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Motorola's Canopy Technology Bridging the Digital Divide

A Conversation with Motorola's Chief Futurist

By Trish Cusack

Motorola's Chief Futurist Discusses the Wireless Broadband Internet Arena and Their Solution for Bridging the Digital Divide

In late June 2002, Motorola introduced the new Canopy™ Wireless Broadband Internet Platform at the Wireless Communications Association's (WCA) 15th Annual Convention in Boston, Massachusetts. Motorola's Canopy solution met with overwhelming response from the fixed wireless community and has since continued the momentum by signing a number of distributors and resellers throughout the United States.

Tom is a corporate vice president and director of Motorola Labs and is responsible for leading the company's research organizations in developing and discovering potential technology breakthroughs that will catapult Motorola into the future. For 38 years, Tom has been exploring the ongoing convergence and intertwining of digital and wireless communications. He holds more than 55 patents in cellular-like data transmission, RF data transmission, and related technologies. Most recently, Tom championed development of technologies and global standards aimed at wireless ATM communications and development of wireless technologies for Internet access. In that role, Tom leads the team that developed the Canopy system. Tom is a Dan Noble Fellow and recipient of the Master Innovators award.

Recently, I had an opportunity to talk with Tom Freeburg, Motorola's chief futurist and Father of the Canopy system, about the wireless space, the development of the Canopy product and his vision for the broadband wireless future. Excerpts of this conversation are highlighted in this article.

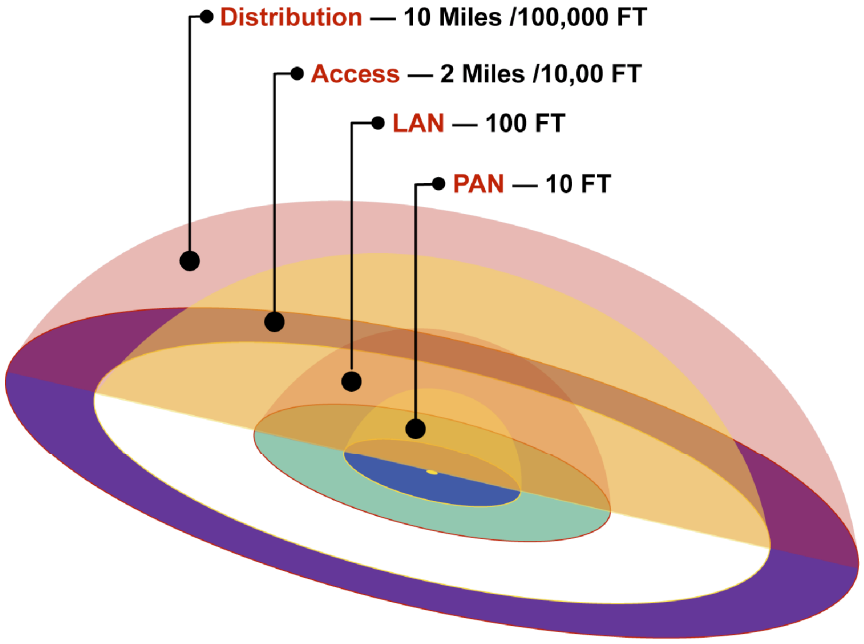
TC: There seems to be a great deal of confusion in the industry surrounding wireless local area networks, personal area networks and fixed wireless systems. Can you give us some insights into each of these areas and describe the functional capabilities of each along with the various types of technologies that might be most appropriate for serving the needs of the marketplace?

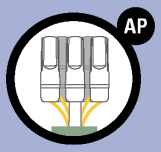
TF: I would have to agree with you. There is a great deal of confusion surrounding each of these areas. I think that the best way to describe them is by using my famous bulls-eye chart (see illustration). As you can see, the chart shows the four different digital wireless spaces. The inner space is what we have typically called Personal Area Networks – or PAN as it is sometimes referred – and has a range of about 10 feet. This space is inhabited by Bluetooth and was really designed to replace the cords that hook the various pieces of your computing or telephone environment together.

