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# Quantum Computing

## IBM and Fraunhofer team up to promote Quantum Computing in Europe

**Headlines:**

- The basics of Quantum Computing
- NVIDIA Brings CUDA to Arm, New Path to Exascale Supercomputing
- The world's biggest chip 1.2 trillion transistors
- Pleora and Lemay.ai Partner to Boost Real-Time Imaging Applications

# In this Edition:

## Cover Story:



## Headlines:




**Daniel Dierickx CEO & co-Founder and Acting Chief Editor at e2mos**

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# The basics of quantum computing—A tutorial

August 13, 2019
by Carolyn Mathas | EDN - Aspencore Network

In classic computing, uncertainty is unacceptable. With quantum computers, however, it's an asset. Quantum computers have an innate ability to learn about the world, dealing in probability, as they explore multiple answers to come up with complex decisions.

## What is quantum computing?

Quantum computers shine when solving involves number or data crunching with huge amounts of inputs. They are designed to tackle complex problems that would take supercomputers from days to being unable to solve. Quantum computers can simulate the universe's subatomic particles by speaking the same language as an electron or proton. We're at the beginning of the quantum computing paradigm that is expected to have a major impact on our grasp of chemistry, biology, and physics.

While interestingly, they are not universally faster than classical computers, they do perform specific types of calculations faster. Each operation may not be faster, however the number of operations necessary to arrive at a result using particular algorithms is exponentially small.

## How it works—The basics

We're all used to binary computers based on processors using transistors to perform calculations. On, off, one, zero…pretty predictable. The game changes completely however, with quantum computers. In this realm, the processing and storage of 1's and 0's of classical systems give way to qubits or quantum bits as the fundamental building block of quantum information, experienced as a two-state quantum-mechanical system. The power of these qubits is their inherent ability to scale exponentially so that a two-qubit machine allows for four calculations simultaneously, a three-qubit machine allows for eight calculations, and a four-qubit machine performs 16 simultaneous calculations.

The basic properties of quantum computing are superposition, entanglement, and interference.

**Superposition** is the ability of a quantum system to be in multiple states simultaneously. The go-to example of superposition is the flip of a coin, which consistently lands as heads or tails—a very binary concept. However, when that coin is in mid-air, it is both heads and tails and until it lands, heads and tails simultaneously. Before measurement, the electron exists in quantum superposition.

**Entanglement** as a quantum property is taking objects and connecting them by permanently entangling them together. When adding an additional qubit to a quantum computer, a 50-cubit quantum machine can examine two to the power of 50 states simultaneously. The increase in power plus the entanglement of qubits allows quantum computers to solve problems efficiently, finding a solution faster, with many fewer calculations.

**Interference** can be used to control quantum states and amplify the signals that are leading toward the right answer, while canceling signals that are leading to the wrong answer.

**Coherence/decoherence:** Quantum computers are extremely sensitive to noise and environmental effects. Unfortunately, information only remains quantum for so long. The number of operations that can be performed before the information is lost, therefore, is limited. Knowing in advance how long quantum information will last before it is out of coherence is critical.

Quantum chips must be kept colder than outer space to create superpositions and entanglement of qubits and retention as long as possible. Communication with qubits that are inside a dilution refrigerator is accomplished by using calibrated microwave pulses so that the qubit is put into a superposition, or the qubit's state is flipped from 0 to 1 by applying a microwave pulse between two qubits. Microwave signals are also responsible for entanglement. In order to find a solution, parts of a problem are encoded into a complex quantum state and that state is manipulated, driving it closer to a solution—but it will take multiple operations to get to the best solution.

When quantum computers provide an answer, it is in the form of a probability. When the question is repeated, the answer changes. The more times the question is repeated, the closer the response comes to theoretical percentage or correct answer. This requires that the code be designed so that the qubits are in the correct state for a given problem. Quantum code uses wave-like properties that cancel out wrong answers and amplify the correct ones.


**Editor's Note:** This article is part of an AspenCore Network Special Project on quantum computing that aims to provide you with a starting point for assessing this emerging technology and its potential impact on your business.
Other articles cover what's next, powering the quantum computer, and supercomputers.
**Click the logo** to see a list of other Special Projects that we've done thus far.

