

SFGate.com www.sfgate.com

[com](#) [Return to regular view](#)

[Networking nodes share data](#)

[Wireless devices can act as remote controls for household or business](#)

- Birgitta Forsberg, Chronicle Staff Writer

Friday, April 8, 2005



Scattered throughout John James' horse ranch in the Santa Cruz mountains are wireless sensors he uses to measure temperature and humidity.

Inside the sensors, communication devices the size of a quarter, called nodes, send streams of messages to each other, conveying the temperature and humidity information to a base station in James' house.

The nodes wake up, relay data from one to another, synchronize their clocks and then fall back to sleep. They sleep 99.5 percent of the time, allowing their batteries to last up to five years.

For James, an engineer at Crossbow Technology in San Jose, the setup is just a way of testing the company's wireless mesh network.

But, in the future, such networks are expected to transform our world, both at home and at work.

You will be able to control your house through your mobile phone, checking whether you forgot to close the garage door, adjusting the temperature so your house will be warm when you get home, locking or unlocking the door.

The applications go far beyond the home. Scientists will be able to monitor the environment, farmers will carry out agricultural chores from the comfort of a control room. And armies will be able to drop thousands of sensors with built-in wireless routers in enemy territory to spy on troop movements.

Wireless mesh technology allows designers to build electronic networks without ripping

apart buildings, tearing up streets or stringing miles of cable. That allows digital technology to be woven into structures, landscapes and cityscapes in ways that would have been inconceivable with hard-wire connections.

What's distinctive about the mesh networks is the role of nodes, which are cheap, small and energy efficient. That allows wireless networks to be set up at prices that householders and businesses might be able to afford.

Sensor communication

While wireless technology that allows sensors to talk to a base station, or terminal, has been around for a long time, it has not been possible until recently for information to be transmitted from sensor to sensor. Each sensor talks to three or four others, so it doesn't matter if one breaks down.

If every sensor were able only to talk to a base station, several base stations would be needed in a large building or powerful sensors that are too big and expensive to be practical would be required.

Cheap and efficient, mesh network technology opens a world of possibilities.

"You could put our sensors along the U.S.-Canadian border to see how people move across the border. The sensors would just communicate from one to the other," said Rob Conant, vice president for marketing and business development at Dust Networks, which sells mesh networks. The United States is at the vanguard of this technology, which is being tested for a variety of applications by global manufacturers such as Eaton, Siemens and Philips.

"There is a lot of piloting going on as (manufacturers) search for the types of applications this will work for," said Glen Allmendinger, president of the San Francisco firm Harbor Research.

Right now, experts estimate the size of the market to be about \$100 million. But in a few years, it is expected to balloon to \$1 billion.

"This will seep in everywhere, but with less fanfare than other devices, such as cell phones," said Joyce Putscher, director of principal analysts at research firm In-Stat.

Several young companies are staking out positions in wireless mesh networking, which now seems ripe for major commercial development. Two of the companies making nodes are in the Bay Area. Crossbow and Hayward's Dust Networks both were started by engineers who were trained at UC Berkeley.

Dust is involved in a lighting project with the Department of Energy to create an advanced, energy-saving wireless lighting system.

The idea is to use Dust's wireless sensors to do what now is usually done with a hard-wired system -- automatically turn the lights on when someone walks into a room, dim the light when it's sunny and turn it off when the room is empty. Installation would be cheap because it is not necessary to rewire the building.

"In the U.S., we spend \$20 billion a year on lighting," Conant said. "This is the highest cost in a building, even higher than maintenance. On a sunny day like this, I get enough light from the windows at my office, but nobody thinks of turning the light off. You can get a 40 percent reduction of electricity use if you manage your lighting."

A large office building would need 20,000 to 30,000 nodes to control lighting, heating and cooling, providing a return to the owner after one to two years, Conant said.

From an environmental perspective, lower electricity consumption would cut down on emissions from power plants. Reduced demand for energy would reduce the threat of blackouts. And companies could slash their energy bills.

As is often the case with emerging technologies, mesh networking until recently was a sort of Wild West, in which different companies used incompatible software.

