Beyond Silicon: HP Outlines Comprehensive Strategy for Molecular-scale Electronics

March 14 2005

For the first time, HP has laid out in one place a comprehensive, practical strategy for a computing future beyond traditional silicon technology.
The vision – and the challenges – are captured in nearly two dozen papers published today in a special nanotechnology edition of Applied Physics A, the premier European journal of applied physics.
"We believe we have a practical, comprehensive strategy for moving computing beyond silicon to the world of molecular-scale electronics," said Stan Williams, HP Senior Fellow and director, Quantum Science Research (QSR), HP Labs. "We have a three-pronged approach: fundamental scientific research into the quantum effects that dominate the nanometer scale, a new architecture that can tolerate defects in molecular-sized circuit components and cost-effective methods of fabrication."

Williams said that HP Labs has discussed these ideas separately before, but the special edition of Applied Physics A – which includes papers dealing with each of the three areas – provides an opportunity for a detailed look at HP's overall approach.

In conjunction with the publication, HP is pursuing the multi-tiered theme in an invitation-only international nanotechnology symposium at HP Labs on March 25. Michael Stuke, editor-in-chief, Applied Physics A, will join 16 prominent scientists from universities, national labs, scientific institutes and companies around the world at the event.

"Our special issue presents pioneering achievements by world-class experts in areas ranging from basic nanoscience and ultraprecise nanotechnology to breakthrough applications for nanoelectronics, many of them backed by important new patents," said Stuke. "The combination of this publication and the HP-hosted symposium offers researchers a unique opportunity to gain a comprehensive view of the challenges facing the future of nanotechnology."

There is a great deal of discussion concerning the future of Moore's Law – the rule formulated by Intel founder Gordon Moore more than 40 years ago that computing power essentially doubles every two years – and when the industry will hit economic or fundamental physical limitations. At that point, a new type of technology will be required to continue improving basic computing capability well into this century.

"Computers of tomorrow could be quite different from what they are today," said Williams. "When you can make a computing appliance so tiny that it could fit across the width of a hair, you could enable many, many different things to become 'smart.' Computing could become as ubiquitous as electricity – it's just there, making things work. The possibilities are limited only by human imagination."

The HP vision is based on its patented crossbar architecture – one set of parallel nanowires running approximately perpendicular to another set, sandwiching a thin layer of an electrically switchable material. Every intersection of wires can then form an electrical switch, which could be programmed to configure the crossbar to perform various functions, such as store a bit or perform a logic operation.

The crossbar architecture is potentially easier and less expensive to manufacture than conventional silicon technology, because it doesn't require the same level of mechanical precision and is well-suited to tolerate the inevitable defects that are bound to occur in the fabrication process at such tiny dimensions. One of the papers in the publication describes a new approach to defect tolerance that is particularly suited to the crossbar structure.

Williams said QSR is also looking at fundamental science underlying computing at the molecular scale.

"At the nano level, quantum mechanics takes over from classical physics – electrons behave more like waves than particles. We are studying how we can use quantum properties to enable new functions in a circuit," he said. Theoretical physicists working in QSR have contributed articles on quantum effects to the special edition.

Finally, the HP group is examining how future devices could be made – practically and economically – at the nanoscale. "There's a great tradition of technology transfer at HP," said Williams. "We work only on those things that we believe could ultimately be important to HP's bottom line in the future."

To that end, QSR researchers are examining the properties of various metals for wires and materials for switches that could be used in fabrication at the nano level. They are also proposing ways in which the tiny devices could be linked to conventional microelectronics.

The researchers are also looking at a variety of fabrication processes, from nano-imprint lithography – a kind of production process akin to a traditional printing press – to chemical self-assembly by growing silicon nanowires between electrodes. One paper in the publication describes how silicon nanowires are especially useful as sensors to detect specific DNA molecules.

"Clearly, there's a lot of work to do before nanoscale devices become reality, and no one organization will ever be able to do it alone," said

Williams. "That's why we're publishing in the scientific literature and holding our own symposium. All of us in the scientific and technical community have much to learn from one another."

Citation: Beyond Silicon: HP Outlines Comprehensive Strategy for Molecular-scale Electronics (2005, March 14) retrieved 25 April 2024 from https://phys.org/news/2005-03-silicon-hp-outlines-comprehensive-strategy.html