Giga bits per second wireless at 60 GHz: Ultra Wide Band and beyond

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Executive summary – New technology that takes advantage of available wireless spectra holds out the possibility for enabling whole new businesses. In addition to wireless high definition television, compact, integrated devices make it possible to connect more consumer devices reliably, provide radar safety devices for cars and enhance the security features of high-capacity communications for individuals.

In this Executive Technology Report, Peter Andrews interviews Brian Gaucher, a Master Inventor and manager at Watson Research Lab. Brian and his team have worked on wireless of all "flavors," including wireless keyboards, mice, the standard communications protocol IEEE 802.11 during its infancy, as well as Bluetooth systems and cellular handsets. More recently, the IBM team has moved on to focus on the millimeter-wave wireless characteristics of silicon germanium technology.

Peter Andrews Tell me about this area of wireless research and what is distinctive about it.

Brian Gaucher It may seem odd to say this, but most all the basic science for electronics and communications was done many years ago. For instance, in our present work we can trace its roots back over 100 years to J.C. Bose and Guglielmo Marconi in the late 1800s, who were working on 60 gigahertz (GHz) [communications capabilities] and what has been termed Ultra Wide Band (UWB). With no intention to trivialize our work, which is extremely challenging, today we are left with is what I'll call implementation and refinements to that basic science:

1. What we are doing that is unique is delving into this space with a silicon mindset. That is, [we are] using the benefits of silicon at frequencies that would have been laughable just a few years ago. Now, with careful design we can do what [only those using] gallium arsenide could do.
2. We have a historical trend of wireless that says we need more bandwidth than we have at [today's] 2.4 or 5 GHz. [There is an opportunity at] 60 GHz, [which] is also an unlicensed band, but has 5000 megahertz (MHz) of bandwidth. And so if [we] make this cost-effective, our work here could enable a whole new set of businesses and so I think it is critically important.
3. [Finally,] we are now integrating entire 60 GHz transceivers into single chip packages, including the antenna, something no other technology or system has been able to do.

Peter Andrews I can see a lot of benefits between the lines there. Could you specify what the chief benefits of working in 60 GHz wireless are?
Brian Gaucher The attributes of 60 GHz are:

- The available bandwidth of 5000 MHz vs. approximately a few hundred MHz in the lower bands
- The propagation characteristics that effectively [overcome the limited] range to 100 MHz
- The small wavelength at 60 GHz, [which] allows the design of very tiny elements that could not even be considered to fit on a chip at lower frequencies
- If a single transceiver can be built as I suggested, in a single chip package, then arrays of these can be put together that can provide even more value (like *spatial power combining*, *beam steering* and *beam forming*) – effectively this means you can point or "speak" only where you wish and limit others from listening or interfering with you and you with them.
- By that very nature it also becomes more secure and the redundancy makes it fault tolerant and much more....

Peter Andrews Point and speak?
Brian Gaucher Effectively directing your radio signal only to where you want it. Also, this can be thought of as "speaking" to one another without interfering with others or them listening in. More capacity for greater numbers of users and greater security.

Peter Andrews What sorts of applications might come from this work? Which industries would be most likely to use 60 GHz wireless?
Brian Gaucher In part, commercial applications are driven by the spectrum availability. Again, the 60 GHz band is available unlicensed worldwide. This is the only real choice for doing things like wireless Gigabit (Gbit) Ethernet, streaming video like HDTV (high definition television) or TiVo systems, for example.

This technology is directly applicable to the automotive radars that Mercedes, Jaguar and others are starting to sell. And, think about the mesh networks that are beginning to turn up. Those are networks that form around anyone with a communications device like a WLAN (wireless local area network) or cell phone.

With this technology, you can have cars talking to one another as you drive, alerting each other to accidents that the drivers can't even see. On the military side, there are many uses as well. They want future combat systems such as troops with covert communications that are wearable and secure, another perfect benefit [of] this band.

Also, satellite links and phased array radars can use these modules. (radars typically use spinning antennas/radars, much like you see at airports that direct airplanes, only ours don't have to physically move. They are flat panels that are steered electronically.)

Peter Andrews What have been the biggest challenges you've faced?
Brian Gaucher We expected the technical challenges to be the toughest, for example, can our silicon germanium technology, modeling tools and circuit design really predict and deliver the performance we needed? That part worked out extremely well. These technical challenges are not easy or over, but it seems we have a good handle on them. The hardest part is really taking something unknown and convincing others that this is a viable business direction.

Peter Andrews It helps if innovators have business acumen.
Brian Gaucher More so than I ever expected, and I spend a great percentage of my time doing this.

Peter Andrews Any guesses on what use will impact the general public first and when?
Brian Gaucher Historically, wireless was driven from the enterprise down to the home, since people who found wireless convenient at work wanted that same freedom at home. This [trend] may continue if Gbit Ethernet is successful or this model may turn upside down, in that it's the home user with the higher bandwidth needs now.

HDTV and TiVo systems today cry out for a wide band high data rate wireless solution such as this. The UWB system I mentioned earlier is what the IEEE (Institute of Electrical and Electronics Engineers) is targeting, first at 5 GHz, but we are pushing this 60 GHz version of UWB in the background at the IEEE too. We believe that the leap forward in speed that 60 GHz technology provides at similar cost and power will enable new businesses and business models – such as corporations and wireless hot spots like Starbucks and McDonalds – to provide Gbit Ethernet connectivity, as well as video, to its customers.

Peter Andrews As you've worked on this, what has been the biggest surprise?
Brian Gaucher Aside from the fact that this really works...well, to me the biggest surprise is the attention this is getting across so many areas right now. This is quite exciting and a bit overwhelming, since I'm more a "techie" than a business person.

Technology to watch
Gigabit Ethernet
IEEE 802.11 protocol
Mesh network
Millimeter-wave frequency
Phased array radars
Silicon Germanium technology
Spatial power combining
Transceiver
Ultra wide band (UWB)
Wearable mobile communications
Wireless communications
Wireless fidelity (WiFi)
Wireless local area network (WLAN)

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Realtime: "A sense of ultracompressed time and foreshortened horizons, [a result of technology] compressing to zero the time it takes to get and use information, to learn, to make decisions, to initiate action, to deploy resources, to innovate" (Regis McKenna, *Real Time*, Harvard Business School Publishing, 1997.)

Ease-of-Use: Using user-centric design to make the experience with IT intuitive, less painful and possibly fun

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