# Scientists develop revolutionary microchip that uses 30 times less energy

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Leaving your mobile phone charger at home when you go for a two week long vacation may just be the norm one day as scientists from Nanyang Technological University (NTU) and Rice University, United States, have successfully created a microchip that uses 30 times less electricity while running seven times faster than today's best technology.

The technology, dubbed PCMOS (probabilistic complementary metal-oxide semiconductor) was invented by Professor Krishna Palem of Rice University and Director of NTU's Institute for Sustainable Nanoelectronics (ISNE). The U.S.-Singapore team making the announcement is led by Professor Palem and NTU's Associate Professor Yeo Kiat Seng, Head of Division of Circuits and Systems, School of Electrical and Electronic Engineering (EEE), College of Engineering.

The team's goal is green computing. They are looking for applications where PCMOS can deliver as well as or better than existing technology but with a fraction of the energy required.

"Probabilistic design methodology, if used for consumer devices, would result in energy efficient devices," says Professor Palem who conceived probabilistic design. "For example, for consumers, it could mean the difference between charging a cell phone every few weeks instead of every few days. In addition to the encryption application that we have demonstrated, among other applications, it is equally well-suited for computer graphics."

Professor Palem explains that in streaming video application on a cell phone for example, it is unnecessary to conduct precise calculations. The small screen, combined with the human brain's ability to process less-than-perfect pictures, results in a case where the picture looks just as good with a calculation that is only approximately correct.

Dr Natalie Kong Zhi Hui, Teaching Fellow, in NTU's EEE and a member of team, says "Our technology is a significant contributor towards environmental-friendliness - green computing, or probabilistic computing, with an extremely energy-aware attribute. This is due to the fact that, unlike conventional designs that view noise as a nuisance, our design concept embraces noise as a "gem" - this novel technology recycles noise."

The microchip is a successful proof-of-concept of the PCMOS technology which has demonstrated an improvement of 30 times in terms of energy consumption while running seven times faster than the contemporary CMOS design.

This is in contrast with today's silicon transistors become increasingly 'noisy' as they get smaller, thus engineers have historically dealt with this by boosting the operating voltage to overpower the noise to ensure accurate calculations, leading to higher energy consumption levels.

"With this PCMOS technology, noise/parameter variations are part of the overall design and are managed as a resource to achieve significant energy savings. Our vision is to see a new generation of probabilistic-based nanoelectronics with diverse applications in media, biomedical, information technology (IT) and consumer electronics. The success of this project would go a long way in promoting the advent of a new generation of 'green' IT at lower costs to consumers," says Professor Yeo.

Professor Yeo, Dr Kong, Professor Palem and his student, Dr Pinar Korkmaz, successfully ran the first real-world tests of the revolutionary prototype microchip. This is a culmination of various chip designs and testing that started in 2005.

According to Professor Yeo, PCMOS is also ideally suited for encryption, a process that relies on generating random numbers. Thus the microchip can be quickly incorporated in electronic devices such as in computer gaming, lotteries and cryptography (internet security) where random calculations are valuable. "This is in addition to applications where there is a need to produce statistical simulation, such as in financial and economic forecast so that more accurate predictions can be made," says Professor Yeo.

Equally important is that the implementation of PCMOS piggybacks on the current "complementary metal-oxide semiconductor" technology, or CMOS, that chipmakers already use. This means that chipmakers can use existing equipment to support PCMOS, resulting in lower entry costs for the new technology.

The Rice-NTU team plans to follow its proof-of-concept work on encryption with proof-of-concept tests on microchips for cell phones, graphics cards and medical implants. They look forward to taking this concept of probabilistic design, which is one key focus of NTU's ISNE, to the next level.

"In Singapore, the next level is to create a larger activity with roots at NTU and which spans an increasingly vigorous international network based at Rice. The vision for this will include next generation electronics, based on principles drawn from the mathematics of probability as it relates to areas such as risk analysis, perceptual neurobiology, nanoscale devices and computing with applications to exciting domains such as graphics and multimedia, education and global

health," says Professor Palem.

The team hopes PCMOS technology will enter the consumer computing market in as little as four years and may present itself as a parallel to mainstream CMOS technology in the near future.

On the web: www.ntu.edu.sg/publicportal/

Source: Nanyang Technological University

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