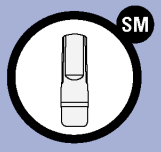
The next circle out is the Local Area Network space – or LAN - and has a typical range of about 100 feet. This is the space where such systems as 802.11A/B fit. The third space out, which is the space that Motorola's Canopy product inhabits, is what is commonly called the access or local loop or last mile space. It has a typical range of about two miles or 10,000 feet. Finally, the fourth space out, which is generally called distribution, the zone in which all of this started about 25 years ago – and has a range of about 20 miles or 100,000 feet. This space is occupied by, for instance, the MMDS systems that have been deployed by Sprint and WorldCom at 2.5 GHz.

The key issue here is, each of these spaces is not only different physically and geographically but its applications are different. For each of these reasons, one should not be at all surprised that the best technology, the most appropriate technology, for each of these spaces is substantially different. For instance, stretching 802.11 down to reach the Bluetooth space increases the cost and power, makes the system less flexible, larger, and may in fact hurt deployment. Similarly, 802.11A is not a good solution for the wireless access space that Canopy fits. The most appropriate technology in the local loop or access space is substantially different from the most appropriate technology in the LAN

space. This is something that we cannot emphasis enough. I tell the Canopy folks daily, "We are not a LAN."







TC: What gave Motorola the idea to develop and ultimately bring to market this last mile solution and what types of characteristics did you feel were important to build into the product's foundation?

TF: At Motorola, we have been growing the technology of broadband radio for several decades. All the while, we have been moving upwards in frequency, moving downwards in cost. We have been trying to get a better handle on the parameters that control performance, manufacturability, cost and user satisfaction.

About five years ago, when the Internet really started to grow in importance, it became clear to us that the most important users of the Internet itself are private individuals in their homes. That is, the delivery of broadband Internet service to private residences is perhaps the largest and most important market to be faced. Therefore, when we conceived the idea of our Canopy technology as a device for delivering Internet service, we decided that it was appropriate to focus on the private home.

Now, if you like the consumer market as the primary target, it means several things that might not be appropriate to business. First and foremost, it means that the cost of the overall system and especially the cost of the equipment that goes into the residence have to be kept as low as possible. This to us means simplicity.

Second, we decided that it was very important to focus the performance of the system on the most used function, the one that people at home spend most of their time doing on the Internet - browsing. With this in mind, Canopy was designed to optimize the browsing experience. Sure, it does as a great job with e-mail and FTP; however, where it really shines is in the speed of browsing. It is instantaneous reaction!

Third, we figured out that it was extremely important that the system be very scalable. That is, the performance should be very good and continue to be very good whether you have one or two users on a particular access point or up to its maximum capacity of 1,000 or 1,200 users. In contrast, many of the systems that are being deployed today, using as an

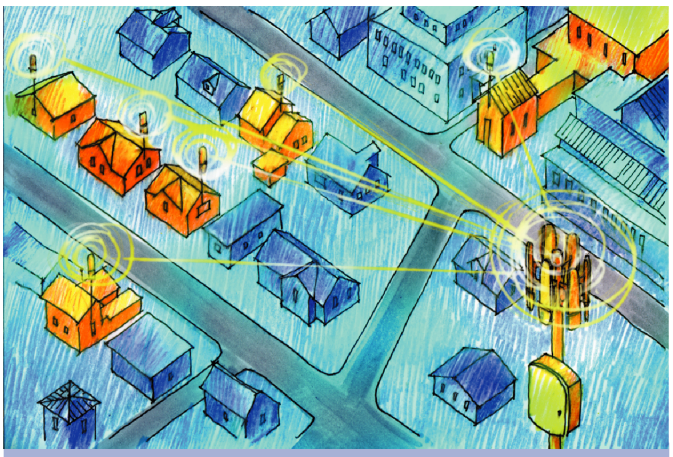
About the Canopy Solution

Motorola's new Canopy™ system uses the unlicensed 5 GHz (U-NII) spectrum and wireless components specifically designed for small cell configurations, making it ideal for geographic areas where cable and DSL services are unavailable or system deployment is not feasible because of infrastructure cost. The start-up costs associated with the licensing spectrum, running fiber and building large Internet access systems have left many communities and small businesses underserved until now.

example beefed up 802.11 technology, have very good throughput numbers when doing a file transfer and may turn out to look very fast when you have one or two or even three users. By the time that you get the systems loaded at anywhere near their capacity, the interaction between subscribers and the overall loading performance is such that they become unbearably slow and the latencies, the delays, build-up to where performance in many of these aspects is unsatisfactory.

