FAQ

ElectronicDesign

What are the Key Memory Requirements for Next-Gen IoT Devices?

Internet of Things (IoT) devices must provide complex capabilities with limited power resources. Flash memory has a key role to play in storing firmware as well as operating systems and boot code. In addition, it can store sensor data, user login information, and other IoT device data, and it supports edge computing by allowing local data processing.

Q1: Which flash-memory products are enabling next-gen IoT devices?

A: Key memory products powering next-generation IoT devices include embedded MultiMediaCard (e-MMC) memory, Universal Flash Storage (UFS), and single-level cell (SLC) NAND flash memory. e-MMC is compact and offers low power consumption. UFS, designed to supersede e-MMC, combines high-speed read/write performance, low power consumption, and quick application launch times, and is scalable to higher densities than those available with e-MMC. SLC offers fast performance for lower-capacity applications. It also provides superior reliability and can withstand many more program/erase cycles compared with the higher bit-per-cell devices used in UFS.

Q2: What are the key challenges when designing memory storage for next-generation IoT devices?

A: Key considerations include the workload an application imposes on flash storage and how that workload affects wear-out. e-MMC and UFS were primarily designed for memory-card storage and often used to store videos, pictures, and music — storage applications that tend to have many more read cycles than program/erase cycles. In contrast, IoT applications often use flash memory not for bulk storage but rather to log data, which can result in many more program cycles, leading to premature wear-out.

Also, keep in mind that UFS is a relatively new technology. Consequently, not all application processors and SoCs support UFS, and the software ecosystem for UFS is not as extensive as that for e-MMC. Both these situations are rapidly improving, and UFS will be an excellent choice for IoT applications going forward.

Finally, although SLC has a simple cell structure compared with other flash memory, it can be complex to design with. Raw SLC NAND lacks the standard JEDEC interfaces and integrated controllers of e-MMC and UFS and can require a dedicated controller to manage the program and read

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operations as well as implement error correction and wear-leveling algorithms.

Q3: What makes e-MMC, UFS, and SLC ideal for IoT applications?

A: e-MMC, UFS and SLC offer a choice of memory densities in compact form factors. They are power-efficient, optimizing battery life in wearable and other battery-powered IoT devices. Multiple types of flash memory can be combined in an IoT device — often in the form of a system-on-module — to optimize cost, density, and reliability with respect to repetitive program/erase cycles. In addition, e-MMC and UFS allow the configuration of user-data area as pseudo SLC to support write-intensive applications.

Q4: In what instances would lower-density products, such as SLC and e-MMC, be the preferred memory choice for IoT applications?

A: e-MMC memory can be the most cost-effective solution for many of today's IoT devices, which, unlike smartphones and laptops, do not require large data capacities. e-MMC also supports longevity. Its JEDEC standard is no longer changing, so designers of new IoT devices can continue using older SoCs or MCUs without having to redesign the storage interface. KIOXIA offers e-MMC in 4-gigabyte (GB) to 128-GB configurations in JEDEC standard 11.5mm x 13mm, 153-ball BGA packages (with the 4GB version also offered in an 11mm x 10mm package).

SLC NAND is the reliable choice for applications requiring many program/erase cycles, although it will cost more for a given memory capacity. KIOXIA offers SLC in capacities from 1 gigabit (Gb) and up to 256 Gb.

Q5: If an IoT device requires small, low-pin-count, high-density packaging, which memory type would be most suitable?

A: UFS is evolving to keep pace with rapid changes in smartphones and offers lower latency, higher

bandwidth, and better power efficiency than e-MMC. It also supports full duplexing and serves IoT applications that require higher capacity than e-MMC offers. KIOXIA offers UFS in 32GB to 1TB capacities in JEDEC standard 11 x 13mm and 11.5 x 13mm 153-ball BGA packages. KIOXIA UFS devices also include two key technologies: WriteBooster enhances write performance through a temporary SLC buffer without sacrificing capacity, and High Performance Booster improves random read-access performance by caching logical to physical translation tables.

Q6: What are some of the IoT applications that KIOXIA is powering?

A: KIOXIA memory finds extensive use in the smart home and the smart city, and it powers a variety of smart health, industrial, and natural resources IoT applications. KIOXIA has identified applications for e-MMC and SLC in smart appliances, infotainment systems, dash cams, smart meters, biometric sensors, farm analytics systems, and seismic sensors.

In addition, UFS is used in video conferencing systems and enterprise surveillance systems, while SLC is used in heart monitors and warehouse safety equipment. IoT devices can employ more than one type of flash memory — for example, e-MMC and SLC both find use in smart lighting systems; e-MMC and UFS serve in smart speakers; and e-MMC and SLC find use in machine-to-machine routers.

Q7: What are the top considerations when choosing a flash memory solution?

A: Flash memory comes in a variety of formats and capacities, so make sure you choose the version that is right for your application with respect to density, speed, reliability, extended temperature ranges, power consumption, SoC support, and availability throughout your product's life cycle. As the inventor of flash memory, KIOXIA offers an evolving line of products along with an extensive support system that will help solve the challenges of next-generation IoT devices.