Forum General Meeting
  www.sdrforum.org/MTGS/next_meeting.html
- June 17-19, 2002, Washington, DC – Satellite Internet Forum 2002
  www.actconferences.com/sif2002
- June 20, 2002, Washington, DC FCC OET Technological Advisory Council (TAC) Meeting
  www.fcc.gov/oet/tac
- June 23-15, 2002, Miami, FL – LatinTel Summit 2002
  www.latintel-summit.com/html/event.htm
- June 24-27, 2002, Boston, MA – Wireless Communications Association International (WCA) Annual Conference
  www.wcai.com/events.htm
- June 25-26, 2002, Vienna, Austria – Fixed Wireless Solutions 2002
  www.scievents.com/bwe/default.asp
- June 27-28, 20002, Vienna, Austria – 802.11 Applications and Demonstrations Conference Europe
  http://www.scievents.com/802.11e/
- July 8-12, 2002, Vancouver, BC – IEEE 802.16 Working Group Session 20
  grouper.ieee.org/groups/802/16/calendar.html
- July 17-19, 2002, Banff, AB – International Association of Science and Technology for Development (IASTED) Wireless and Optical Communications (WOC) 2002
  www.iasted.org/conferences/2002/banff/c356.htm
- August 11-13, 2002, Stockholm, Sweden – 12th IEEE Workshop on Local and Metropolitan Area Networks
  www.lanman2002.org
- August 11-14, 2002, Boston, MA – IEEE Radio and Wireless Conference (RAWCON) 2002
  rawcon.org
- September, 2002 (date to be determined), San Jose, CA – 802.11 Applications and Demonstration Conference
  www.scievents.com/802.11/
- September, 2002, (date and place to be determined) – 802.16 Working Group Session 21
  grouper.ieee.org/groups/802/16/calendar.html
- September 8-13, 2002, Atlanta, GA – Networld + Interop Vegas
  www.key3media.com/interop/atlanta2002.php
- September 13-15, 2002, Denver, CO – ARRL and TAPR Amateur Radio Digital Communications Conference
  www.tapr.org/dcc
- September 17-19, Edinburgh, Scotland – Software Defined Radio (SDR) Forum General Meeting
  www.sdrforum.org/MTGS/next_meeting.html
- September 18, 2002, Washington, DC FCC OET Technological Advisory Council (TAC) Meeting
  www.fcc.gov/oet/tac
- October 16-18, 2002, Orlando, FL – CTIA Wireless I.T. and Internet 2002
  www.wow-com.com/events

- November 11-15, 2002, Koloa, HI – 802.16 Working Group Session 21
  grouper.ieee.org/groups/802/16/calendar.html
- November 12-14, San Diego, CA – Software Defined Radio (SDR) Forum General Meeting
  www.sdrforum.org/MTGS/next_meeting.html
- December 3-5, 2002, Santa Clara, CA – 802.11 Planet Conference and Expo Fall 2002
  seminars.internet.com/80211/fall02/index.html
- December 4, 2002, Washington, DC FCC OET Technological Advisory Council (TAC) Meeting
  www.fcc.gov/oet/tac

Consultation On Broadband Wireless Internet Access

I'm often asked if I am available for consultation on subjects relating to Broadband Wireless Internet Access.

While I consider my primary line of business to be writing and analysis of the Broadband Wireless Internet Access industry, I am available for limited consultation engagements. Limited, because my intense writing schedule for ***Focus*** and a select few other publications allows only a limited amount of time for consultation.

Generally, the most effective consultation that I can offer is an "interactive extension" of the content that appears in ***Focus***. Interactive, where the consultation client is able to request specific information and analysis of issues of greatest, immediate relevance to them. Numerous other types of consultation are possible; please contact me directly for specifics.

In limited circumstances, in-person consultation is possible without the full expense of providing transportation, etc.:

- If the consultation client travels to the Seattle, Washington area where I am based,
- If the consultation client is located in the San Francisco Bay area, as I travel there several times per year to visit vendors and attend trade shows,
- Arrangements are made in advance to meet before or after (but generally not during) various Broadband Wireless Internet Access and related trade shows that I plan to attend (or for which the consultation client is willing to sponsor my attendance).

Speaking Engagements

I am also occasionally asked about my availability as a speaker on the subject of Broadband Wireless Internet Access. I am able to accept a limited number of such invitations, dependent on the circumstances. My position as an Independent Technology Writer, specializing in Broadband Wireless Internet Access allows me to offer an unusual degree of impartiality and candor in my presentations on the topic of Broadband Wireless Internet Access.

Steve Stroh: 425-481-0600 / steve@strohpub.com

With Thanks To…

As an *Independent* Technology Writer, I don't have access to the resources of large news and publishing organizations. What I do have are a number of people I've found over the years that offer high quality information that is highly relevant to the content of ***Focus***, at no cost. Such "free" content providers don't get thanked nearly often enough, and, as part of ***Focus***, I'd like to acknowledge their efforts.

- Broadband Wireless Business Magazine – Broadband Wireless Weekly Report
  www.shorecliffcommunications.com/magazine/default.asp
- David Farber – Interesting-People List
  www.interesting-people.org
- Glenn Fliesch man – 802.11b Networking News
  80211b.weblogger.com
- Jim Geier – Wireless Nets Newsletter
  www.wireless-nets.com
- Jeff Harrow – Harrow Technology Report (formerly Rapidly Changing Face Of Technology newsletter)
  www.theharrowgroup.com
- David Isenberg – The SMART List
  www.isen.com
- Dewayne Hendricks – Dewayne-Net Technology List
  www.warpspeed.com
- Robert Hoskins – Broadband Wireless Exchange Magazine
  www.bbwexchange.com
- Ed Mitchell – Ham Radio Online: Common Sense Views On Technology (despite the title, not focused on Amateur Radio)
  www.hamradio-online.com
- Alan Reiter – Reiter's Wireless Data Web Log
  reiter.weblogger.com
- Wireless Communications Association International (WCA) – WCA Weekly Bulletin (members only)
  www.wcai.com

Other paid membership / advertising-supported resources include: Broadband Wireless Business Magazine, Cellular Telephony and Internet Association's (CTIA) Daily News, Slashdot, San Jose Mercury News' Good Morning Silicon Valley, Strategic News Service, Wall Street Journal Interactive… and, of course, the many companies and organizations that contact me directly with relevant news.

Focus

On Broadband Wireless Internet Access

Steve Stroh, Editor

www.strohpub.com/focus.htm

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