... to next page

# The basics of quantum computing—A tutorial

... from previous page

## Applications

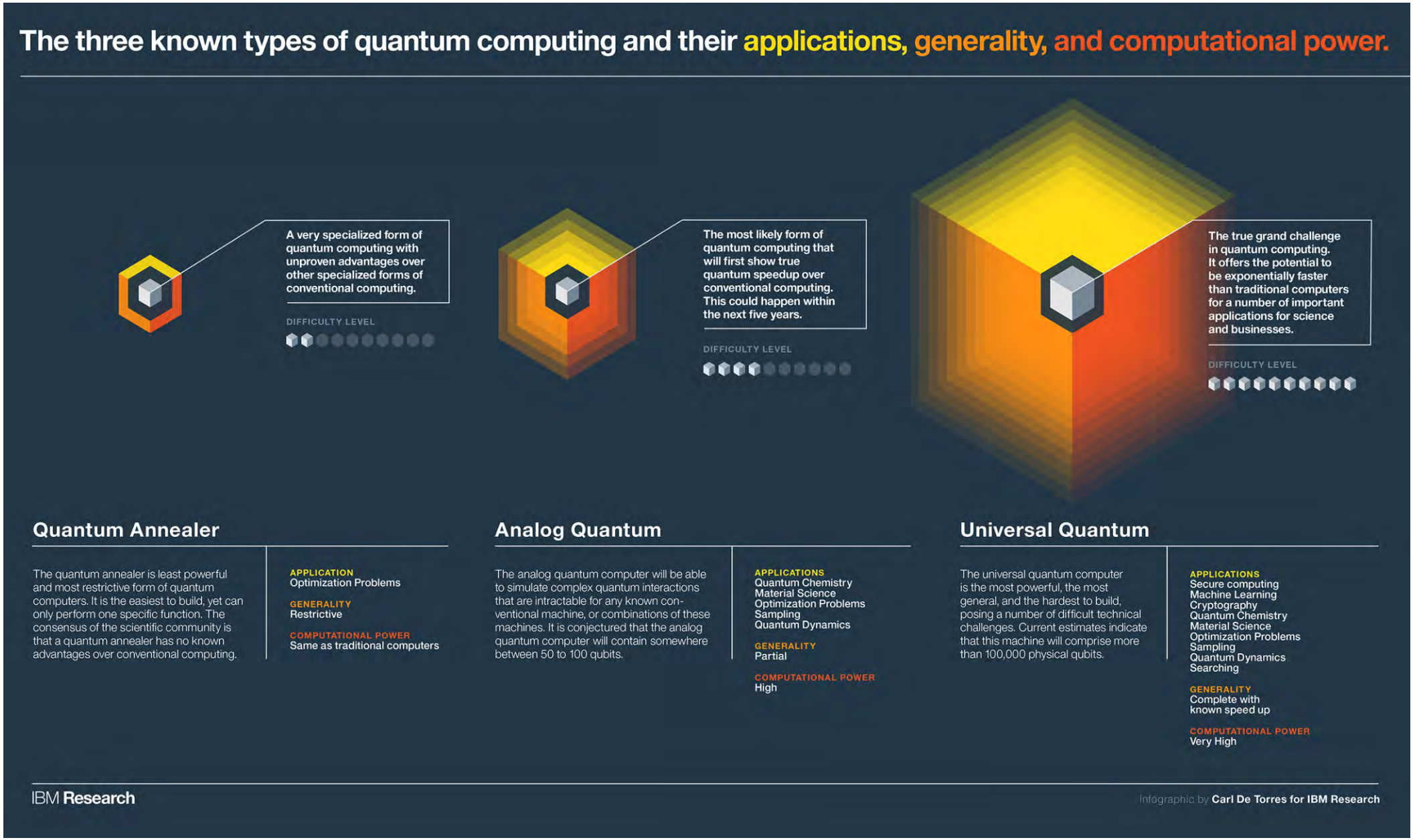
As the technology develops, quantum computing could lead to significant advances in numerous fields, from chemistry and materials science to nuclear physics and machine learning.

Top applications include:

- –Machine learning
- –Super-catalyst design
- –Medicine
- –Chemistry
- –Climate change/Earth science
- –Battery chemistry
- –Material science
- –Engineering
- –Artificial intelligence
- –Information security
- –Biomimetics
- –Energy
- –Photovoltaics
- –Financial services
- –Supply chain and logistics


... to next page

# The basics of quantum computing—A tutorial ... from previous page




... to next page

# The basics of quantum computing—A tutorial

... from previous page

## Get your hands on it

So, how do you start out with quantum computing? According to Dr. Marco Pistoia, IBM's distinguished research staff member, and senior manager, Quantum Computing Software, IBM Research, "Engineers should first familiarize themselves on the fundamentals of quantum computing, such as the concepts of superposition and entanglement."

