CASE STUDY

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Cornelis Networks and AMD team up to enable Lawrence Livermore National Laboratory to fight global pandemic

Meet Mammoth

CPU Architecture
AMD EPYC™ 7742 (2nd Gen)

Cores/Node
128

Total Cores
8,832

CPU Clock Speed
2.25 GHz

User-Available Nodes
Login Nodes – 2
Management Nodes – 1
Batch Nodes – 64
File System Router Nodes – 2

Memory Total
131,072 GB

CPU Memory/Node
2,048 GB

Peak Performance
294.0 TFLOPS

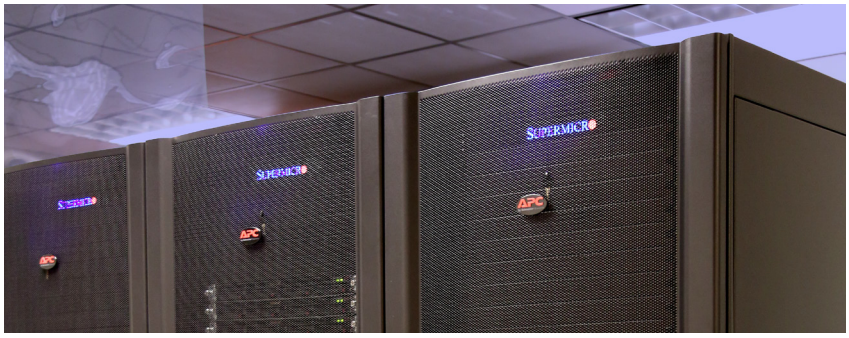
Local Storage/Node
3.84 TB SSD

Interconnect
Cornelis Omni-Path, 200 Gbps

OS
TOSS 3 / RHEL 7

Program
CARES Act

Year Commissioned
2020



CUSTOMER	Lawrence Livermore National Laboratory (LLNL)
INDUSTRY	Government/Scientific Research
CHALLENGE	To discover novel therapeutics for the COVID-19 virus in record time
SOLUTION AT A GLANCE	• 2nd Gen AMD EPYC CPUs • Cornelis™ Omni-Path™ • Supermicro rack servers and other accessories
RESULTS	• Reduced genomic analysis from a few days to a few hours • Accelerated COVID-19 research anti-body design throughput by a factor of eight[1]
TECHNOLOGY PARTNERS	AMD and Supermicro

Responding to a pandemic

The global collaborative response to the COVID-19 pandemic has been unprecedented. The vast amount of research, testing, and development required to produce potential drug therapies or a vaccine usually takes years. When responding to COVID-19, time was of the essence.

In 2020, the U.S. Congress passed the Coronavirus Aid, Relief, and Economic Security (CARES) Act. This legislation provided funding to Department of Energy (DOE) national laboratories to support research and development efforts related to COVID-19. One of the centers funded was the Lawrence Livermore National Laboratory (LLNL), part of the National Nuclear Security Administration (NNSA), a semi-autonomous agency within the U.S. DOE.

"AMD is proud to have supported this vital research being done by the team at LLNL with Mammoth in conjunction with our technology partners at Cornelis Networks and Supermicro."

Robert Hormuth, CVP
Architecture & Strategy, Data Center
& Embedded Solutions Group, AMD

At LLNL, the big memory cluster, Mammoth, is being used by scientists to perform genomics analysis and to aid the development of antiviral drugs and designer antibodies to neutralize the SARS-CoV-2 virus. To put things in perspective, LLNL researchers had to construct over 90,000 structural models that cover 14,000 human proteins and then use those models to complete extensive searches to identify functional sites (binding site pockets) in human proteins. Each of the structures are then screened against a created library of 1.9 million "pocket" templates. Mammoth is also conducting non-traditional HPC simulations and next-generation graph analytics related to genomics and other aspects of computational biology.

"The ability of large-memory systems to integrate genomic analysis with large-scale machine learning for predictive modeling of therapeutic response will be important for accelerating the development of effective new therapeutics." said Jim Brase, Deputy Associate Director for Computing, LLNL. **"Mammoth is integral to the development of new tools to combat COVID-19, but also for fast response in a future pandemic."**

Mammoth, a new breed of memory-dense HPC

Genomic Analysis

As part of the COVID-19 response, researchers at LLNL were tasked with processing huge amounts of data. This consumed valuable time. It became evident that designing a HPC cluster with a large memory capacity was key to shortening the genomic analysis time to result.

"Our long-standing partnership with Cornelis executives has allowed us to co-design and deploy systems optimized for the networking and I/O requirements of high performance computing, data analytics, and machine learning workflows."

Bronis de Supinski, CTO
High Performance Computing, LLNL

Through collaboration between LLNL, Cornelis Networks, AMD, and Supermicro, the HPC system Mammoth was born. The racks, servers, and motherboard were supplied by Supermicro, while the interconnect was provided by Cornelis.

Mammoth comprises 64 nodes outfitted with AMD EPYC 7742 CPUs. Each node includes two 64-core CPUs with 128 threads, features high memory bandwidth, and supports 2 terabytes (TB) of DRAM memory and nearly 4 TB of nonvolatile memory.

Anti-body Design

The extra memory afforded by Mammoth allows researchers to process data at a much higher rate. LLNL researchers are also applying Mammoth to the genome of the SARS-CoV-2 to analyze how the virus evolves and simulate how its structure changes when mutations are introduced.

"Cornelis is excited to continue our track record of successful collaboration with the team at Lawrence Livermore. Enabling Livermore's critical research efforts like those to eradicate COVID-19 are central to our mission as a company and we look forward to our continued partnership."

