Communications

High-Speed Laser Brings Fiber and Satellites Together

The debate over the relative merits of fiber vs. satellites may be a moot point: their respective supporters may soon see each other as mutually compatible. Recent developments in high-speed laser and photodetector technology have made the transmission of satellite signals over fiberoptic cable possible. AT&T Bell Laboratories researchers now have demonstrated a system of transmitting signals from the 500-megahertz bandwidth of a standard satellite C-band (four to six billion cycles per second) over more than 20 kilometers of optical fiber without using repeaters.

Typically, coaxial cable is used to transmit microwave signals between a satellite antenna and the terminal equipment. But high losses (microwave cable loss increases as the square root of the frequency) mean the signals must be reamplified within tens of meters. Fiberoptic cable would solve that problem, since fiber attenuation does not depend on modulation frequency. However, the light sources and detectors must be able to operate efficiently at high frequencies. "We haven't used lightwave systems until now because we couldn't turn lasers on and off fast enough to handle a satellite's mid-to-high frequency transmission rates," said John Bowers, a member of the technical staff at Bell Labs.

Bowers is principal researcher of the group that developed an experimental 1300-nanometer high-speed constricted-mesa laser for the project. The design uses the dielectric layer for current confinement, a task accomplished in the p-n junction of most lasers. According to Bowers, other laser designs could be used for C-band satellite transmission, but a constricted-mesa design is required to transmit signals from the higher-frequency K-band. A separate absorption grading multiplication avalanche photodiode detector developed recently by Bell Labs was used to detect the signals. In this application, the microwave signal modulates the intensity of the laser in a direct-modulation/direct-detection scheme.

The Bell Labs group actually measured bit error rates and signal-to-noise degradation sent up to a satellite, down to the earth station, and across a 20-km fiberoptic cable. The entire signal experienced only 1 decibel degradation. Bowers will present the results of the experiment at the OFC/IOOC '87 conference, to be held this month in Reno NV.

A C-band satellite signal carries about 12 channels, each about 36 megahertz wide, according to Lawrence Stark, director of applications marketing at Ortel Corp., Alhambra CA. The signals are transmitted at vastly different power levels, from the very high level of FM video, down to lower level QPSK digital signals. The laser and detector must be able to handle all signal levels simultaneously.

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"The advantage of using fiber cable is that the antenna can be located some distance away from the controller," Stark said. For example, a company could have all its microwave transmission equipment in the basement of its corporate office and keep its antenna in a rural location, where signal interference and building restrictions are lower. Ortel has just announced two commercial 1300-nanometer laser diodes that operate at 3 and 6 gigahertz and are designed for high-speed analog transmission applications, including antenna remoting.

For one customer, Ortel installed a 5-kilometer fiberoptic link from a remote antenna to a transmission processing center. The link operates at 200 megahertz in the the 1.7-GHz frequency range. "We screen our lasers to make sure they have the linearity required for such high-bandwidth signals," Stark said. The lasers are said to have a 1-dB compression point, a figure of merit that shows linearity at any input frequency.

—Holly Bigelow