

# AT&T INNOVATION BRIEFS

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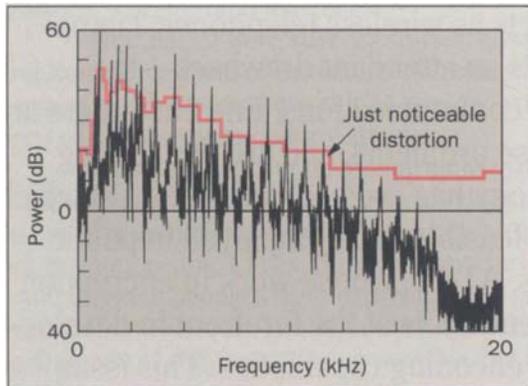
*Innovation Briefs are summaries of recent discoveries and developments within AT&T Bell Laboratories. Those wishing further information, or AT&T readers who would like to contribute future items, are encouraged to contact the AT&T Technical Journal editor.*

## **Primary Colors Emitted from Organic Material**

AT&T Bell Laboratories researchers have made significant progress in a new field of electronics that uses organic semiconductors to emit light in different colors and to transmit data photonically. The work advances the day when the ease of fabrication and cost of full-color electroluminescent flat-panel displays will compete with active-matrix liquid-crystal displays, and when high-speed photonic chips that use light to communicate with each other will be in common use. Using a single, organic, electroluminescent material, a research team produced miniature light-emitting diodes (LEDs) on glass that generate the three primary optical colors: red, green, and blue. This achievement permits the manufacture of full-color displays without the difficult and expensive step of integrating the patterns of three distinct chemicals. In addition, the team fabricated LEDs that emit white light, which leads to the possibility of thin, low-voltage back lighting for portable displays. The LEDs fabricated for AT&T Bell Laboratories' full-color display contain 8-hydroxyquinoline aluminum (Alq), a compound (patented by Eastman Kodak Company) that normally emits only green light. The fabrication process does not limit the LEDs to a particular organic material. A second research team has also used Alq, as well as a number of conjugated polymers, to produce optoelectric interconnections on silicon. Using well-established semiconductor manufacturing techniques, the team fabricated LEDs both on silicon wafers, the basic building blocks for most computer chips, and on silicon optical detectors that respond efficiently to the wavelengths emitted by the LEDs. The detectors can be made at the same time, and with the same processes, as their electronic circuits. Photonic interconnections have already been used effectively in long-distance and data networks. If costs can be further reduced, electroluminescent organic materials may someday make an important contribution to optoelectric technology.

## **Digital-FM Audio Broadcasting System Developed**

AT&T has developed a system for digital audio broadcasting (DAB) in the terrestrial FM radio band (88–108 MHz). The DAB system is designed for the reception of CD-quality stereo signals in a 200-kHz slot without interfering with digital or analog transmissions in adjacent frequency slots. Digital audio coding for the system is provided



**Perceptual audio coding (PAC)**

by the AT&T Bell Laboratories algorithm for Perceptual Audio Coding (PAC). The PAC system compresses 1.4 megabits per second (Mbits/s) CD-stereo to bit rates on the order of 128 to 160 kilobits per second (kbits/s) with negligible loss of audio quality. Robust transmission over the fading, mobile-radio channel is provided by means of a rate-1/2 error-protection code and by powerful new techniques for time diversity, channel equalization, and error concealment in the PAC decoder. The DAB system is one of several being evaluated by the Electronic Industries Association and the National Radio

Systems Committee. The intention is to obtain a Federal Communications Commission recommendation for terrestrial DAB by 1996. Representation in the DAB standard will provide direct revenue opportunities in terms of algorithm licensing and audio-decoder sales, as well as indirect benefits in other segments of the business: solid-state audio players, and network services using high-quality audio.

#### **Anonymous Credit Processes Explored**

Computing systems researchers at AT&T Bell Laboratories are exploring a number of applications in which an individual's privacy can be preserved by increased use of the communications network. In one such application, called the anonymous credit processes, information is distributed among the electronic equivalents of credit-card companies, banks, and the Federal Reserve. Cryptographic protocols have been developed that limit the information any one party can obtain, and that enable communications without the source and destination knowing each other's identity. Analysis has shown that five different parties must collude in order to associate a person's identity with that person's purchases when the anonymous credit processes are used. In addition to purchasing and detailed billing, the set of protocols performs all functions of conventional credit-card processes, such as receiving credits for returns, challenging purchases, and detecting unusual use patterns. They also provide additional protections, however, against loss or theft. Another application of these processes could be in paying for services in a network, without giving one's credit number to the vendors. Further, the protocols and information-separation techniques being developed for the credit processes could also be applied in other areas where personal security is desired, such as preserving any desired degree of privacy in a national health-insurance plan.