Gunnar K. Gunnarsson, Vice President of Solutions
Delivery and Support, Cornelis Networks

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Ground-breaking results

Deploying Mammoth dramatically decreased LLNL's standard genomic analysis run time for workflows from days to hours allowing researchers to focus on much larger workflows – using larger genomic databases or more accurate comparisons. This made those studies go from 'major heroic effort' to a more routine six week cycle.

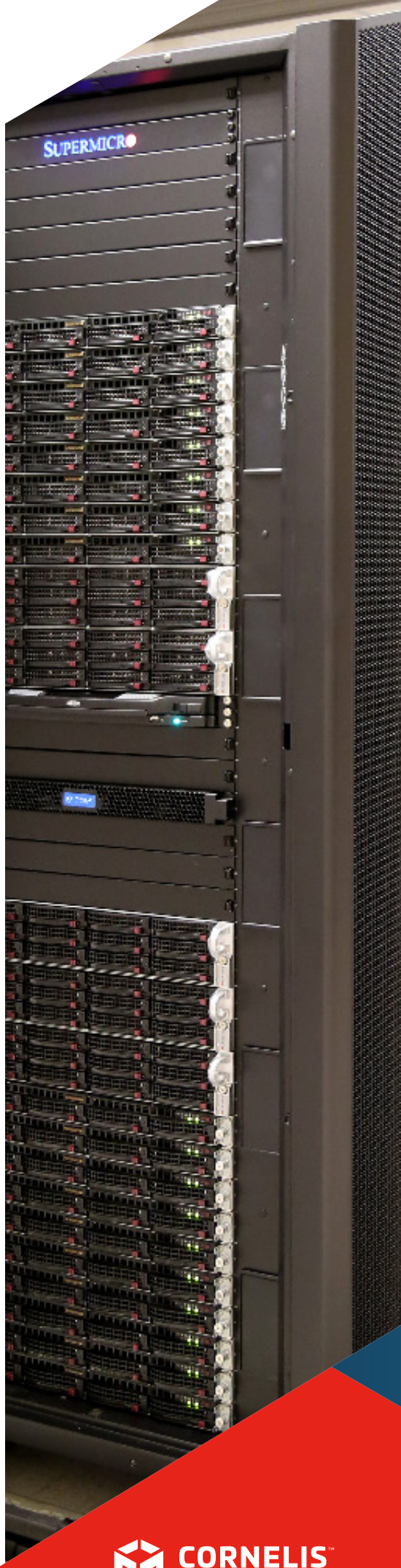
"Mammoth with 128 cores and 6TB of memory per node is extremely powerful. It allows me to perform genomic calculations faster and more efficiently, without the need for reruns. Running the complex, full design and analysis cycle now takes me just under six weeks which would normally take several months on previous systems."

"The Mammoth system further afforded analysis of large data sets without the need to split those datasets into smaller components, thereby accelerating our processing time from days to hours."

Adam Zemla, COVID-19 Researcher, LLNL

In addition, the Mammoth system was capable of running 128 Rosetta Flex calculations (code for computing binding free energies) simultaneously. This greatly accelerated research for SARS-CoV-2 antibody designs. The memory-dense clusters, along with the low latency and extreme message rates of the Cornelis Omni-Path fabric, assisted LLNL in increasing their anti-body design work throughput by a factor of eight.

The deployment of Mammoth in record time and the promising research findings it yielded were a bright spot for LLNL as the world watched the pandemic unleash itself. The big memory capacity proved to be ideal for running advanced simulations and research projects that involved large datasets to solve some of the pressing COVID-19 scientific challenges. Following these breakthroughs, LLNL is now looking at graph analytics as Mammoth's next critical workflow to help governments to track the spread of the virus.



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About Cornelis Networks

Cornelis Networks is a technology leader delivering purpose-built, high-performance fabrics accelerating High Performance Computing (HPC), High Performance Data Analytics (HPDA), and Artificial Intelligence (AI) workloads. The company's current and future product lines enable customers to efficiently focus the computational power of many processing devices on a single problem, simultaneously improving both result accuracy and time-to-solution for highly challenging application workloads. Cornelis Networks delivers its end-to-end interconnect solutions worldwide through an established set of server OEM and channel partners.

For more information, visit **cornelisnetworks.com**

About LLNL

Lawrence Livermore National Laboratory is a U.S. federal research facility based in Livermore, California. It is a premier research and development institution for science and technology applied to national security. It also applies its special expertise towards multidisciplinary capabilities including energy and environmental needs, scientific research and outreach, and economic competitiveness. Throughout its history, LLNL has been a leader in the use of computing for scientific discovery, starting with the purchase of one of the first UNIVAC computers. Its Sierra system is currently the third most powerful supercomputer in the world.

For more information, visit **llnl.gov**

About AMD

For more than 50 years AMD has driven innovation in high performance computing, graphics, and visualization technologies—the building blocks for gaming, immersive platforms, and the data center. Hundreds of millions of consumers, leading Fortune 500 businesses, and cutting-edge scientific research facilities around the world rely on AMD technology daily to improve how they live, work, and play. AMD employees around the world are focused on building great products that push the boundaries of what is possible.

For more information about how AMD is enabling today and inspiring tomorrow, visit **amd.com/epyc**

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1. This eight is a per node improvement vs. the previous best workhorse system for the antibody binding work. The user can turn around 128 simulations in 3 hours on a Mammoth node vs. 16 in 3 hours on an IvyBridge node. Note: On that system, cores were idled.

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