Supporting Edge Processing with Micron® 2100AI PCIe with NVMe™ Industrial SSDs and Kontron COM Express® Modules

Industrial end customers are embracing the value of the Industrial Internet of Things (IIoT). In doing so, the need for memory and storage is growing substantially. As more and more data is collected at the edge—instead of sent to the cloud—edge processing is becoming vital.

To address edge processing needs, a series of standardized computer-on-modules that offer increased performance density with graphic support has launched: Kontron's COM Express® Type 6 module with Micron's 2100AI SSD with NVMe.

Through the use of consistent connector pinout and feature implementation, the Kontron COMe-cTL6 module is exchangeable and offers flexibility for customers designing into embedded devices based on individual carrier boards. With the introduction of a hexacore CPU, memory expansion up to 128GB, and an additional NVMe SSD onboard, the module is a differentiator to earlier applications. The onboard Micron 2100AI SSD uses 3D NAND TLC technology and supports industrial-grade features including a temperature range of -40 to 95°C (with automotive options up to 105°C).

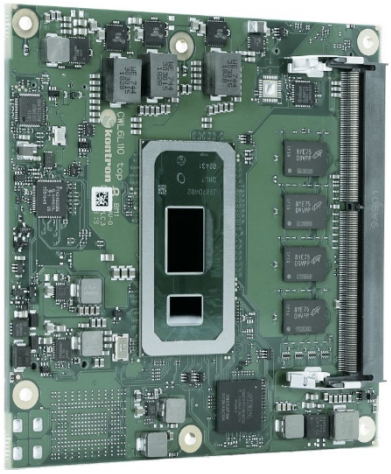

Figure 1: COM Express® Compact Type 6 Module
https://www.kontron.com/products/boards-and-standard-form-factors/com-express/com-express-compact/come-ctl6-e2-.html

While most industrial customers are familiar with single level cell (SLC) and multi-level cell (MLC)-based NAND storage solutions, the use of 3D TLC NAND TLC may bring about questions with reliability of next-generation solutions.

This paper explores the differences between NAND generations, describes the benefits of 3D NAND technology, and outlines the benefits Micron's industrial SSDs based on Kontron's COM Express portfolio can provide to meet industrial platform requirements.

Exploring NAND Technology

The NAND cell has been around for decades. Not only has the lithography shrunk during this time, but the number of bits stored on a cell has also changed. Single bit per cell (SLC) was the first generation, multi- or two-bits-per-cell (MLC) came next, followed by three-bits-per cell (TLC).

SLC (Single-Level Cell)	MLC (Multi-Level Cell)	TLC (3 bits per cell)
• Refers to NAND devices that store one bit of data per memory cell • Usually used in MMI, servers, embedded applications, and caching tasks • Highest retention and endurance of all NAND technologies; most program/erase (P/E) cycles	• Refers to NAND devices that store two bits of data per memory cell • Usually used in commodity memory products (SD/USB/MMC/MP3) and commodity SSD devices • 2X the density of SLC, but longer program time, fewer P/E cycles	• Refers to NAND devices that store three bits of data per memory cell—3X times the density of SLC • Usually used in high-density memory products (SSD/SD/USB/MP3) • Contains advanced features to improve the performance of modern SSDs

The NAND Cell

There are two basic NAND cells: legacy 2D (planar) NAND and 3D NAND.

The legacy 2D NAND cell has a physical limitation where increasing density requires reducing the cell size, which requires higher ECC protection and results in fewer P/E cycles and lower retention (Figure 2).

The 3D NAND cell increases density by stacking more NAND cells on top of each other (called tiers) without affecting the cell size. Micron 3D NAND also takes advantage of CMOS under the array (CuA), a feature that enables support of native TLC with an advanced featured called SLC mode. This enables customers to tune the 2100AI SSD to their application by selecting TLC for large amounts of static data and SLC for dynamic data.

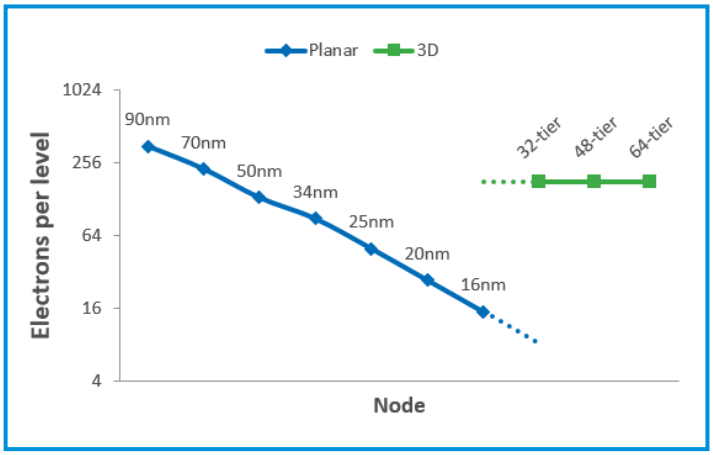

Figure 2: 2D (Planar NAND) vs. 3D NAND Scaling

Micron's 2100 AI/AT SSD

Micron's 2100 PCIe with NVMe industrial SSD, used in the Kontron COM Express modules, takes advantage of all the benefits of modern TLC NAND: better energy consumption, low latency, and high performance.

The 2100 SSD, available in 64GB to 1TB capacities in BGA and M.2 22x30 form factors, offers BoM control and long lifecycle. While industrial customers may be accustomed to SATA interface-based SSDs, Micron's 2100AI is a PCIe NVMe SSD solution. While PCIe NVMe is not a new solution and is widely supported across multiple processing chipset vendors, PCIe is a relatively new interface technology in the industrial segment. As with any new technology, concerns have been expressed regarding power consumption of PCIe-based SSDs.

