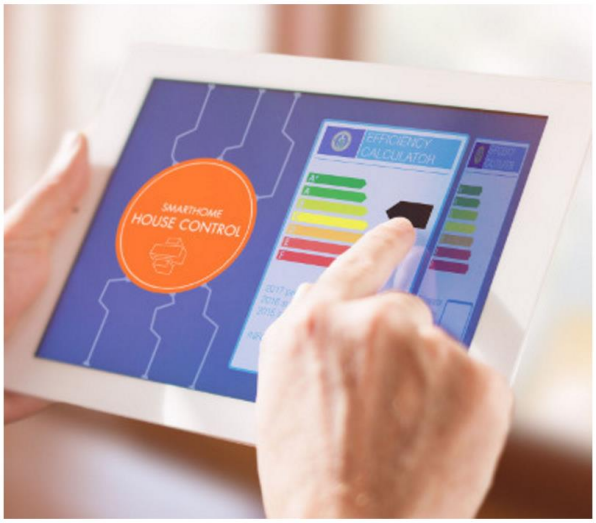
ReThink Mobile Computing with Crossbar ReRAM Technology

The smartphone has changed the world, people's daily lives and work. It has become the universal device that is always with you. Wearable devices and sensors are changing the way people take care of themselves and interact with the world while they're on the go. The latest IDC report shows that smartphone volume shipments will grow from 1.48 billion units in 2016 to 1.77 billion units in 2021. In this huge volume market segment, smooth, instantaneous interactions between the user and the device are as vital as size and battery life. Users expect their batteries in smartphones and wearable devices to last weeks. Unfortunately, current solutions based on Flash-based solid state storage face challenges to last more than even a single day.

The users of mobile devices expect smaller size, more portability, high performance, and low power, enabling them to function reliably for long periods in a broad range of environmental conditions. Wearable device users expect to experience very fast wake-up and application launch times, then automatic return to stand-by mode before the next user interaction in order to extend battery life.

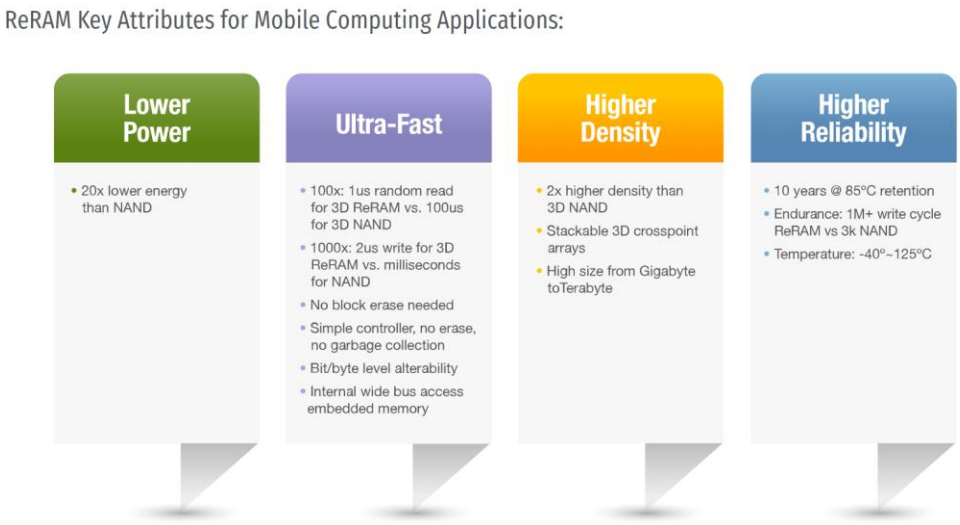


4G networks are deployed worldwide, and 5G networks are finally closer to reality as well. 5G promises to deliver faster internet speeds and improved throughputs, enabling virtually unlimited data consumption. With 5G, users will enjoy high-definition multimedia streaming on their mobile devices. Also, 5G will deliver improved device-to-device communication support, lower latency and less battery consumption than 4G platforms. Eventually, this will drive the smartphone to operate with ultra-fast performance, low latency, and low energy.

