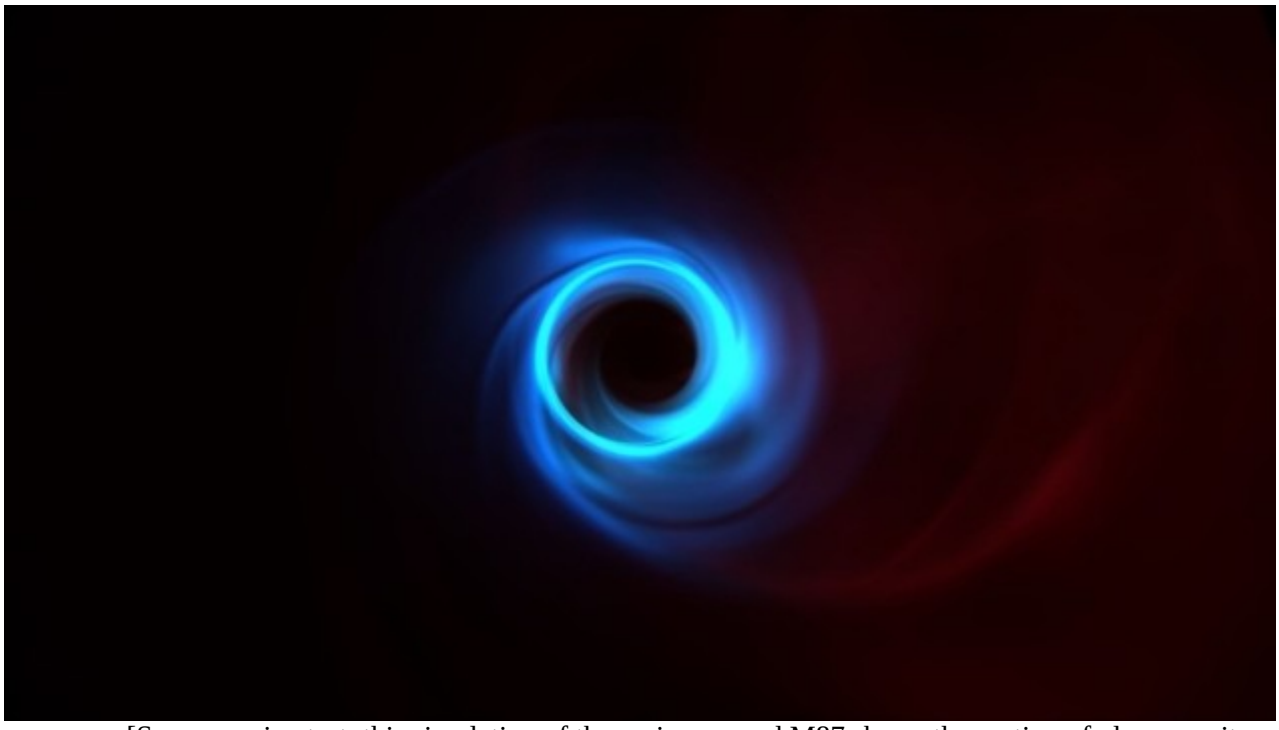
High Performance and Quantum Computing



[Supermassive test: this simulation of the region around M87 shows the motion of plasma as it swirls around the black hole. The bright thin ring that can be seen in blue is the edge of the shadow. (Courtesy: L Medeiros/C Chan/D. Psaltis/F Özel/University of Arizona/Institute for Advanced Study) - Physicsworld]

- The Future of High Performance Computing

High-performance computing (HPC) utilizes supercomputers and parallel processing techniques to quickly complete time-consuming tasks or complete multiple tasks simultaneously. Technologies such as edge computing and artificial intelligence (AI) can broaden the capabilities of HPC and provide high-performance processing power for various fields.

In the age of Internet computing, billions of people use the Internet every day. Therefore, supercomputer sites and large data centers must simultaneously provide HPC services to massive Internet users. We must upgrade our data centers with fast servers, storage systems, and high-bandwidth networks. The aim is to leverage emerging new technologies to advance web-based computing and web services.

The general computing trend is to take advantage of shared network resources and the vast amount of data on the Internet. Trends in parallel, distributed and cloud computing with clusters, MPPS (massively parallel processing), P2P (peer-to-peer) networks, grids, clouds, web services, IoT, and even quantum computing.

Data has become a driving force for business, academic, and social progress, driving significant advances in computer processing. By 2025, an estimated 463 exabytes of data will be created globally every day. High-performance computing (HPC) presents new opportunities to address emerging challenges in these areas as organizations embrace a "data-everywhere" mentality.

HPC is a discipline in computer science in which supercomputers are used to solve complex scientific problems. As HPC technologies have grown in computing power, other academic, government, and commercial organizations have adopted them to meet their needs for fast computing. Today, HPC dramatically reduces the time, hardware, and cost required to solve mathematical problems critical to core functionality. As a mature field of advanced computing, HPC is driving new discoveries in disciplines such as astrophysics, genomics, and medicine; it is also driving business value in unlikely industries such as financial services and agriculture.

