PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY A

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Preface

Cite this article: Cumming DRS, Furber SB, Paul DJ. 2014 Beyond Moore's law. *Phil. Trans. R. Soc. A* **372**: 20130376.
http://dx.doi.org/10.1098/rsta.2013.0376

One contribution of 11 to a Discussion Meeting Issue 'Beyond Moore's law'.

Subject Areas:
electrical engineering, microsystems, nanotechnology, optics, sensory biophysics

Keywords:
microelectronics, silicon photonics, sensors, microsystems

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Beyond Moore's law

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Computer and communications technologies have permeated all areas of modern life, including business, education, government, science and entertainment. These developments are all underpinned by micro-electronics that, for half a century, has been driven by Moore's law. Named after Gordon Moore, one of the founders of Intel, the 'law' describes the exponential growth in the complexity of integrated circuits year on year, driven by the search for profit. This rapid progress has delivered astonishing levels of functionality and cost-effectiveness, as epitomized by the boom in sophisticated digital consumer electronics products. However, this exponential growth in complexity cannot continue forever, and there is increasing evidence that, as transistor geometries shrink towards atomic scales, the limits to Moore's law may be reached over the next decade or two. As the physical limits are approached, other factors, such as design costs, manufacturing economics and device reliability, all conspire to make progress through device scaling alone ever more challenging, and alternative ways forward must be sought.

Microelectronics therefore seeks to develop in new ways, not only to continue to deliver better performance in traditional markets, but also to grow into new markets based on devising new, non-electronic, functions on integrated circuits. Microelectronics relies on complementary metal oxide semiconductor (CMOS) technology, the backbone of the electronics industry. Beyond Moore's law, it is foreseen that microelectronics will be a platform to support optical, chemical and biotechnology to deliver a step change beyond electronics-only integration.

Research is now heavily engaged in the integration of non-electronic devices and systems using CMOS as a cheap platform. Building upon electronics, it is increasingly possible to create highly heterogeneous systems using a great variety of technologies. New and

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revolutionary technologies such as 'post-light' genome sequencing are now rising to dominance in the market place. It is now clear that heterogeneous integration will make an impact in the relatively integration-poor fields of biomedical, sensing and healthcare technologies.

However, this is not the only important strand of 'beyond Moore's law' technology that we explore in this Discussion Meeting Issue. While new applications for CMOS will be discovered, there is also a pressing need to continue to develop computer and communication technologies yet more. Integrated optics and, more specifically, silicon photonics represent a major pathway that is being vigorously explored. The objective is to increase information bandwidth dramatically in low-cost technologies to deliver high-bandwidth communications.

The research and funding landscape is now changing to acknowledge and support this potential for scientific and technological advance. As the field develops scientifically, new opportunities are emerging that will use low-cost electronics, and exploit the added value of design and manufacture for integration. To achieve this, a multidisciplinary approach is essential: traditional physics and engineering research must now work closely alongside biological, chemical and medical science to develop new applications and acquire new capabilities. At the Discussion Meeting and satellite meetings that were held in May 2013, we were able to explore this diverse and complex landscape with internationally leading speakers in the field. This Discussion Meeting Issue offers a glimpse into the topic and the excitement that is felt by many scientists and engineers as they prepare to tackle new challenges in the coming years.