Online courses, including several that are free, are beginning to spring up, via the cloud. Whether you need to harness the technology for the future of your career, or you're just curious about its capabilities, you can get involved and try the technology out. Although this is really early into the development of the technology, access to quantum computers is available globally. Here are a few to get started on.

## IBM

"To make quantum computing more accessible to scientists, engineers, and even students, IBM launched the public, cloud-based IBM Q Experience, and the open source Qiskitplatform, through which it is possible to access real quantum hardware. Quantum programs can be written in Python," says Dr. Pistoia. "To date, more than 145,000 users have run more than 10 million experiments on IBM Q Experience systems and have published more than 170 related research papers. This broad, global interaction is crucial in the current so-called noisy intermediate-scale quantum (NISQ) era, where practitioners can already execute experiments on quantum computers and learn the quantum computing programming model." Don't be concerned about being a beginner; there are multiple user guides available, including one for beginners.

## D-Wave

D-Wave Systems Inc. works on an annealer architecture rather than universal superconducting technology. D-Wave'sLeap allows anyone to sign up and access one minute of free time on a cloud-connected 2000Q each month. Since quantum computing solves problems in milliseconds, including factoring large numbers, optimizing routes, or calculating molecular structures, a minute is a generous amount of time.

## Rigetti Computing

Rigetti's Forest SDK is a lightweight, downloadable SDK that incorporates a powerful QVM and runs on your local machine. It's a great way to get started with quantum programming and enables users to create quantum entanglement in less than 10 lines of code. Get started and access a variety of resources here.

## Where are we today?

Headlines consistently confirm rapid advances in the field of quantum computing. There are quantum critics in the wings and quantum supporters jumping on the bandwagon and naturally, venture capitalists have their checkbooks out even though quantum computing has yet to perform anything that could not have been done on classic computers.

Companies involved represent the who's who in technology. IBM, Google, Intel, Microsoft, D-Wave Systems, and Rigetti Computing represent only a handful. The industry is wide open for startups as well.

D-Wave Systems Inc. offers a unique quantum annealing approach for applications requiring decision making based on high levels of reasoning. Their solution returns the lowest possible energy solutions by focusing on optimization. D-Wave recently announced their least "noisy" entry, the Pegasus, and also offers the real-time online quantum computing environment Leap. Leap is the latest addition to D-Wave Quantum Cloud Services that virtualize quantum computing for almost anyone with a computer and a broadband connection to use.

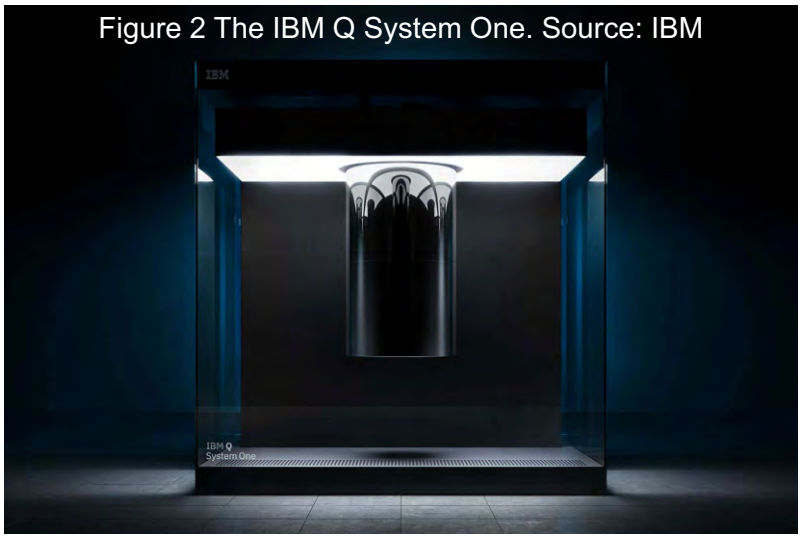
Although Intel was not an early player, it is making strides in the segment. Two recent contributions include Tangle Lake, and a full silicon wafer of test chips, each containing up to 26-qubits that rely on the spins of individual electrons being tested at Delft University of Technology, in The Netherlands.

