For more than 50 years, visionaries have heralded the prospect of a nanoelectronic computer built from the atoms or molecules up. For nearly as long, many have predicted the demise of the silicon microelectronic technology underlying conventional computing as we know it.

However long it takes silicon to breathe its last gasp, the time is coming when the computing industry must look elsewhere for the means to sustain the rapid increase in capability that has enabled the development of a wide range of new applications, as well as large, profitable markets for memories and processors.

**KEY CHALLENGES**

Anticipating this new era, a growing research community has coalesced around the two key challenges of computing without silicon microelectronics:

- inventing a scalable device and fabrication technology to replace the transistor, and
- designing architectures for systems that can perform information processing using such devices.

For many computer architects, the first challenge takes priority. After all, we are used to operating under the protection of well-designed abstractions that permit our architectures to accommodate anything from ideal switches to the least palatable of devices that might be foisted upon us. However, the nanodevices that prevail over silicon seem destined to break even the sturdiest of abstractions. The relationships between computation and communication shift as we approach the nanometer scale, such that novel nanodevices impose new rules about the partitioning and allocation of “code” and “data,” for example. This can be a blessing in disguise: although it requires system designers to look beyond stored-program architectures with which they are comfortable, it also liberates them to work with new hardware primitives. In fact, postsilicon nanodevices might not even compute in a binary fashion.

Thus, several standout nanocomputer architects have adopted a more transcendent approach that also addresses the second key challenge. They have realized that by breaking down abstractions and facing challenges in an integrated fashion from the devices up, novel systems might be developed that ultimately go beyond von Neumann processing on silicon. Moreover, some have taken steps to demonstrate how this could be accomplished in the near term.

**IN THIS ISSUE**

This special issue brings together articles from four teams that have devised architectures to meet these chal-
These four articles provide an illuminating cross-section of the opportunities and challenges of computing in the nascent postsilicon era. They demonstrate ways in which we might transition from microelectronics to nanoelectronics, first by using hybrid architectures and, ultimately, by looking beyond conventional microtechnologies to novel postsilicon approaches. It is through such approaches that the nanocomputing community will continue to engineer seamless growth in the capability and complexity of computing systems for many years to come.

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