Networking standards

But in December 2004, major customers, such as Philips, Samsung, Honeywell, Mitsubishi and Motorola, agreed to a set of hardware and software standards for wireless mesh networks, giving the technology a huge push forward. The standard is called ZigBee, alluding to honey bees zigzagging in order to tell each other that they have found nectar, spreading the information from one bee to the other, just like in a wireless mesh network.

Although ZigBee allows nodes to communicate, some experts don't consider it to be a true mesh network because the initial deployment happens to require some plugged-in devices.

Among the wireless mesh network companies, Ember -- a Massachusetts Institute of Technology spin-off in Boston that makes chips and software that use the ZigBee protocol -- claims to be the force behind the standard. Ember insists it is the only company rolling out chips for mesh networks in volume. Ember's chairman is Bob Metcalfe, inventor of Ethernet, one of the most important data-network standards.

"Our competitors do not like us," said Venkat Bahl, head of Ember's marketing. "Other vendors are scarcely meeting Philips' demands, and they are not manufacturing multiple million units. ... Ember commercializes the products for real-world deployment."

Ember sells its chips for less than \$5 each. They can, for example, be found in British marine electronics company Raymarine's wireless boat autopilot that enables a fisherman to change the direction of the boat without leaving his seat.

Crossbow and Dust have developed their own non-ZigBee communications software, although Crossbow also makes some ZigBee-based nodes.

Crossbow, which makes complete wireless mesh network products, not just chips, also styles itself a leader. Intel, the world's largest chipmaker, is one of its backers.

"We are the first company to sell a true mesh network and we have sold it for two years. The other companies are just starting. We turned a profit in 2002," said Mike Horton, Crossbow's 31-year-old president.

Challenging the standard

Horton founded the company in 1995, when he was studying engineering at Berkeley. The company got into wireless-sensor networking about four or five years ago. Horton has even named his 7-month-old daughter Mica after the company's nodes.

Companies with their own protocol, such as Dust and Crossbow, often have difficulty surviving if a standard gains acceptance.

"Companies are demanding to buy from multiple sources these days, in case anything happens to the supplier or if the supplier grows big and powerful like Microsoft and they end up as hostages," said Robert Heile, chairman of the alliance promoting the ZigBee standard.

Kristofer Pister is a Berkeley professor who coined the term smart dust in 1995 in an allusion to the belief that someday nodes will be the size of dust particles. He co-founded Dust in 2002. He disputes the idea that ZigBee will overwhelm other technologies, arguing that Dust will be able to compete because its technology is for industrial use.

"When Sony came with its Betamax, it needed standards for consumers," he said. "But Hollywood moviemakers needed higher quality. When it comes to consumer applications, people want to have the ability to buy a switch from Home Depot or Wal-Mart and see it work. But a company purchasing a building automation system from company X is very unlikely to buy additions from company Y."

Dust recently got \$22 million in venture capital.

"Kris Pister and his colleagues at Berkeley are world leaders in this class of technology," said Paul Koontz at Foundation Capital, a venture capital firm that has invested \$7 million in Dust.

There are still some technical problems to overcome before wireless mesh networks become practical.

"We are working on the reliability of communication. Buildings are messy places, electrically. Communicating between floors with radio waves is tough, as the floors usually are made of steel decks which block radio signals," said Francis Rubinstein, a scientist at the Lawrence Berkeley Lab.

While radiation doesn't seem to pose a problem -- radiation from a mobile phone is a thousand times stronger, according to Conant at Dust -- privacy and security issues could.

In the future, the technology is expected to become ubiquitous and connected to the Internet. If you lose your wallet on a vacation in New Jersey or France you could locate it via the Internet from the Bay Area. You could be tracked through your own personal node in the future. And those who didn't have nodes would be detected when they passed a motion sensor.

"Unlike the PC, which is as full of holes as a Swiss cheese, this technology is much more secure. It's the same as driving through an automatic toll booth -- it knows who you are but it doesn't tell anybody else," Harbor Research's Allmendinger said.

E-mail Birgitta Forsberg at bforsberg@sfchronicle.com.

Page C - 1

URL: <http://sfgate.com/cgi-bin/article.cgi?file=/c/a/2005/04/08/BUGT6BTQ3R37.DTL>

[©2005 San Francisco Chronicle](#)