ORIGINAL

ORIGINAL

Wiley, Rein & Fielding

1776 K Street, N.W.
Washington, D.C. 20006
(202) 719-7000
Fax: (202) 719-7049
www.wrf.com

EX PARTE OR LATE FILED

David E. Hilliard
(202) 719-7058
dhilliard@wrf.com

February 8, 2000

Ms. Magalie Roman Salas
Secretary
Federal Communications Commission
445 12th St., S.W.
Washington, DC 20554

RECEIVED
FEB - 8 2000
FEDERAL COMMUNICATIONS COMMISSION
OFFICE OF THE SECRETARY

Re: ***Ex Parte* Notification**
ET Docket No. 98-153
Ultra-Wideband

Dear Ms. Salas:

This is to note that on February 7, 2000, I made an *ex parte* presentation to Mr. Peter Tenhula, Senior Legal Advisor to Commissioner Michael Powell, and Mr. Mark Alvarez, an intern in Commissioner Powell's office, concerning this proceeding. I noted that there was substantial support in this proceeding for moving to the next stage through the issuance of a notice of proposed rulemaking. In that regard, I urged the prompt adoption of such a notice and advocated that the notice should be open with respect to the various technical issues surrounding ultra-wideband while calling upon interested persons to build the record in support of the resolution of the technical and other policy questions posed in the notice. I also left a copy of the article on ultra-wideband and Time Domain that appeared in *The Economist* and *U.S. News and World Report*. Copies are enclosed with this notice.

Should any questions arise concerning this matter, please contact me.

Respectfully,

David E. Hilliard

David E. Hilliard
Counsel for Time Domain Corporation

cc: Messrs. Tenhula and Alvarez (w/enclosure)

No. of Copies rec'd 0+1
List ABCDE

The Economist

Bandwidth from thin air

Two new ways of transmitting data by wireless exploit unconventional approaches to create valuable additional capacity

They may be invisible, yet chunks of radio spectrum are fought over just as much as parcels of land. Governments raise billions by auctioning parts of the spectrum to mobile-phone companies and radio and television stations. Other frequencies are reserved for air-traffic control or the sending of distress signals. The most desirable addresses on the spectrum, like apartments in the trendiest parts of town, are in short supply—hence the high prices paid for them. To make the most of limited "bandwidth", as it is known, engineers have devised elaborate schemes to allow several devices (such as mobile telephones) to share a single frequency by taking turns to transmit.

Two emerging technologies now promise to propel such trickery into new realms, by throwing conventional ideas about radio transmission out of the window. The first involves multiple simultaneous transmissions on the same frequency. The second, by contrast, transmits on a huge range of frequencies at once. Outlandish though it sounds, the effect in both cases is to create hitherto unforeseen reserves of valuable bandwidth, practically out of thin air.

Don't all talk at once. Actually, do

Turn the dial (or press a button) on a radio, and you determine which station's signal is played through the speaker. Now imagine that several radio stations are transmitting on exactly the same frequency, so that their signals interfere with one another. Is it possible to build a new kind of radio, capable of separating the signals, so that just one of them can be heard clearly?

The conventional answer is no. Once radio signals have been mixed together, trying to separate them is like trying to unscramble an egg. In 1996, however, Gerard Foschini of Bell Labs (the research arm of Lucent Technologies, based in Murray Hill, New Jersey) suggested that multiple transmissions on a single frequency could be separated after all—by using more than one receiving antenna and clever signal processing. The result was a technology called Bell Labs Layered Space-Time, or BLAST.

The prototype system, which is now being tested, transmits via an array of 12 antennae, all of which broadcast a different signal, but on exactly the same frequency. At the receiving end are 16 antennae, also spaced out, each of which receives a slightly different mixture of the 12 broadcast signals—which have bounced and scattered off objects along the way.

Computer analysis of the differences between the signals from the receiving antennae, helped by the fact that those receiving antennae outnumber the transmitting ones, enables the 12 original signals to be pieced together.

Exploiting this result, it should become possible to transmit far more data than before over a wireless channel of a particular size. For convenience, the researchers used a channel "width" of 30kHz, the size of the channel used by analogue mobile phones. Normally, a data-hungry process such as accessing a web page over such a link is painfully slow. But using BLAST, transmission speeds of up to 1m bits per second have been achieved. By increasing the number of antennae at each end, it should become possible to squeeze even more capacity out of a fixed-size channel, albeit at the cost of far greater computational effort.