... to next page

# The basics of quantum computing—A tutorial

... from previous page

Figure 2 The IBM Q System One. Source: IBM




Earlier this year, IBM announced the industry's first commercial system, theQ System Oneonly available toIBM Q Network organizations. The IBM Q introduces programmable universal quantum computing through the cloud-based IBM Q Experience and the commercial IBM Q Network platform for business and science applications. The company claims its Q System One is a step forward for both stability and commercial research. It is also partnering with Exxon Mobil on a network that could be used for predictive climate models and electric grid management.

On the heels of Google's 72 qubit Bristlecone quantum processor available in the cloud and Cirq, an open-source framework for running algorithms on the quantum computers, Google also released OpenFermion, a platform for developing quantum algorithms for chemistry problems, and OpenFermion-Cirq, an open-source library which compiles quantum simulation algorithms to Cirq. Google claims that Bristlecone will soon achieve quantum supremacy, when a quantum device performs a task a classical supercomputer cannot complete in a reasonable amount of time.

Rigetti Computing's new Quantum Cloud Service (QCS) includes Forest, a software toolkit for quantum programming in the cloud. Rigetti also unveiled what it claims is the world's most powerful quantum processor, a 128-qubit model that tops Google's 72-qubit Bristlecone chip. To start, QCS users will be limited to a 16-qubit chip and the service will also be limited to certain customers and partners of Rigetti, becoming widely available later in 2019. The processor enables quantum algorithms to run 20 to 50× faster on its QCS than on its current cloud setup, speeding up soon after. Rigetti also says that it found a sweet spot where qubits are less sensitive to noise, operating a two-qubit gates with fidelities to 99.2%.

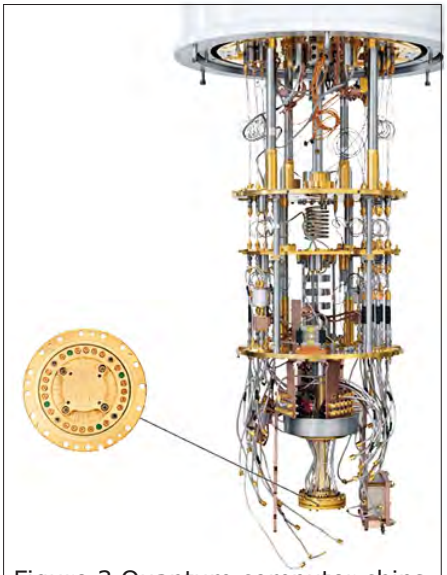


Figure 3 Quantum computer chips within a cryogenic environment. Image courtesy Rigetti Computing. Photo by Justin Fantl.

## Beyond supremacy

While excitement is justifiably high for the promise of quantum computers some say that a truly-relevant machine is likely decades away. Progress, however, is rapid, it may happen much faster. Moore's Law doesn't apply to quantum computing. Instead, quantum computers adhere to the laws of quantum physics, far from the realm of Moore, that might give us a hint to speed of development. According to a recent article in Quanta Magazine by Kevin Hartnett, Hartmut Neven, director of the Quantum Artificial Intelligence lab at Google, first coined Neven's Law by saying whereby quantum computers are gaining computational power relative to classical ones at a "doubly exponential" rate — staggeringly fast. Neven claims that for a while it looks like nothing is happening and then suddenly you've entered a different world.

From understanding the Big Bang, to providing number crunching across a wide-range of industries, quantum computing will continue to evolve at breakneck speeds. The time to access it and learn as it develops is now.

**Carolyn Mathas**
is a freelance technology writer/editor for a number of electronics publications and corporations.

First installation of an IBM quantum computer on European soil

# IBM and Fraunhofer team up to promote quantum computing in Europe

**Research News** | Berlin, September 10, 2019 – IBM (NYSE: IBM) and the Fraunhofer-Gesellschaft, Europe's leading organization for applied research, have today announced an agreement to set up a partnership that will advance research in the field of quantum computing. The aim of this cooperation is to develop expertise and new strategies for the use of quantum computing in industry and for applied processes.

Under the terms of the joint initiative, an IBM Q System One quantum computer is to be installed at a German location. It will be the first facility of its kind in Europe. The IBM Q System One is designed to perform multi-qubit operations to an extremely high level of quality, stability, reliability and reproducibility. These factors and the resultant large quantum volume – a measure of the power of a quantum computer – mean that the IBM Q System One is the ideal platform for state-of-the-art research into concrete quantum computing applications in science and industry.