- Supercomputing Technology

Supercomputers play an important and growing role in various fields of national importance. They are used to solve challenging scientific and technical problems. "Supercomputer" is an umbrella term for computing systems capable of supporting high-performance computing applications requiring large numbers of processors, shared or distributed memory, and multiple disks.

A supercomputer is a computer with the architecture, resources, and components to enable massive computing power. Today's supercomputers consist of tens of thousands of the fastest processors capable of performing billions and trillions of calculations or calculations per second.

Supercomputer performance is measured in floating point operations per second (FLOPS) rather than millions of instructions per second (MIPS). As of today, 500 of the fastest supercomputers in the world run Linux-based operating systems.

Supercomputers are primarily designed for businesses and organizations that require large amounts of computing power. Supercomputers combine the architectural and operational principles of parallel and grid processing, where a process executes simultaneously on thousands of processors or is distributed among them.

Supercomputing technology has indelibly changed the way we approach the world's complex problems, from weather forecasting and climate modeling to keeping our nation safe from cyberattacks. All the most powerful supercomputers in the world now run on Linux.

- Linux and Supercomputing

Linux dominates supercomputing. The Linux operating system runs all 500 of the fastest supercomputers in the world, which helps advance artificial intelligence, machine learning and even COVID-19 research.

While most modern supercomputers use the Linux operating system, each manufacturer makes their own specific changes to the Linux derivatives they use, and no industry standard exists, in part because differences in hardware architecture require changes to be tailored to each The hardware design optimizes the operating system.

Why do supercomputers use Linux? After seeing the expert opinion, let's detail the characteristics of Linux that make Linux the best choice for supercomputers:

- Modularity of Linux
- General properties of the Linux kernel
- Scalability
- Open source nature
- Community support
- Cost

Given that modern massively parallel supercomputers typically separate computation from other services by using multiple types of nodes, they typically run different operating systems on different nodes, for example using small, efficient lightweight cores such as compute node cores (CNK) or Compute Node Linux (CNL) is a Linux derivative on compute nodes, but on larger systems such as servers and input/output (I/O) nodes.

- Quantum Science and Technology

Quantum science stems from the study of the smallest objects in nature. Today, it promises to deepen our understanding of the universe and provide breakthrough technologies ranging from quantum computers to ultra-precise measurement devices to next-generation materials.

Learn about fundamental concepts in the field of quantum science, including superposition, entanglement, and the uncertainty principle. Learn how quantum principles and our understanding of them can be used to benefit society and facilitate new research across disciplines.

Technologists are now exploring the power of quantum computers, which are 100 million times faster than any classical computer and theoretically capable of solving computational problems considered impossible today. The appeal of quantum computers is their promise to help quickly answer such difficult questions that today's computers take decades to solve.

[Alberta, Canada]

- Quantum Computing and Quantum Supremacy

Quantum computing is a fundamentally different approach to computing than the type of computing we do today on laptops, workstations, and mainframes. It won't replace these devices, but by leveraging the principles of quantum physics, it will solve specific and often very complex problems of statistical nature that current computers struggle to solve.

Quantum computers process information millions of times faster than classical computers. By 2030, the quantum computing market is expected to reach $64.98 billion. Companies like Microsoft, Google and Intel are racing to build quantum computing tools.

A quantum computer is an amazing device. While its applications are still limited at the moment, we now know that it can be faster than the fastest computer we can currently use. Quantum supremacy (also known as quantum supremacy) is the point at which quantum machines surpass classical computers.

Quantum computers are not meant to replace typical computers. In practice, they will be stand-alone tools for solving complex, data-heavy problems, especially those leveraging machine learning, where systems can make predictions and improve over time.

- The Future of Quantum Computing

Quantum computers have four fundamental functions that differ from today's classical computers: (1) quantum simulation, in which quantum computers model complex molecules; (2) optimization (i.e., solving multivariate problems at unprecedented speed); (3) quantum Artificial intelligence, with better algorithms, can transform machine learning in different industries like pharma and automotive; (4) Prime factorization, which can revolutionize encryption.

There are four types of quantum computers currently under development that use:

- light particles
- trapped ions
- superconducting qubit
- Nitrogen vacancy centers in diamonds

Quantum computers will enable many useful applications, such as being able to simulate many changes in chemical reactions to discover new drugs; developing new imaging techniques for healthcare to better detect problems in the body; or speeding up our design of batteries, new materials and flexibility The speed of electronics."

- The Way Forward: Bringing HPC and Quantum Computing Together

When approaching the design, development and integration of quantum computing solutions, it is important to keep in mind that for the foreseeable future, quantum computers will act as computing accelerators requiring substantial classical computing support.

The ultimate goal of a self-contained quantum computer is a laudable goal, but it's still far in the future. For now, the goal should be seamless interaction between quantum computers and existing HPC infrastructure.

To maximize the chance of a successful collaboration, it is best for the quantum computer to be on premises. That is, the quantum computer should be located at the HPC center.

[More to come ...]