The technology is not, however, intended for mobile use. The multiple transmitting and receiving antennae, and the powerful signal-processing hardware involved, will be difficult to fit inside portable devices. In any case, too much moving around causes the mixture of signals received by each of the antennae to vary in ways that even the most sophisticated computer cannot cope with. Instead, according to Reinaldo Valenzuela, who is in charge of the research,

BLAST is more suitable for use in fixed wireless applications, such as providing high-speed Internet access to homes, schools and offices, or establishing telephone networks in isolated areas without laying cables.

If transmitting several signals on the same frequency sounds odd, what about transmitting on many frequencies simultaneously? That is the principle behind another novel form of wireless-communications technology known as ultra-wideband (UWB). This is being developed by a small company called Time Domain, which is based in Huntsville, Alabama. The technology is the brainchild of Larry Fullerton, an engineer who has spent the past 23 years working on the idea.

Whereas conventional transmitters (and BLAST transmitters) operate at a particular frequency, just as a single key on a piano produces a particular note, a UWB transmitter emits a pulse of radiation that consists of lots of frequencies at once, akin to the cacophony that ensues when all the keys on a piano are pressed at the same time. The pulse is very short—just half a nanosecond (billionth of a second)—and is transmitted at extremely low power. Because it is a mixture of so many frequencies, such a pulse passes unnoticed by conventional receivers, which are listening for one particular frequency.

But to a UWB receiver, listening on a wide range of frequencies at once, it registers as a distinct pulse. Information is sent by transmitting a stream of pulses—apparently at random (to fool conventional receivers), but actually at carefully chosen intervals of between 50 and 150 nanoseconds, in a pattern known to both transmitter and receiver. By varying the exact timing of each pulse to within a tenth of a nanosecond, slightly early and slightly late pulses can be used to encode the zeroes and ones of digital information. The resulting system can transmit data at 10m bits per second, without any interference with conventional transmissions.

Or so Mr Fullerton and his backers at Time Domain contend. So far, however, America's Federal Communications Commission (FCC) has not approved the technology for anything more than experimental use. But there are signs that UWB could, after a long gestation, soon emerge into the marketplace. At a conference in September to rally support for it, Susan Ness, an FCC commissioner, spoke in support of the technology and said regulations permitting it to be used would be announced next year.

Several firms are lining up to make products based on UWB technology. Time Domain, which owns the relevant patents, plans to supply these firms with its chip, called PulsON, to do the hard work of generating and detecting UWB pulses. And as well as communications, UWB also has an intriguing potential use in radar (see article).

Neither BLAST nor UWB quite create something out of nothing. Both technologies cunningly conjure up extra bandwidth at the cost of increased computational complexity. Over the past few years, however, the cost of computing power has plummeted, and demand for bandwidth has soared. Trading one for the other could prove to be a very good deal.

How to look through walls

Besides its use in communications (see other article), ultra wideband (UWB) pulse radio might have a future as a radar that can see through walls, and do so in great detail. It should, its manufacturers hope, be able to distinguish a cat from a cat burglar, or detect barely breathing bodies under several metres of rubble after an earthquake. More mundanely, do-it-yourself enthusiasts will be able to use it to check for power cables and pipes beneath the plaster before they start drilling.

UWB radar works like normal radar in so far as it depends on sending out radio signals and listening for the reflection. But unlike ordinary radar, which takes the form of continuous waves, UWB signals are short pulses of energy.

As a means of radio communication, UWB works because the chips in the receiver are able to time the pulses they are hearing to within a few thousand-billionths of a second. Even at the speed of radio (ie, the speed of light), a pulse will travel only a few millimetres in that time. Since, in the case of radar, the receiver is also the transmitter, it knows exactly when a pulse was sent. By measuring how long that pulse takes to return, it can place the distance to the point of reflection to within that level of accuracy—enough to tell whether an aircraft's wing-flaps are up or down. Four million pulses a second are sent out to provide a near-perfect picture of what the target looks like.

