Science & Technology

Laser communication at the speed of light

by Marsha Freeman

On Feb. 10 of this year, the first section of the world's largest laser-powered telecommuncations system began operation as a New York to Washington, D.C. fiber optic link began to carry its first data. By 1984, the system will be extended to cover the full 776-mile route from Boston to Virginia. The American Telephone and Telegraph Company (AT&T) is spending $125 million for this new system since it will be a more economical method of transmitting voice and computer data in the future.

Fiber optical communications make use of the fact that laser light, being all of one wavelength, occupies a very small space, and the beam can be very narrow. Light can be transmitted through hair-thin glass fibers over long distances, and still carry more information than today's conventional copper-wire cables.

Today, while fiber optics technology is just becoming commercially available, it costs about $3 per meter of cable. While this is a significant drop from the $5 per meter cost only nine months ago, it is still nowhere near the cost of $.15 per meter for coaxial copper cable. Because the fiber optic cable can carry so much more data, however, the cost of actually transmitting the same amount of data the same distance with the two systems is lower for the laser system.

The fiber optics system will cost $.05 to transmit the amount of information that would require $3.00 worth of copper cable to transmit. Industry sources estimate that the $3 per meter cost of fiber optics cable will come down to $1 per meter over the next year, due to an increase in production and use.

In the AT&T light-wave system, up to 144 hair-thin glass fibers are fitted together to form a cable of about one-half inch in diameter. Such a cable will have a carrying capacity of up to 80,000 simultaneous telephone conversations; a copper cable having the same carrying capacity would have to be almost 10 times the size and 100 times the weight.

The information is transmitted through a pair of fibers by a pair of lasers blinking on and off more than 44 million times a second. This capacity represents the equivalent of digitally coding and transmitting the entire contents of the Bible across the country in seven seconds.

When these tiny pulses of light reach their destination, a device called a photo-detector receives the light and turns it back into an electrical signal, which is then transmitted to the user. By 1987, AT&T plans to upgrade the Boston to Virginia system to handle up to 240,000 simultaneous conversations in its half inch cable, saving $49 million on construction costs by 1990.

Fiber optical cable systems will be used under the sea in the next decade for transatlantic communcations, but some of the real potential of laser communcations will bring us information from even further away.

The Jet Propulsion Laboratory (JPL) in California, which manages all of the planetary programs for the National Aeronautics and Space Administration (NASA), is working on ways to make use of laser technology to communicate with spacecraft that are billions of miles away.

In the immediate future, JPL will use fiber optical cables to integrate sets of large antennas which are part of the Deep Space Network (DSN), to improve the accuracy of spacecraft tracking and navigation. Each station in the DSN has a series of antennas on the ground which receives radio signals from spacecraft. In this way, NASA receives data from the planetary probes, and issues them commands, including important navigational commands.

In order to determine precisely where a spacecraft billions of miles away is, so it can be directed on a course for a planetary encounter in the future, scientists measure the difference in the time it takes for the spacecrafts signal to reach two antennas on the ground. To do this at the level of accuracy required, the ability to distinguish differences in time of a billionth of a second are required.

A "clock" is set to that accuracy, which then has to relay the exact same time signal to two antennas that are nearby but not in the same place. If the transmittal of that "go" of the stopwatch to each antenna is by an electrical signal on conventional cable, a comparative measurement cannot be easily obtained, since the time the "go" signal takes to reach each antenna is not the same.

When the signal travels at the speed of light, however, scientists can be sure that the time reference is the same to the accuracy of a trillionth of a second, which is the order of magnitude precision needed to get the measurements required. In addition, by tying two or more antennas into a single functioning unit, even though they are not in precisely the same place, scientists can improve the quality of the weak signal received from a distant spacecraft.

With the signal from the spacecraft now-multipled, the distance at which man will be able to talk to the machines he sends out into the Solar System will be considerably extended. The quality of the communcations he receives will also be considerably improved.

At the present time, there are probes which are leaving the Solar System, and another, Voyager 2, which will encounter at least two more of the outer planets man has never really "seen."