Purdue University researchers have developed a way to finely control ultrafast laser pulses’ spectral properties to create more powerful optical-communications technologies.

The laser pulses last a trillionth to a quadrillionth of a second—a picosecond to a femtosecond. In essence, each pulse could serve as a data bit in future high-speed optical-communications systems, explained Purdue professor Andrew Weiner. Picosecond pulses could yield data rates of one terabit per second, much higher than those of today’s lightwave communications systems, he said.

Each pulse’s intensity changes from start to finish. The Purdue scientists demonstrated that pulse shaping could tune the light by precisely controlling its intensity and phase to enhance signal quality and meet various applications’ needs.

For example, the Purdue technique could be used for data encoding in high-speed fiber services. Weiner said his team is working on an optical version of code division multiple access technology. CDMA currently is used in cellular systems. CDMA, he noted, lets multiple users share a single data channel, thereby increasing a communications system’s capacity by encoding separate transmissions with different waveforms, which the receiver can then distinguish. In the Purdue system, pulse shaping would enable creation of the different waveforms.

The technology could also be used in advanced sensors for detecting substances such as pollutants or chemical-warfare agents. Users could shape pulses so that the system would react differently to, and thereby identify, multiple substances.

The Purdue research builds on the work of other scientists who have developed ways to use grooved glass, metal, or other materials to separate a light pulse into hundreds of thousands of spectral, or frequency, components.

In pulse shaping, researchers modify the phase or amplitude of some or all of a light beam’s spectral components. In essence, this form of modulation places data on the various spectral components in parallel and thus at very high speeds.

The Purdue scientists have learned to use optical arbitrary waveform generation—which uses waveguides to shape a pulse—to precisely control the intensity and phase of 100 spectral components within a single pulse. This is only a small percentage of the components in a laser pulse, but it represents an important start, explained Weiner.

Weiner said the Purdue team is the first to shape light pulses lasting only a quadrillionth of a second and to demonstrate the control necessary to shape 100 spectral components.

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Femtocells Promise Faster Mobile Networks

Wireless-network operators are looking at an approach that could let them increase the bandwidth of their third-generation (3G) cellular technologies, which currently provide less performance than promised to many homes and small offices.

The providers are considering the implementation of femtocells, book-sized base stations that could overcome some of the problems that plague systems using only traditional cellular towers.

Several providers plan initial deployments perhaps next year, with large-scale implementations likely in 2009, said Timo Hyppola, head of indoor radio solutions at Nokia Siemens Networks, a telecommunications-equipment supplier.

Because tower-based systems send transmissions over long distances, signals frequently experience attenuation due to loss of intensity and contact with physical barriers. Attenuation due to signal contact with walls is a particular problem for indoor users of 3G systems, said Allen Nogee, market research firm In-Stat’s principal analyst for wireless technology and infrastructure.

Service providers, which have spent considerable money acquiring licenses and equipment, are looking for ways to increase the bandwidth they deliver while continuing to use their existing 3G infrastructures, such as those based on Evolution Data Only (EV-DO) technology.

Femtocells offer a smaller service area—tens of meters, depending on the manufacturer—than cellular towers—which typically cover 3 to 5 kilometers. Femtocell signals travel over a shorter distance and thus experience less attenuation.

“The technology offers the best rate available on the network,” explained Nokia Siemens Networks wireless technology analyst Rich Osman. And, he noted, adding femtocells is easier and less expensive than building cellular towers, which requires governmental approval. Consumers or providers install femtocells in local neighborhoods, near user premises.

The typical femtocell consists of a radio-based node and a wireline backhaul to the service provider’s network gateway, explained Wen Tong, a Nortel Networks Research Fellow. A device—such as a mobile phone, a set-top box, or a modem—could then use to buy drinks and food. In addition, families could link bracelets to track children so that if a child passes a beach access point’s electronic sensor and the sensor doesn’t also detect a parent’s bracelet, the system would send a text message to the parent’s cell phone.

Moreover, access-point sensors would let the city know which beachfront sections are most crowded and thus in most need of safety personnel. The city also plans to replace manned parking booths with automated credit card terminals. The terminals would link to the wireless system and let visitors know which lots are full and where they could find parking spaces.

The city will own it and pay the vendor that builds and operates the system about $600,000 over five years from an estimated $4 million to $5 million in net revenue generated by beach activities, Baltuch said.

The city expects increased revenue in part due to more efficient use of resources. However, the automation will eliminate some summertime jobs such as parking attendants.
Tilera’s TILE64 chip, the result of 10 years of research, has 64 cores. Each is wired to and thus able to pass data directly to any other core or even to I/O or external memory without having to send information through a central bus first.

When using a bus, said Tilera chief technology officer Anant Agarwal, “data can back up [when] the bus simply doesn’t have the bandwidth to ship all the packets.” Bus usage typically causes multicore chips’ performance to top off at only four to eight cores, he noted.

Analyst Nathan Brookwood with market research firm Insight64 said he was impressed with Tilera’s TILE64 presentation at the recent HotChips symposium on high-performance processors. “I think it should get a pretty good reception from potential customers,” he said.

The TILE64—which currently runs only on Linux but which Tilera is porting to other operating systems—has 64 tiles, divided into eight rows of eight each. Every tile includes a RISC processing core that runs at maximum speeds varying from 600 MHz to 1 GHz. Users can choose to run the chips at less than their maximum speeds to, for example, reduce unnecessary energy consumption.

Because the direct connections to tiles are shorter than they would be to and from a central bus, TILE64 has an intercore bandwidth of up to...
assigning them to cores for parallel processing. A user can turn a TILE64 into several virtual processors for use on multiple tasks. Tilera is initially focusing on the networking equipment and video-streaming server markets, which require high performance and low power consumption, Agarwal explained.

According to Brookwood, the biggest challenge to TILE64’s marketplace success will be the same one that faces other multicore chips: the development of software tools that enable the processor to optimally divide up work and handle it in parallel.

Also, added Agarwal, the chip is so different from conventional processors that convincing the computing industry of its value could be tricky. However, he noted, customers—networking equipment vendor 3Com, videoconferencing-infrastructure vendor Codian, and video-system vendor GoBackTV—are already buying the TILE64 chip, and other deals are in the works. Having early customers will help Tilera market the chip, and successful implementations could alleviate some concerns, Brookwood noted. However, he added, problematic implementations could hurt adoption.

Tilera plans to release a less expensive 36-tile chip next year and a more costly 120-tile processor by early 2009.

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