Quantum computing promises to deliver the power required to analyze the complex systems of business and industry, to disentangle the convoluted interdependencies in molecular and chemical reactions, to master complex optimization problems and to significantly increase the performance of artificial intelligence. Such advances could open the door to new scientific discoveries and deliver enormous improvements in supply-chain management, logistics and the modeling of financial data and data for classic engineering problems.

The German federal government is to invest 650 million euros over the next two years to promote the advance of quantum technology from basic research to market-ready applications. The establishment of the Fraunhofer Center for Quantum Computing is in accordance with the objectives of the federal government's framework program. At the same time, it will provide the IBM Q Network with a major European hub for quantum computing. The focus here will be on achieving a unique concentration of quantum skills in Germany and building a community of researchers, developers, IT professionals and industry experts in this field.

This joint initiative between the Fraunhofer-Gesellschaft and IBM will bring together prominent partners from research and industry under the common roof of a new Fraunhofer competence center for quantum computing. To be known as the Fraunhofer Center for Quantum Computing, this facility will be operated and managed by the Fraunhofer-Gesellschaft, which already conducts research throughout the field of quantum technology at 14 of its institutes.

"Quantum technology is set to have a major impact on Germany's future, in both the scientific and economic sphere," says Germany's Federal Minister of Education and Research, Anja Karliczek. "Last year, the Federal Government therefore launched the program 'Quantum technology: from basic principles to market applications', which provides a clearly defined framework for action. Federal funds of 650 million euros will be invested in research and the development of quantum technology over the period until 2022. Fraunhofer-Gesellschaft's collaboration with IBM in the field of quantum computing can make an important contribution to the realization of this program. It is vital that we now begin developing various fields of application for quantum computing, not least for small and medium-sized companies, which play a significant role in the German economy."

"Bavaria will get a quantum computer – i.e., a computer that is very much faster than any of the current generation," adds the Bavarian Minister of Economic Affairs, Regional Development and Energy, Hubert Aiwanger. "Researchers from the renowned Fraunhofer-Gesellschaft are going to be cooperating with IBM. This state-of-the-art computer will provide a major boost for Bavarian research and industry, placing us at the very forefront of this sector."

"IBM has been in Germany for over 100 years and over that period has continuously invested in the country's digital future. Having its own quantum computer system will enable Germany to advance research, development and business in Europe and beyond," says Matthias Hartmann, general manager of IBM Germany. "It will bolster the country's position as a leading hub for technology and innovation."

"This partnership is a pioneering initiative in the field of applied quantum computing and marks a crucial advance for German research institutions as well as companies of all sizes in our country," explains Professor Reimund Neugebauer, president of the Fraunhofer-Gesellschaft. "The installation of an IBM Q System in Europe is unprecedented and will enable the development of new strategies for quantum computing, at the new Fraunhofer center, under full data sovereignty according to European law."

In cooperation with the IBM Q Network, the new Fraunhofer center will help harness the full potential of quantum computing. Participating companies will have access to IBM's advanced quantum systems via the IBM Cloud. Experts from industry and research require new skills and know-how in order to capitalize on quantum computing. As part of the IBM Q Network, companies will therefore receive support and training from industry-leading specialists at IBM.

# NVIDIA Brings CUDA to Arm, Enabling New Path to Exascale Supercomputing

Monday, June 17, 2019

*Global HPC Leaders Join to Support New Platform*

International Supercomputing Conference -- NVIDIA today announced its support for Arm CPUs, providing the high performance computing industry a new path to build extremely energy-efficient, AI-enabled exascale supercomputers.

NVIDIA is making available to the Arm® ecosystem its full stack of AI and HPC software — which accelerates more than 600 HPC applications and all AI frameworks — by year's end. The stack includes all NVIDIA CUDA-X AI™ and HPC libraries, GPU-accelerated AI frameworks and software development tools such as PGI compilers with OpenACC support and profilers.

Once stack optimization is complete, NVIDIA will accelerate all major CPU architectures, including x86, POWER and Arm.

"Supercomputers are the essential instruments of scientific discovery, and achieving exascale supercomputing will dramatically expand the frontier of human knowledge," said Jensen Huang, founder and CEO of NVIDIA. "As traditional compute scaling ends, power will limit all supercomputers. The combination of NVIDIA's CUDA-accelerated computing and Arm's energy-efficient CPU architecture will give the HPC community a boost to exascale."