While it may seem like a PCIe NVMe SSD consumes more power, real power consumption can be based on energy consumption (Figure 3). As seen from Micron's measured data across eMMC, UFS and PCIe storage products, PCIe x2 or x4 are similar to UFS in energy consumption vs. eMMC. In addition, NVMe allows for power limits thresholds for better granularity in real system usage models.

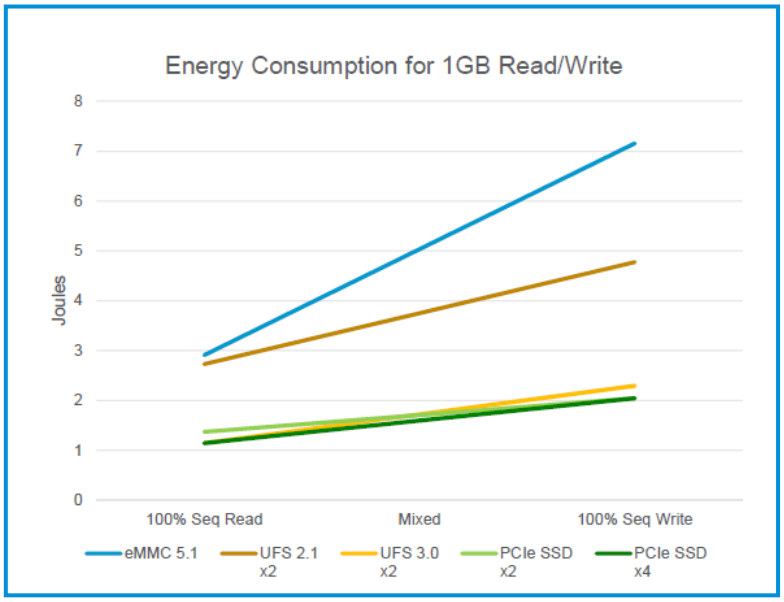

Figure 3: Energy Consumption Estimates Across Storage Interfaces

Additional benefits from NVMe PCIe solutions include low latency and high performance. As shown in Figure 4, the NVMe software stack has several benefits over the SCSI (UFS) stack. NVMe stacks are simpler with lower latency, providing greater than 15% and 25% improvement in system read and write speeds, respectively.

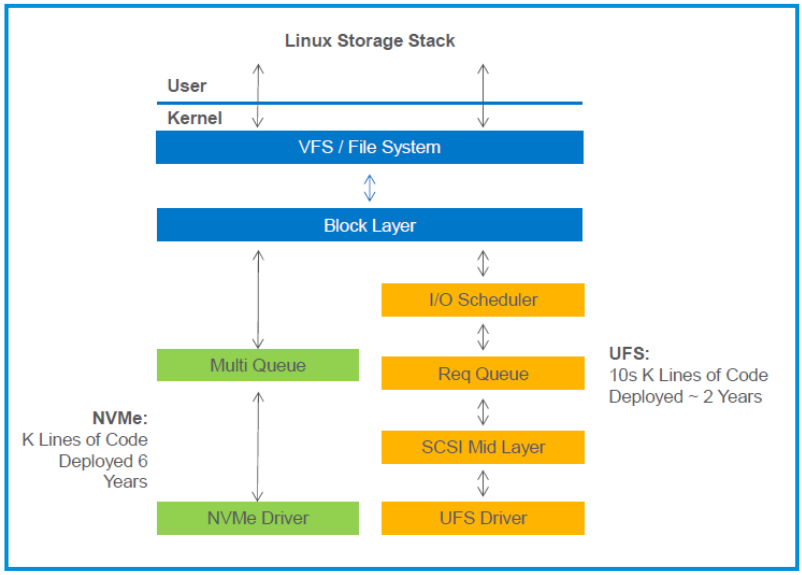

Figure 4: Software Stack Comparison – Lower Latency with NVMe[1]

High Endurance and Capacity Features

Designs that require high endurance can take advantage of application-specific features such as namespace, which is provided by PCIe NVMe SSDs. SLC mode allows an end user to define namespace 1 as high endurance SLC NAND. The namespace can redefine 10%, 20%, 30%, 40%, 50% or even 100% of the SSD NAND array to SLC mode. This innovative feature allows customers to take advantage of high endurance and high capacity simultaneously. When SLC is not being used, the data is partitioned into TLC.

In addition to having a removable M.2 form factor, the 2100 BGA SSD offers a highly ruggedized solution for industrial applications, enabling designs that can take advantage of up to 1TB storage space in one device. Systems requiring greater than 1TB can utilize multiple devices with the 16mm x 20mm package size.

Meeting Industrial Platform Requirements

Industrial SSDs are traditionally used in industrial applications such as factory automation, test and measurement, medical and transportation. However, the proliferation of edge computing and use of artificial intelligence (AI) in IIoT applications is driving a similar need for faster storage that is not supported by legacy interfaces like SATA and eMMC. Along with the performance benefits that NVMe provides, industrial customers should begin to consider Micron's industrial SSDs based on Kontron's COM Express® portfolio for their future industrial platform requirements.

Micron Industrial Quotient Valued Partner

Micron and Kontron are part of the Micron Industrial Quotient (IQ) partner program where industrial value propositions such as longevity, reliability, ruggedness, quality and application-specific features are the pillars of strength. For more information, visit: http://www.micron.com/IQ

1. Source: Elad Baram : PCIe/NVMe in Mobile Devices FMS 2015.