that nocturnal rodents aren't scurrying around when predators can see them. The mutant mice were "grossly deficient" in masking, Weitz says.

Masking seems to be controlled by a signal carried directly to the SPZ by a small subset of ganglion cells, neurons found in the retina. Because the EGF mutants ran despite the light, that suggested that the EGF receptor is also responsible for masking and sent the researchers looking for that signal. They found that a small percentage of ganglion cells—about the percentage that are known to connect to the brain area called the hypothalamus, where both the SCN and the SPZ are located—contain EGF. "We don't know that those cells project to the hypothalamus yet," says Weitz, "but the numbers and distribution are very similar to the subset of ganglion cells that do." Weitz cautions that the data are not conclusive, but they suggest that both light and the clock may use the same molecular pathway to send the "don't run" signal. Clifford Saper of Harvard Medical School plans to use a method developed in his lab to see whether the EGF-containing retinal cells connect to the hypothalamus.

Meanwhile, Weitz and colleagues will continue to test molecules secreted from the SCN, looking for others that regulate wheel-running. For example, there must be a positive regulator that triggers the running activity at night. With such a molecule in hand, Weitz says, they can then look at how the positive and negative signals interact in the SPZ, whether they are received by the same or different neurons, and how those neurons interact to tell the motor centers of the brain to run or not to run. –MARCIA BARINAGA

LASER TECHNOLOGY

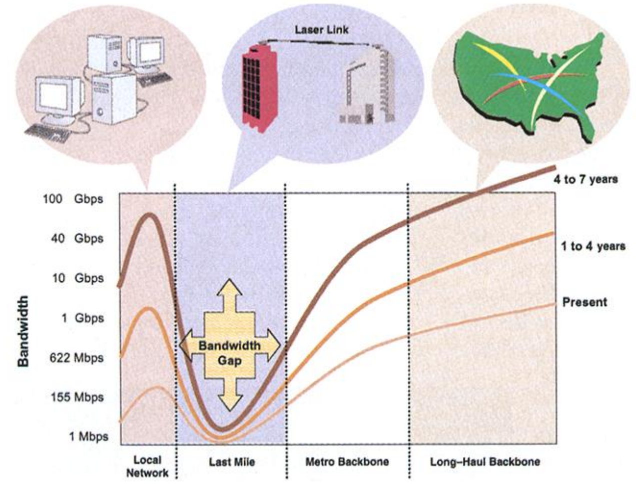
Hot New Beam May Zap Bandwidth Bottleneck

Still waiting to download full-length movies over the Internet or chat on a video phone? Blame the "last mile problem."

Long-distance fiber-optic cables transmit billions of data bits every second, plenty for these applications. But it would require digging up city streets, and more, to connect those cables to your home or office. Companies have recently been pursuing an alternative to laying fiber called free-space optics, in which an infrared (IR) laser beams data to a receiver on your rooftop. But the only cheap semiconductor lasers available aren't really up to the job. They work at a relatively short wavelength of about 1.5 micrometers, and the beams typically travel only a few hundred meters before being absorbed by water vapor in the air.

A report published online this week by *Science* (www.sciencexpress.org) suggests a new way to go the distance. A Swiss research team led by Jérôme Faist and Mattias Beck of the University of Neuchâtel describes making a new semiconductor IR laser with a wavelength of about 9 micrometers. Because water vapor—and even rain, snow, and smog—absorbs only a tiny amount of light at that wavelength, free-space optical systems built with the new laser should work at distances of 2 kilometers.

"We're very excited about it," says Jim Plante, president of Maxima Corp., a San Diego, California, company that is working to develop free-space optics technology. "With this technology we can conquer the weather." The longer wavelength lasers could also open a wealth of new research opportunities in atmospheric chemistry and medical diagnostics.



Filling the gap. A new laser may boost short-range data flow on a par with long-range fibers.

The Swiss group's lasers operate in a section of the spectrum known as mid-IR. Mid-IR lasers that generate light in a chamber filled with CO_2 gas have been around since the 1960s. But these lasers are bulky and expensive and must be cooled with cryogenic liquids. Research teams have begun to make semiconductor chip–based models that are small and potentially cheap, but they also require very low temperatures to keep them from burning out. Even then, the lasers spit out only intermittent pulses, rather than the continuous stream of light that is preferable for most applications.

To solve these problems, Faist, Beck, and their colleagues designed a novel structure for a "quantum cascade laser." QCLs, first developed in 1994 by Faist and Federico Capasso at Lucent Technologies' Bell Laboratories in Murray Hill, New Jersey, are an offshoot of traditional semiconductor lasers. In standard chip-based lasers, different semiconductor alloys emit different wavelengths of light. Gallium arsenide, for example, emits red light, whereas gallium nitride emits blue. In a QCL, however, the wavelength of the light is determined by the thickness of the active materials used. Each device consists of numerous semiconductor layers. When an electric current flows through them, electrons cascade down an electronic waterfall, an energetic staircase with numerous steps; when an electron hits a step, it emits a laser photon.

That's the theory. In reality, however, not all the electrons cascading in mid-IR QCLs are converted to photons. Many are absorbed by the semiconductor lattice, which generates enough heat to burn out the devices quickly. Researchers coped with the heat buildup by cooling the lasers to cryogenic temperatures and generating staccato pulses instead of a continuous beam.

The Swiss researchers, however, decided to make the laser shorter and narrower. "That allows electrons to tunnel more efficiently through the whole structure" and generate less heat, Beck says. Embedding the active region of the device in indium phosphide, an excellent heat conductor, whisked away the remaining heat. The new lasers not only work at room temperature but can produce a continuous beam of light without burning out.

Plante says the approach could revolutionize free-space optical communications. Although companies specializing in the technology have raked in more than a billion dollars in investments, Plante says, the industry has been struggling to put shorter wavelength lasers to work. "The use of mid-IR allows you to get the job done," he says. His company has already begun testing Faist and Beck's new QCLs, the latest versions of which can transmit data hundreds of times faster than a standard ISDN or T1 line.

The novel mid-IR lasers could be equally important for spectroscopy studies designed to detect particular gases in the air, says Frank Tittel, an applied physicist at Rice University in Houston. Potential users include atmospheric scientists measuring pollutants and medical researchers diagnosing disease from compounds in a patient's breath. Cheap and portable mid-IR QCLs, says Tittel, "would be a great jump forward." –ROBERT F. SERVICE

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