"Arm is working with our ecosystem to deliver unprecedented compute performance gains and exascale-class capabilities to Arm-based SoCs," said Simon Segars, CEO of Arm. "Collaborating with NVIDIA to bring CUDA acceleration to the Arm architecture is a key milestone for the HPC community, which is already deploying Arm technology to address some of the world's most complex research challenges."

According to the Green500 list released today, NVIDIA powers 22 of the world's 25 most energy-efficient supercomputers.

Key factors making this possible are: the ability of NVIDIA GPU-powered supercomputers to offload heavy processing jobs to more energy-efficient parallel processing CUDA® GPUs; NVIDIA's collaboration with Mellanox to optimize processing across entire supercomputing clusters; and NVIDIA's invention of SXM 3D-packaging and NVIDIA NVLink® interconnect technology, which allows for extremely dense scale-up nodes.

NVIDIA's support for Arm-based HPC systems builds on more than 10 years of collaboration. NVIDIA uses Arm for several of its system on a chip products available for portable gaming, autonomous vehicles, robotics and embedded AI computing.

## Strong Ecosystem Support

World leaders of the HPC industry and Arm ecosystem, including supercomputing centers and systems providers and system-on-a-chip manufacturers, have voiced their support.

"Our customers are looking for high-performance, Arm-based processors to run their most demanding workloads. We are thrilled that NVIDIA is moving CUDA and the rich ecosystem built around NVIDIA to Arm. This will accelerate our work in building out the software ecosystem for Arm-based servers and enable breakthrough Ampere platforms with NVIDIA GPUs for efficiency and performance."
— Renee James, chairman and CEO, Ampere Computing

"Atos is a pioneer in the ARM ecosystem through the Montblanc project and an Arm computing blade design available for the exascale supercomputers, BullSequana X. We are really pleased to support NVIDIA's major announcement to turbo-boost Arm, which will accelerate the convergence of the AI and simulation worlds while optimizing energy efficiency."
— Pierre Barnabé, senior executive vice president, head of Big Data & CyberSecurity Division, Atos

... to next page

"At Cray our vision for the exascale era is systems that integrate AI and analytics with modeling and simulation, systems that enable and often require a diversity of processor architectures and systems that are built for data-intensive workloads required in science, engineering and digital transformation. We are excited to partner with NVIDIA to help realize this vision in our supercomputers by leveraging their CUDA and CUDA-X HPC and AI software stack to the Arm platform and integrating it closely with our Cray system management and programming environment (compilers, libraries and tools) already enabled to support Arm processors across our XC and future Shasta supercomputers."
— Peter Ungaro, president and CEO, Cray

"EuroHPC enables European collaboration on high performance computing to advance research, innovation and industrial growth. We are very interested in testing NVIDIA's GPU-accelerated computing platform for HPC and AI on Arm as a potential building block for future pre-exascale solutions."
— Kimmo Koski, managing director, CSC

"The European Processor Initiative aims to endow the European Union with its own high-end, low-power, general purpose and accelerator solutions. EPI and SiPearl, its industrial hand, consider very positively the new possibilities offered by NVIDIA. The combination between the EPI Arm-based microprocessor and NVIDIA accelerator could make a perfect match for equipping building blocks in the future European exascale modular supercomputers."
— Philippe Notton, general manager, EPI

"Both NVIDIA and Arm leverage technologies that offer high performance computing customers greater levels of energy efficiency. NVIDIA's support for Arm complements our latest developments on the HPE Apollo 70, an Arm-based, purpose-built HPC system, and now, NVIDIA GPU-enabled. With the HPE Apollo 70 supporting a 2U GPU tray and multiple energy-efficient cooling options, we can further help the HPC industry address increasingly unsustainable levels of power consumption."
— Bill Mannel, vice president and general manager of HPC and AI, HPE

"The Jülich Supercomputing Centre is driving developments at the forefront of supercomputing and establishing modular technologies to make the best resources available most effectively to researchers in Europe to help them solve the world's greatest challenges. Particularly in view of the exascale systems planned for the coming years and the rise of large-scale AI calculations, NVIDIA's support of the Arm processor is a very exciting development, which is essential for the establishment of true modularity for supercomputers and composable data centers of the future. It will help to advance supercomputing in Europe."
— Thomas Lippert, director, Jülich Supercomputing Centre

"We are excited to work with NVIDIA and server OEMs to couple the CUDA-X platform and NVIDIA GPUs with the Marvell ThunderX2 family of server processors. The combination of ThunderX2's best-in-class 64-bit Armv8 performance and NVIDIA GPUs offers breakthrough levels of energy efficiency and application performance, enabling world-class HPC and AI solutions for exascale computing."
— Matt Murphy, president and CEO, Marvell