The fourth important aspect of our design is that we decided that our Canopy system had to be made extremely robust against interference. This has several advantages. By utilizing a very simple modulation scheme – we are in fact using wide-band digital FM, 20 MHz of bandwidth to pass 10 megabits of data – we achieve a carrier to interference (C/I) ratio of only two decibels. Other schemes may require from eight to as high as 30 decibels. This means that the same amount of spectrum through cellular type reuse can carry much, much, more data than if you were using a system with more spacing between cells of the same frequency.

Because of this modulation scheme, users that are nearby other users do not interact with each other - they do not affect each other's transmissions. This is a very important issue. It also means that because nearby users and nearby cells do not interact, the schemes necessary for system control and system stability in accessing the channel can be much simpler, thereby, making the system not only less complex and less expensive but also much more stable and much more scalable. We don't need to introduce additional, expensive, contrary and difficult to predict mechanisms for maintaining system stability and throughput in the face of increasing load and increasing throughputs.



There are four different wireless spaces. Each one of these spaces was designed/allocated with very specific purposes in mind and is not only different physically and geographically but its applications are different. Motorola's Canopy system inhabits what is commonly called the access, local loop or last miles space.

TC: Does the Canopy solution require frequency planning to avoid system interference?

TF: No, that is one of the beauties of the Canopy system. Its simple modulation scheme eliminates the need for any frequency planning. In fact, you can use the same frequencies at every access point cluster because the C/I ratio required, if you prefer the ratio of desired signal to undesired, is so small that you don't have to worry about one cell interfering with the next. You can use exactly the same frequencies in every cell. We have what the cellular people would call a one-cell reuse pattern.

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On the other hand, if you were building a network with a system that required eight or nine dB of C/I, which would be perhaps equivalent to the very best 802.11A type systems at their slowest rate, you would need approximately seven different sets of frequencies. This is significantly more than is available in the 5 GHz band for wideband transmissions. At the 50-megabit throughput range of 802.11, you would probably need about 100 different frequencies to really achieve that 50-megabit throughput. This makes the Canopy system design very easy because every access point looks like every other. It is basically, the long sought after "self-planning" system. There is another issue about interference - the interaction of Canopy and other systems in the same frequency band. The Canopy technology is inherently very resistant to interference. Furthermore, the protocol itself that Canopy uses is resistant to interference.

802.11A and other systems that are out there tend to have rather difficult problems when another system in the vicinity attempts to use the same frequencies. We have done some very careful testing with Canopy and 802.11A in the 5 GHz band and have found out that they can in fact coexist fairly well. You can put an 802.11A system immediately adjacent to a Canopy access point and Canopy hardly notices the 802.11A system.

Of course, the 802.11A system does not like this much at all. Nonetheless, further testing has convinced us that 802.11A can be, in fact, compatible with Canopy. You can of course, select different frequencies for the 802.11A than where the Canopy system is operating. In addition, even on the same set of frequencies, if you put the 802.11A inside the building, say 50 feet away from the Canopy unit outside of the building, there is hardly any noticeable interaction.

TC: I noticed that the Canopy product is available in both the 5.2 and 5.7 GHz bands. Why did you elect to offer products in both bands and what parameters should be used in planning a system?

