Optimize Efficiency with the Purpose-Built “Ruler” Form Factor

The “ruler” form factor is optimized for non-volatile memory in the data center.

Executive Summary

The “ruler” form factor is Intel’s groundbreaking solution to the many challenges facing data centers. Worldwide, data centers have had to rely on form factors that were not designed for the unprecedented needs of increasing data. By asking what they needed, and then rethinking SSDs from the standpoint of the form factor, Intel invented the new “ruler” form factor to directly meet data centers’ requirements for growing capacity, easy serviceability, and thermal efficiency.

The “ruler” form factor allows for previously unrealizable efficiency on multiple fronts: capacity, operations, and management. It limits downtime by simplifying management, and it serves easy expandability. By exploiting the dimensions of the 1U box used in server racks, it can help data centers reduce Opex. Because the “ruler” form factor serves the data needs of today and tomorrow, the Enterprise and Datacenter SSD Form Factor (EDSFF) workgroup is evaluating the new form factor as a soon-to-be industry standard.

The Challenges

Data centers face mountains of data on a daily basis. Yet, while the industry grapples with increasing volumes of data, data centers have had to rely on form factors that were designed upon the limitations of the past. Until now, no company had created a form factor that addressed data centers’ exacting needs for growing capacity, easy serviceability, and thermal efficiency in the face of exponentially growing data.

As an innovation leader, Intel took on the challenges of these data center requirements. Intel directly asked data center storage managers, cloud service providers, and hyperscale data center customers what was needed. The clear answer: as much capacity as possible in a 1U box; fully front serviceability; optimized thermal efficiency; and, a solution that drives down TCO.

Intel took customer input and created a revolutionary solution. Intel’s “ruler” form factor is the first to be optimized for non-volatile memory in the data center.

Legacy of Storage Form Factor Limitations

Before data centers, form factors were built to fit common forms, each limited in unique ways. The Add-in-Card started out as a PCIe*-based card for things like graphics, audio, and networking. It lacked hot plug support, and needed additional components such as cabling and connectors.

The U.2 form factor was designed to have the same dimensions of a 2.5in HDD because many mainstream servers still support HDDs and SSDs. As the U.2 remains the mainstream PCIe SSD form factor due to ease of use and serviceability, continuing to scale the capacity of SSDs in this U.2 form factor comes with thermal and performance tradeoffs and complex PCB designs.
M.2 was designed for client and mobile systems, like laptops and tablets, to be thin and light. While it has seen adoption in the data center for boot and in some hyperscale compute nodes, these drives have limited capacity because of the board size, and often require custom thermal solutions. The M.2 form factor also does not natively support hot-plug.

**Customer-Inspired Solution**

The new “ruler” form factor delivers high per-drive, per-server, and per-rack capacity. In addition, its efficient thermal design, integrated enclosure, latch, and LEDs improve overall manageability and serviceability, paving the way for a new direction in SSDs. The new purpose-built design represents a unique combination of technology innovation and common sense.

**Breakthrough Space-Efficient Capacity**

Customers told Intel they needed a form factor to maximize capacity while still fitting into a 1U server rack. The “ruler” form factor does this by first taking advantage of height at 38.6mm, the maximum the 1U can accommodate while still allowing for a hot swappable module. More PCB real estate of the “ruler” allows for more NAND media packages per SSD. A dense drive-to-drive pitch allows 32 drives across 1U, while still being thermally efficient.

**Operational Efficiency**

Data center customers wanted fully front serviceability and thermal efficiency. To address this, the “ruler” design allows for unimpeded airflow and a connector (“sail” or orthogonal type) that sits right behind the drive and connects down to the horizontal backplane, avoiding the vertical backplane designs that block airflow. Next, Intel used a single-PCB design that enabled all components to touch the case directly. Finally, there is a large surface area for the drive. As a result, the “ruler” form factor is 55% more thermally efficient than a 15mm U.2.1

By consolidating racks, using the “ruler” form factor, data centers can reduce their Opex. Warm storage use cases for HDDs often use 1TB and 2TB HDDs to get the required IOPS/TV needed to enable required performance levels for object and block storage. In this scenario, it takes an entire 42U rack of 2TB HDDs to reach 1PB of storage. But with a 32TB “ruler” form factor SSD, based on 64-layer, TLC, Intel® 3D NAND technology, the solution can deliver 1PB in 1U.

Transitioning to the “ruler” form factor from other legacy form factors allows customers to reduce server Capex. With high per-drive, per-server, and per-rack capacity. It provides improved manageability and serviceability in tandem with efficient thermal design to reduce maintenance costs and completely disrupt the total cost of ownership. The long and the short of it? The Intel “ruler” form factor is the measure of the future. For more information, visit intel.com/ssd

**Efficient Management at Scale**

Because Intel is committed to solution-level design, the “ruler” form factor provides fully front serviceable storage. This includes hot plug, hot removal, LED support, and a form factor that serves easy expansability.

The innovative “ruler” design also has integrated carrier, latch, and lights. Intel took extra caution to design the pin pitch to ensure robustness of the connector. The integrated programmable LEDs on the “ruler” form factor help to quickly locate failed drives, offline drives, and unpopulated slots. There is an LED for activity (input/output of data), status (warnings, temperature, failed drives), and to identify which slot a drive occupies.

**Conclusion**

Everything about the “ruler” form factor answers customer needs and has a purpose with an advantage. Built for data centers, it gives customers an SSD with high per-drive, per-server, and per-rack capacity. It provides improved manageability and serviceability in tandem with efficient thermal design to reduce maintenance costs and completely disrupt the total cost of ownership. The long and the short of it? The Intel “ruler” form factor is the measure of the future. For more information, visit intel.com/ssd