"As the leader in HPC networks, our InfiniBand and Ethernet technologies connect many of the largest supercomputers in the world, including the first generation of Arm-based systems. We look forward to continuing to work with NVIDIA to deploy our advanced 200Gb/s HDR and computational-networking technologies to optimize HPC and artificial intelligence workloads and to super-connect the next generation of Arm-based supercomputers."
— Eyal Waldman, founder and CEO, Mellanox Technologies

"We have been a pioneer in using NVIDIA GPUs on large-scale supercomputers for the last decade, including Japan's most powerful ABCI supercomputer. At Riken R-CCS, we are currently developing the next-generation, Arm-based, exascale Fugaku supercomputer and are thrilled to hear that NVIDIA's GPU acceleration platform will soon be available for Arm-based systems."
— Satoshi Matsuoka, director, Riken Center for Computational Sciences, and professor, Tokyo Institute of Technology

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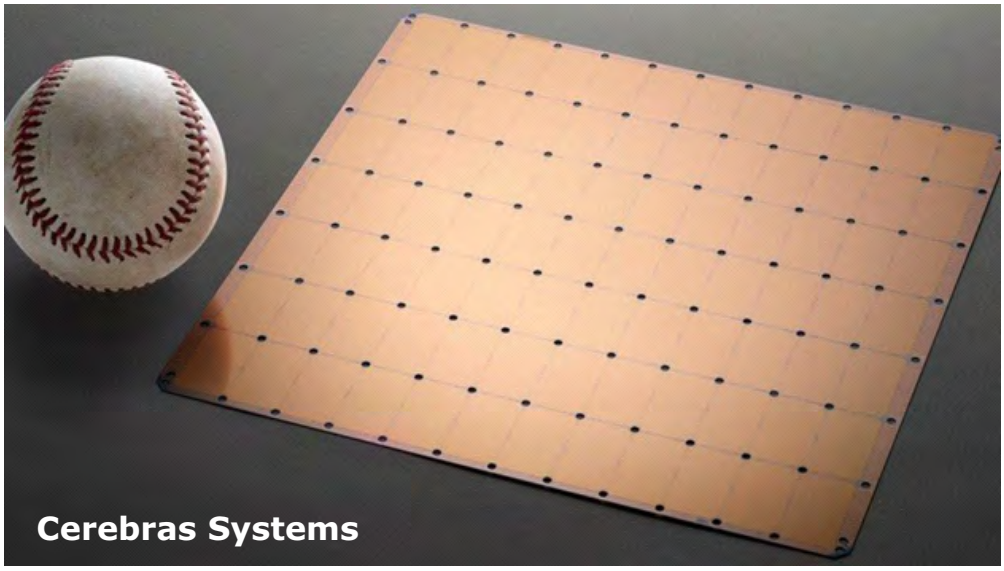
## About NVIDIA

NVIDIA's (NASDAQ: NVDA) invention of the GPU in 1999 sparked the growth of the PC gaming market, redefined modern computer graphics and revolutionized parallel computing. More recently, GPU deep learning ignited modern AI — the next era of computing — with the GPU acting as the brain of computers, robots and self-driving cars that can perceive and understand the world.

More information at http://nvidianews.nvidia.com/.

# The world's biggest chip is bigger than an iPad and will help train AI

Aug 20, 2019 | Martin Giles




*Cerebras Systems' new semiconductor boasts 1.2 trillion transistors and will turbocharge AI applications.*

**The news:** At the Hot Chips conference in Silicon Valley this week, Cerebras is unveiling the Cerebras Wafer Scale Engine. The chip is almost 57 times bigger than Nvidia's largest general processing unit, or GPU, and boasts 3,000 times the on-chip memory. GPUs are silicon workhorses that power many of today's AI applications, crunching the data needed to train AI models.

**Does size matter?** The world's semiconductor companies have spent decades developing ever tinier chips. These can be bundled together to create super-powerful processors, so why create a standalone AI mega-chip?

**Purpose-built for Deep Learning:**
**enormous compute, fast memory and communication bandwidth**

· 46,225 mm2 (215 x 215) chip 56x larger than the biggest GPU ever made
· 400,000 core 78x more cores
· 18 GB on-chip SRAM 3000x more on-chip memory
· 100 Pb/s interconnect 33,000x more bandwidth

The answer, according to Cerebras, is that hooking lots of small chips together creates latencies that slow down training of AI models—a huge industry bottleneck. The company's chip boasts 400,000 cores, or parts that handle processing, tightly linked to one another to speed up data-crunching. It can also shift data between processing and memory incredibly fast.