TF: The FCC has allocated three different frequency bands for unlicensed operation in the Unlicensed National Information Infrastructure (also known as the U-NII) bands. The lowest 100 MHz is reserved for indoor only operation, that is, wireless LANs. Since Canopy is an outdoor system, we don't use that band at all. The next band up, 5.25 to 5.35 GHz, is licensed for outdoor operation, point-to-point and point-to-multipoint with one watt of effective radiated power. This limits the Canopy range to the order of two miles. The top band, centered on about 5.7 GHz, is also available for point-to-point and point-to-multipoint operation. It has an interesting proviso in it however; in point-to-multipoint operation, you can use about four watts of power – a little bit more than the lower band. In point-to-point operation, you can use 200 watts. In that band with Canopy, we can build versions that have not just the two mile range but by addition of a gain reflector to the antenna much like the antenna used in a satellite TV receiver, we can increase the range in point-to-multipoint to 10 miles and point-to-point operation to as high as 25 to 35 miles. Now remember, all of those longer ranges are only allowed in the 5.7 band segment, not in the 5.2 segment. Therefore, our standard Canopy configuration would be based on using the 5.2 GHz for the final link to the customer with access points located four miles apart, that is a two-mile radius or closer, which turns out to be very appropriate for the kind of densities in many smaller cities. Then we would suggest using the 5.7 GHz band with its higher power and therefore longer range for connecting the access points – next step above the users' home – back to the carrier's hub and back to the Internet.

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TC: How easy is the Canopy system to maintain?

TF: Maintenance … what's maintenance? Canopy is designed so that it should be as reliable in operation, in terms of things breaking or changing, as any home appliance that you should expect to buy today. What is the average life of your TV set – five to 10 years without failure? We certainly expect Canopy to outlive the typical computer that it is connected to the Canopy system. After all, there are no moving parts, one unit, no external antennas and no funny connectors.

TC: Many ISPs are considering becoming WISPs. What can Canopy technology mean for their business models?

TF: Canopy is intended to be the product that it is easiest to design into your system and easiest to install. Almost plug-and-play. We have built into the product the features that most carriers want and are used to having. The cost points are also surprising low. We believe that we are competitive with any alternative out there when you look at full installation - I hesitate to use the term life cycle - but full installation and start-up costs. All of these things mean a tremendous amount to anyone in - or considering entering—the WISP business.

TC: What is your vision for Canopy's future?

TF: We can talk about Canopy's future in several ways. Like anything in the computer industry, the demand for bandwidth is going to increase. That is why we tried to build Canopy so that it is robust against increasing demand.

There is no question in my mind that in a few years we will be selling Canopy with faster data rates. That is a ways off however and we should not be too concerned about it. There is another issue, one that may be a little bit hard for the end user to envision today - but a little easier for the carrier - the features of the system. One thing that is not immediately apparent when you look at Canopy is the degree to which the Canopy devices themselves are programmable. For instance, the entire Canopy unit is reprogrammable. Not only did we use a high-end Motorola Power PC microprocessor, with lots of memory and more power than we could foresee needing, but we implemented all the radio "back-end" functions in a Field Programmable Logic Array (FPLA).

We then built a protocol that allows new software and FPGA definition to be loaded over the air into that box without even taking that user out of service. The system operator can upgrade the entire network software – and hardware - without any interruption in service. This allows us to make drastic changes, if it turns out to be of interest to do so, in the basic hardware of both the digital and radio aspects of the Canopy.

We then embarked on a program of increasing the functionality of the basic Canopy platform taking advantage of these programmability features. This is built along two threads. One thread is in-service enhancement where we add features to the baseline product without increasing the price and of course your odd bug fix – although there hasn't been very many in Canopy's life, which I find very gratifying. We, of course, make those available to system operators without charge.

The other thread is substantial new features, for which there is a charge just like there is a charge when you add a new kind of spreadsheet to your desktop computer. Again, these features can be purchased and downloaded over the air without interrupting system operation. We believe that between these two threads and the programmability offered here that we have a very solid growth path in functionality, capability and features for Canopy at minimal impact and cost to existing Canopy carriers and users.

"Canopy was designed to optimize the browsing experience."

TC: What types of applications/what type of markets is Canopy best suited?

TF: Canopy has already been deployed in a good many applications beyond the business of delivering broadband Internet services to private homes. The obvious is using point-to-point for delivering Internet service to businesses. Beyond that, using Canopy for intercampus or intracampus links for businesses or municipalities, linking fire stations together for training, or even remote security purposes. Canopy works great with many of the IP based video cameras making remote control security or remote presence truly possible.

TC: Tom, thank you for your time. You have certainly provided us with some fascinating insights into the wireless broadband space and in particular Motorola's Canopy product offering.

TF: Not at all, thank you for the opportunity.

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