Researchers Prove Existence of New Basic Element for Electronic Circuits -- 'Memristor'

17 memristors in a row are visible on this AFM image. The memristor consists of two titanium dioxide layers connected to wires. When a current is applied to one, the resistance of the other changes. That change can be registered as data. Image credit: J.J. Yang / HP Labs

HP today announced that researchers from HP Labs have proven the existence of what had previously been only theorized as the fourth fundamental circuit element in electrical engineering.

This scientific advancement could make it possible to develop computer systems that have memories that do not forget, do not need to be booted up, consume far less power and associate information in a manner similar to that of the human brain.

In a paper published in today's edition of *Nature*, four researchers at HP Labs' Information and Quantum Systems Lab, led by R. Stanley Williams, presented the mathematical model and a physical example of a "memristor" – a blend of "memory resistor" – which has the unique property of retaining a history of the information it has acquired.

Leon Chua, a distinguished faculty member in the Electrical Engineering and Computer Sciences Department of the University of California at Berkeley, initially theorized about and named the element in an academic paper published 37 years ago. Chua argued that the memristor was the fourth fundamental circuit element, along with the resistor, capacitor and inductor, and that it had properties that could not be duplicated by any combination of the other three elements.

Building on their groundbreaking research in nanoelectronics, Williams and team are the first to prove the existence of the memristor.

"To find something new and yet so fundamental in the mature field of electrical engineering is a big surprise, and one that has significant implications for the future of computer science," said Williams. "By providing a mathematical model for the physics of a memristor, HP Labs has made it possible for engineers to develop integrated circuit designs that could dramatically improve the performance and energy efficiency of PCs and data centers."

One application for this research could be the development of a new kind of computer memory that would supplement and eventually replace today's commonly used dynamic random access memory (DRAM). Computers using conventional DRAM lack the ability to retain information once they lose power. When power is restored to a DRAM-based computer, a slow, energy-consuming "boot-up" process is necessary to retrieve data from a magnetic disk required to run the system.

In contrast, a memristor-based computer would retain its information after losing power and would not require the boot-up process, resulting in the consumption of less power and wasted time.

This functionality could play a significant role as "cloud computing" becomes more prevalent. Cloud computing requires an IT infrastructure of hundreds of thousands of servers and storage systems. The

memory and storage systems used by today's cloud infrastructure require significant power to store, retrieve and protect the information of millions of web users worldwide.

Memristor-based memory and storage has the potential to lower power consumption and provide greater resiliency and reliability in the face of power interruptions to a data center.
Another potential application of memristor technology could be the development of computer systems that remember and associate series of events in a manner similar to the way a human brain recognizes patterns. This could substantially improve today's facial recognition technology, enable security and privacy features that recognize a complex set of biometric features of an authorized person to access personal information, or enable an appliance to learn from experience.

Williams is the founding director of HP Labs' Information and Quantum Systems Lab, which is focused on turning fundamental advances in areas of mathematics and physical science into technologies useful for HP. For the past 12 years, Williams and his team have conducted primary scientific research into the fundamental limits of information and computing, which has led to a series of breakthrough discoveries in nanoelectronics and nanophotonics.

More information is available at http://www.hpl.hp.com/research/quantum_systems.html .

Source: HP