ULTRARAM

Ultralow-power, Non-volatile, Random Access Memory Arrays for Datacentres and Space Applications

PUBLIC SUMMARY

Demand for digital information is generating more than 1 zettabyte (1021 bytes, or one billion 1 TB drives) of data traffic to and from datacentres per year, and using more electricity than The Netherlands and Belgium combined, or ~1% of total world electricity consumption. Overall, information and communication technologies (ICT) accounts for more than 2% of global carbon emissions, similar to the contribution from aviation fuel. Furthermore, demand keeps growing, potentially reaching 20% of global electricity by 2030. [Nature 561, 163 (2018), https://doi.org/10.1038/d41586-018-06610-y].

A dramatic and fundamental improvement in underpinning ICT energy efficiency is thus essential. ULTRARAM™, a novel, ultra-efficient, memory technology is a prospective solution. It has the potential to out-perform DRAM (the main memory used in phones and computers), with the substantial advantage of retaining data in the absence of power (as does flash, used in USB and solid-state drives). Wide scale implementation of ULTRARAM™ could almost eliminate memory energy consumption, and facilitate significant improvements in overall system efficiency.

In this project we will build on ground-breaking work of the ATTRACT Phase 1 project by demonstrating 64-bit, ultra-low-power, non-volatile ULTRARAM™ random access memory (RAM) modules on silicon substrates. Multiple RAM modules will be fabricated with devices at a range of feature sizes (nodes) from 100 μm down to 100 nm, and will be thoroughly evaluated, including using accelerated techniques at elevated temperatures. Memories are expected to have (extrapolated) data storage times of more than 1000 years and endurance (write/erase lifecycles) of at least 1012 (100 million times more than flash), with the smallest devices switching at 100 ns at energies of <1 femtojoule, which is lower than any known memory device.

As a candidate 'universal memory', ULTRARAM™ has the potential to radically transform the entire digital technology landscape, from small autonomous Internet of Things (IoT) devices, through to smart phones, laptops and datacentres. The ATTACT Phase 2 project will focus on two specific applications. The first is the space industry, where energy efficiency is crucial, but cost is less important, so is a potential early adopter, accelerating commercialisation. Use in this application will be demonstrated by operating memory modules at low temperatures and investigating their radiation hardness. The second application is datacentres, which is where the potential impact in reducing energy demand will be by far the greatest. This will be done by way of example, by modelling implementation of ULTRARAM™ in the computing infrastructure of the telecom's provider BT, which is one of the largest ICT energy consumers in the UK, accounting for about 0.7% of total UK electricity demand.

This project has received funding from the European Union's Horizon 2020 research and innovative programme under grant agreement No. 101004462