Slower light could mean faster computers

December 22 2006

IBM today announced its researchers have built a device capable of delaying the flow of light on a silicon chip, a requirement to one day allow computers to use optical communications to achieve better performance.

Researchers have known that the use of optical instead of electrical signals for transferring data within a computer chip might result in significant performance enhancements since light signals can carry more information faster. Yet, "buffering" or temporarily holding data on the chip is critical in controlling the flow of information, so a means for doing so with light signals is necessary. The work announced today outlines just such a means for buffering optical signals on a chip.

"Today's more powerful microprocessors are capable of performing much more work if we can only find a way to increase the flow of information within a computer," said Dr. T.C. Chen, vice president of Science and Technology for IBM Research. "As more and more data is capable of being processed on a chip, we believe optical communications is the way to eliminate these bottlenecks. As a result, the focus in high-performance computing is shifting from improvements in computation to those in communication within the system."

Long delays can be achieved by passing light through optical fibers. However, the current "delay line" devices for doing so are too large for use on a microchip, where space is precious and expensive. For practical on-chip integration, the area of a delay line should be well below one square millimeter and its construction should be compatible with current

chip manufacturing techniques.

IBM scientists were able to meet this size restriction and achieve the necessary level of control of the light signal by passing it through a new form of silicon-based optical delay line built of up to 100 cascaded "micro-ring resonators," built using current silicon complementary metal-oxide-semiconductor (CMOS) fabrication tools. When the optical waveguide is curved to form a ring, light is forced to circle multiple times, delaying its travel. The optical buffer device based on this simple concept can briefly store 10 bits of optical information within an area of 0.03 square millimeters. That's 10 percent of the storage density of a floppy disk, and a great improvement compared to previous results. This advancement could potentially lead to integrating hundreds of these devices on one computer chip, an important step towards on-chip optical communications.

The report on this work, "Ultra-compact optical buffers on a silicon chip," by Fengnian Xia, Lidija Sekaric and Yurii Vlasov of IBM's T.J.Watson Research Center in Yorktown Heights, N.Y., is published December 22 in the premiere issue of the journal *Nature Photonics*.

Source: IBM