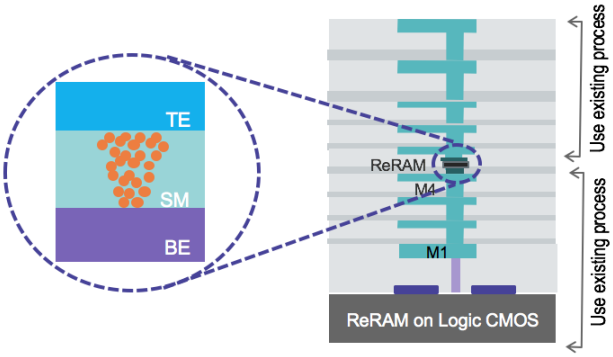
In order to sustain the growing demand for multimedia data access, smartphone storage performance and capacity are poised to increase significantly. This dependence has led device manufacturers to almost double storage capacity on an annual basis. In fact, some high-end smartphones offer more capacity than entry-level laptops now. Today, 256GB is already available in smartphones and 1 TByte storage capacity is not far away. It is crucial for data storage technology to scale to higher performance and higher capacity solutions.

However, the current NAND Flash storage in smartphones is hard to scale to 1 TByte while maintaining acceptable levels of performance and energy consumption. NAND Flash program operation is slow and is done at the granularity of a large page size. Current 3D MLC/TLC NAND Flash needs about one millisecond to program 16Kbytes page. NAND Flash has to be erased prior to being programmed. The NAND erase operation is slow, in the 10ms range and is done for a very large block size, 4-8Mbytes. This is challenging for mobile computing applications with intensive pictures and video and the downloading/uploading of multimedia content to the cloud.

Crossbar's ReRAM memory technology delivers 100X lower read latency, 1000x faster write performance, 2x high density, 20x lower power consumption than today's best-in-class 3D NAND Flash memory. Compared with traditional NAND or SPI Flash, Crossbar ReRAM is bit/byte-alterable, erase-free operation and doesn't have the Flash design constraints to build memory arrays in large blocks. Crossbar's ReRAM technology can be architected with smaller pages (e.g. 256Byte pages vs. 16KByte pages in NAND) that can be independently re-programmed. This new storage architecture drastically simplifies the complexity of the storage controller by removing a large portion of the background memory accesses required for garbage collection. Also, the erase-free architecture with small page granularity that can be re-programmed without a block erase provides an impressive performance boost over Flash-based storage solutions. Crossbar's ReRAM technology is simplifying the management of data writes and reads by the simple storage controller, not only improving the performance and overall endurance of the data storage solution but also reducing the overall power consumption of data manipulation in mobile devices.

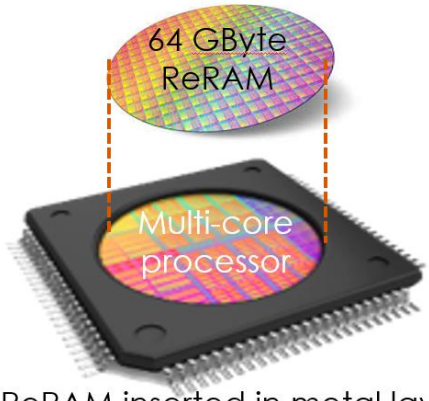


Crossbar's ReRAM is manufactured in standard CMOS fabs using friendly materials and standard manufacturing processes. Easily integrated with CMOS logic IP blocks, Crossbar ReRAM enables extremely integrated solutions with on-chip non-volatile memory application processing cores on a single die to provide an elegant and low power solution.



Crossbar ReRAM standard CMOS manufacturing

Crossbar ReRAM technology enables the possibility to integrate high performance non-volatile memory arrays on top of high-end application processor CMOS chips to get rid of external memory component bottlenecks. This even accelerates the memory access performance with a wide internal bus between embedded ReRAM and application processors.



ReRAM inserted in metal layers of standard CMOS process

On-chip ReRAM benefits:

1. Extend battery life with ultra-low energy NVM memory
2. Accelerate data access with simple memory controller
3. Enable fast memory access with internal wide bus
4. Ultra-fast performance with 1µs random read and 2 µs write

The embedded, always-on computing in smartphones, such as voice activated virtual assistants like Apple's Siri, are getting more and more traction. For these applications to produce rich sets of data, Crossbar's ReRAM innovative memory technologies are helping to deliver low energy, faster read and byte-addressable writes storage characteristics, enabling embedded storage innovation in smartphones.

Whether it's a laptop, a tablet, a smartphone or a wearable device, Crossbar's high-performance, low energy storage solutions enable these devices to be smaller and more feature-packed than ever, giving them the capacity they need for handling today's and future applications and content without sapping crucial battery life. Mobile computing architectures are currently re-invented with ReRAM technology, paving the way to a new era of tightly integrated memory and computing systems.

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