**Fault tolerance:** But if this monster chip is going to conquer the AI world, it will have to show it can overcome some big hurdles. One of these is in manufacturing. If impurities sneak into a wafer being used to make lots of tiny chips, some of these may not be affected; but if there's only one mega-chip on a wafer, the entire thing may have to be tossed. Cerebras claims it's found innovative ways to ensure that impurities won't jeopardize an entire chip, but we don't yet know if these will work in mass production.

**Power play:** Another challenge is energy efficiency. AI chips are notoriously power hungry, which has both economic and environmental implications. Shifting data between lots of tiny AI chips is a huge power suck, so Cerebras should have an advantage here. If it can help crack this energy challenge, then the startup's chip could prove that for AI, big silicon really is beautiful. **MORE:** Cerebras Systems

**Martin Giles**
I am the San Francisco bureau chief of MIT Technology Review, where I cover the future of computing and the companies in Silicon Valley that are shaping it. Before joining the publication, I led research and publishing at a venture capital firm focused on business technology.
Prior to that, I worked for The Economist for many years as a reporter and editor, most recently as the paper's West Coast-based tech writer. **MORE:** Martin Giles

# Pleora and Lemay.ai Partner to Boost Productivity and Profitability for Real-Time Imaging Applications

Ottawa, Canada — August 14, 2019: Pleora Technologies and Lemay.ai, respective leaders in sensor networking and artificial intelligence, today announced a strategic partnership that simplifies the introduction of machine learning capabilities into real-time imaging applications.

Pleora's hardware and software networking technologies interface imaging and data sensors with processing platforms and display panels in industrial, medical, and security & defense applications. Lemay.ai specializes in artificial intelligence (AI), machine learning, and deep learning techniques that augment human capabilities to optimize processes and boost profitability for enterprise and government clients.


With this partnership, Lemay.ai's AI expertise will be integrated directly into Pleora's smart frame grabber and embedded interface products and available as a configurable standalone SDK (software development kit) tuned for real-time vision applications. The companies will be demonstrating the integration of Pleora's RuggedCONNECT Network Video Processing Unit and Lemay.ai's tank detection AI for advanced battlefield awareness and decision support at DSEI (London, UK September 10-13, 2019, stand N3-504). The companies are also collaborating on smart imaging solutions integrating real-time sensor networking and machine-learning based object detection, tracking and classification for industrial automation systems.

"AI promises to significantly improve decision making and automation across all market served by real-time imaging, but designers are struggling with the cost and complexity of implementation," says Harry Page, President, Pleora Technologies. "Partnering with Lemay, we're significantly lowering the barrier to entry so designers and end-users can quickly and cost-effectively leverage the benefits of AI, machine learning, and sensor networking through drop-in hardware and software solutions."

"Our expertise is developing artificial intelligence capabilities that help optimize processes to meet business or mission objectives" said Daniel Shapiro, PhD, CTO at Lemay.ai. "Drawing on our collective experience across a range of industries, our team at Lemay.ai has perfected AI techniques that surpass traditional quality control and classification to identify previously unrecognizable defects on factory floors and deliver more detailed decision support capabilities for security and defense applications."

## About Pleora Technologies

Pleora Technologies invented high-performance frame grabbers and embedded hardware for the delivery of sensor data over Gigabit Ethernet, and leads the market in interfaces for USB 3.0. With this spirit of innovation, Pleora engineers reliable sensor interfaces for system manufacturers and camera companies serving the military, medical, and industrial automation sectors. Pleora provides end-to-end solutions that shorten time-to-market, reduce risk, and lower costs. We partner with our customers and tailor products to meet their individual needs.
Find out more at www.pleora.com.

## About Lemay.ai

Lemay.ai, is a specialized consultancy providing bespoke artificial intelligence, machine learning, and deep learning solutions. The company focuses on the development and rapid deployment of modular machine learning technologies in the fields of fintech, natural language understanding, and research and development. Lemay.ai is in the top tier of the Canadian government's AI supplier list, clutch.co's Clutch Leaders Matrix for "Top AI Developers in Canada", and is a member of the Canadian Association of Defence and Security Industries (CADSI).
Find out more at www.Lemay.ai