DELL Technologies NVIDIA

Pushing the boundaries of HPC

Durham University continues its legacy of HPC leadership with the deployment of new smart network interface controllers.

Durham University | Scientific Research | United Kingdom

ExCALIBUR

Business needs

Durham University and the DiRAC HPC facility need leading-edge high performance computing systems to power data- and compute-intensive scientific research.

Solutions at a glance

- Dell EMC PowerEdge C6525 servers
- 2nd Generation AMD EPYC™ processors
- NVIDIA® BlueField data processing units in SmartNICs

Business results

- Providing Durham and DiRAC researchers with world-class capabilities
- Accelerating UK computational cosmology and scientific computing research and time-to-discovery
- Keeping Durham University at the forefront of cosmology, theoretic foundations and algorithms in high-performance and scientific computing
- Staying at the forefront of technology, investigating potential exascale technologies

Durham continually pushes the boundaries of performance to get to the next big breakthrough

on the edge of innovation

NVIDIA BlueField data processing units provide software-defined, hardware-accelerated data center

infrastructure on a chip

Pioneering new technologies

High performance computing practitioners are always on the cutting edge of innovation, continually pushing the boundaries of performance to get to the next big breakthrough. This is very much the case at Durham University, a research-driven institution with a long legacy of HPC leadership.

The cost of data movement — in both runtime and energy — can be a showstopper on the road to exascale. As supercomputers and machine learning farms become faster, their interconnects grow to become a limiting factor. One way to improve them is to make them smart – to teach them how to route data flows, how to meet security constraints, or even how to perform specific tasks in the network. Smart network devices can take ownership of the data movement, bringing data into the right format before it is delivered, while contributing to security and resiliency.

The Durham Intelligent NIC Environment (DINE) supercomputer, part of the DiRAC memory intensive service at Durham University, is a 16-node cluster equipped with Dell EMC PowerEdge C6525 servers with new NVIDIA® BlueField® SmartNICs.These smart network interface cards enable the intelligent processing and routing of messages to improve the performance of massively parallel codes, in preparation for future exascale systems. They also provide researchers with a test-bed to develop new computing and network paradigms.

Accelerating performance with new data processing units

The NVIDIA BlueField SmartNIC features the BlueField Data Processing Unit (DPU) — an innovative and high performance programmable networking engine. Providing unmatched scalability and efficiency, the dual-port BlueField SmartNIC is the ideal adapter to accelerate the most demanding workloads in data center, cloud, service provider and storage environments.

The Durham team is using BlueField SmartNICs to enable the intelligent processing and routing of messages and improve the performance of massively parallel codes. The DINE cluster is hosted alongside the COSMA supercomputer, and is used by computer science researchers, DiRAC researchers and international collaborators.

The research computing team deployed the BlueField technology in half-height, half-width SmartNIC cards. Each card is configured to operate in a host-separated mode, providing direct access to the Arm cores. Researchers can then launch HPC message passing interface (MPI) codes across the cluster, making use of both the AMD EPYC server processors and the Arm processors. This in turn frees the compute nodes from data transfer tasks and communication duties.

“The DINE supercomputer will allow researchers to probe novel technologies in preparation for running advanced codes on exascale machines,” Basden says. “It will enable a step change in model resolution in fields such as weather forecasting, climate change and cosmology, with a huge scientific benefit.”

To test the BlueField technology, the Durham team had to compile two versions of their code — one that executes on the server processors, and one that executes on the Arm cores. The team reported that recompiling the code for the Arm cores took seconds, while installing the necessary libraries took longer. However, they believe this will be faster in the future.

When they run a job across the DINE cluster, they direct MPI jobs to run on the SmartNIC instead of the CPUs, which allows the CPUs to carry on with their tasks without MPI interruptions. The SmartNICs can also handle unexpected messages (buffering), take over load-balancing or manage message replication to facilitate resilient algorithms.

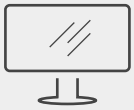
The team believes the technology has the potential to become mainstream. Along the way, faculty, staff, students, collaborators and other fundamental researchers will benefit from working with cutting-edge technologies that allow them to design algorithms and investigate ideas that will help redefine the future of HPC for facilities around the world, according to Tobias Wenzierl, Project Principal Investigator (PI) for DINE.

“We have been suffering from a lack of MPI progress and, hence, algorithmic latency for quite a while, and we have invested significant compute effort to decide how to place our tasks on the system,” Weinzierl says. “We hope that BlueField will help us to realize these two things way more efficiently. Actually, we started to write software that does this for us on BlueField.”

Based on the results at Durham University, the new NVIDIA BlueField SmartNICs are one step further on the journey to the infrastructure-as-code data center, where users can send a job out and have it run wherever it is most optimized for performance and efficiency. Such flexible solutions require algorithmic re-development using novel installations such as Durham’s DINE, and they require interdisciplinary cooperation between industry partners, computing centers such as DiRAC, application domain specialists and theoretical computer science. The DINE system is also leveraged by the ExCALIBUR program, aiming to redesign high priority simulation codes and algorithms to fully harness the power of future supercomputers, keeping UK research and development at the forefront of high-performance simulation science.

Durham Intelligent NIC Environment (DINE)

The Durham Intelligent NIC Environment (DINE) supercomputer is a small cluster equipped with NVIDIA Mellanox SmartNICs.These SmartNICs enable the intelligent processing and routing of messages to improve the performance of massively parallel codes, in preparation for future exascale systems, and provides researchers with a test-bed facility development of new and novel computing paradigms in fields such as weather forecasting, climate change and cosmology, with a substantial scientific benefit.



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