Conventional radar relies on high-frequency (and therefore short wavelength) radio waves to achieve high resolution. Long waves would produce fuzzy images. But when the resolution depends on pulse-length, wavelength does not matter. So UWB radar can employ significantly longer wavelengths, and these can penetrate a wide range of materials, such as brick and stone, which are denied to their shortwave cousins. The result is "RadarVision", which, like the communication technology, is manufactured by Time Domain. Though still experimental, it is being tested by several police forces around America. They are using it to look inside closed rooms that might be harbouring suspects, before the guys with the sledgehammers batter the door down.

If it works, television cop-shows will never be the same again.

[COMMUNICATIONS]

Larry Fullerton

Seeing through walls, tracking down your car

Born: Dec. 11, 1950, Fayetteville, Ark. Education: B.S.E.E., University of Arkansas. Role models: inventors like Edison and Marconi. Proudest accomplishment: winning a gold medal in the high jump in high school. Favorite book: *Atlas Shrugged*. Chief dislike: "Bureaucracy is way up there." Favorite pastime: astronomy. "Galaxies are my favorite."

BY AVERY COMAROW

As a teenage ham radio operator more than 30 years ago, Larry Fullerton would try to squeeze his pipsqueak of a signal into the crowded frequencies assigned to hams. He was routinely muscled aside by beefier transmissions from operators who could afford high-powered equipment. All the boy could do was prowl for vacant spots, slivers of spectrum the bullies had overlooked.

In the decades since, the battle for spectrum space has moved far beyond skirmishes among radio enthusiasts. Most of the radio spectrum has been given away or auctioned off by the Federal Communications Commission. The explosion of pagers, cell phones, and other telecommunications services, as well as advanced government and military systems that use radio waves, has generated intense competition over the remaining scraps.

The Internet is worsening the crunch. By some estimates, tens of billions of computers and other "Internet appliances" will be connected to the Net in five years or so. There won't be enough fiber-optic cable hooked up to carry all that data. If even a small percentage of the new traffic is funneled through satellites and other wireless devices, they will need frequencies from somewhere in the radio spectrum.

And that's where Fullerton, now founder and chief technology officer of Time Domain in Huntsville, Ala., re-enters the picture. The engineer, who came to Huntsville in 1979 to work for NASA but left because he "ran into miles of red tape," has designed a circuit that may ease the squeeze through the use of "ultrawideband" (UWB) technology. The design is etched into high-speed chips that blend silicon and germanium. Fullerton overflows with large and small ideas for chip-based products. One prototype device, called RadarVision™, is a portable radar about the size of a ream of typing paper that can see through walls and detect very small movements. That means it could locate people trapped in the rubble of collapsed buildings and earthquakes. A cheap wireless home telecommunications network and a gadget that can find a car lost in a parking lot also are in the works.

Data hiccup. In Fullerton's scheme, digital data are not transmitted on a single frequency or small band of frequencies, as is typical. Rather, information is sent as a pulse half a billionth of a second long across a wide swath of the spectrum already used by global positioning systems, military satellites, and commercial radar (1 to 3 gigahertz).

Fullerton would sidle unnoticed into the throng by transmitting at extremely low power–no more than 50 millionths of a watt, or less than 1/10,000 the punch of a cell phone. Devices equipped with Fullerton's chip could read the data hiccup, but to conventional communications equipment it would be lost in the background noise. Multiple ultrawideband devices could operate in the same room, because the coding of the pulsed information would be unique to each product.

As RadarVision demonstrates, the ultrawideband pulses also penetrate thick layers of concrete as if they were tissue paper. Integrating the chip into cell phones would allow coworkers to talk with each other within a building, which isn't always possible now.

Fullerton has plans for a $30 home network that would link computers, TVs, wireless phones, and other appliances without wires or cables, and an ultrawideband "tag" that would pinpoint a car in a sea of vehicles parked at an airport or stadium. He wants such products to be affordable–$5 to $100. Several should be poised for delivery by next Christmas.

Whether they will be under the tree depends largely on the FCC, which will have to modify its rules to allow ultrawideband transmissions. Fullerton is optimistic, and his brainchild is attracting capital. Siemens, the German telecommunications giant, put $5 million into Time Domain in November. "I'm not so wise as to know where this will take us," says Bjoerne Christensen, president of Siemens's U.S. venture capital group. But it is an idea, he says, "that represents a truly fundamental change." ●