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Case Study:
UIC Utilizes Liqid Composable Infrastructure for Uneven Applications in Scientific Research

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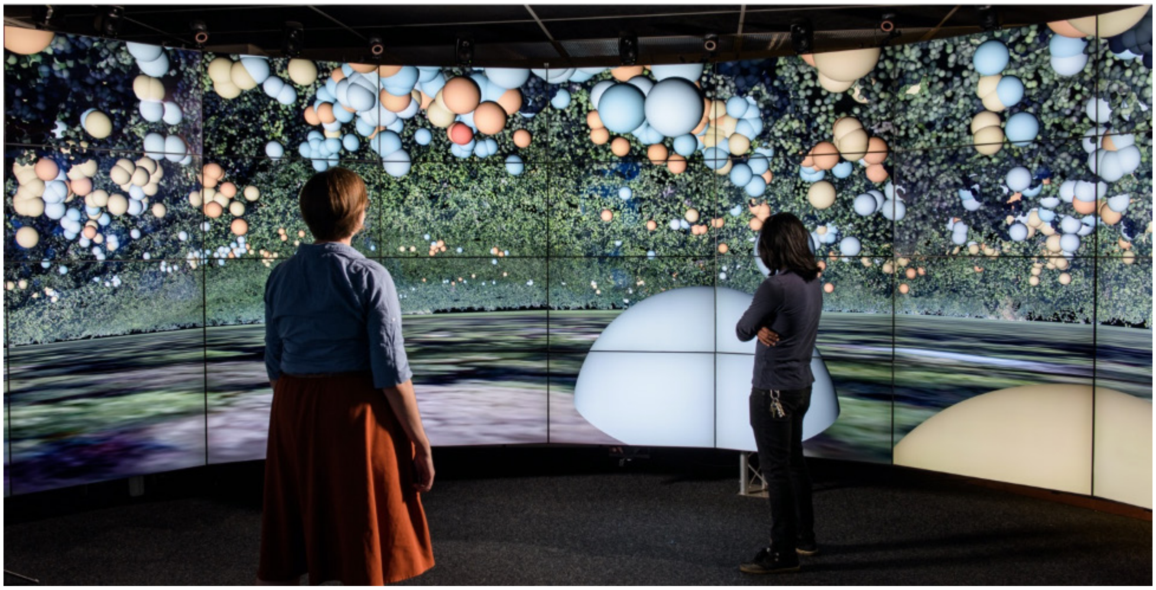

The SENSEI Panama ecology application will benefit from Composable Platform as a Service Instrument for Deep Learning & Visualization (COMPaaS DLV), which applies Deep Learning and Visualization to help anthropologists walk inside their data using virtual reality to study animal behavior. Data courtesy of UC Davis, visualized by EVL and displayed in EVL's CAVE2™. (Photo courtesy of Lance Long, EVL)

About The Electronic Visualization Laboratory (EVL) at the University of Illinois at Chicago (UIC)

An internationally renowned interdisciplinary research laboratory established in 1973, the Electronic Visualization Laboratory (EVL) specializes in research, development, deployment, technology transfer and training in visual data science – with a focus on high-performance visualization and collaboration environments, visual analytics, virtual reality, and advanced computing and networking cyberinfrastructure.

The mission of EVL is to bring together excellence in multiple domains – on campus as well as at other academic institutions, government research labs, companies and non-profits – and apply visual data science tools, techniques and technologies to problem solving, enabling greater insights and knowledge. EVL amplifies the impact of its core mission with its educational mission, applied to all workforce dimensions – education, training, advancement, and mentoring – for undergraduate and graduate students, collaborators and the general public.

"EVL has always looked 10-15 years into the future, and has a legacy of many successes," said Maxine Brown, EVL Director. "As technology enablers, EVL is driven by the needs of its collaborators, and has achieved successes in developing, disseminating and commercializing its hardware and software, in building international user communities who continue to collaborate with us, and in working with industry to help them be more competitive in the global marketplace. Given

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EVL's understanding of the diverse computing requirements of its collaborators, EVL faculty and staff identify new technologies, like Liqid's composable infrastructure, and then inquire how to use them in ways that companies had not intended, thereby educating vendors on the needs of the academic research and education market."

Challenge

Given the wide-ranging, multi-disciplinary, international nature of the lab's mandate, it is not surprising that EVL activities are broad in scope and include research and research training in deep learning, data mining and data analytics, computer vision, natural language processing, artificial intelligence, etc., which are often coupled with visualization (simulation, rendering, visual analytics, video streaming, and image processing).

> **"The Liqid support team has been fantastic. The team is very responsive and interested in learning from and solving the problems we're facing as a research and education institution, not just going through and trouble shooting."**
>
> LUC RENAMBOT, EVL ASSOCIATE RESEARCH PROFESSOR.

Multiple research teams require different topologies to reach their objectives, but are often limited by technology costs and choices. Applying GPU computing to massive datasets is often critical to reaching performance requirements. Limitations of available resources or poorly optimized infrastructure can often stall the pace of research. Not only are advancements in computational capability limited by legacy resource allocation, but valuable accelerator resources such as GPUs and FPGAs can sit idle. The inability to scale also affects the data center's footprint, leading to hardware sprawl and taxing finite university real estate.

While researchers could buy cloud services on their own, the cost for many is still prohibitive. EVL considered purchasing a cluster, but knew they needed a system that was flexible to meet their broad applications' demands, versus an overprovisioned cluster that is rigid, expensive, and destined to become unbalanced. EVL recognized that composable infrastructure would provide them with ease-of-use, scalability and resource agility, representing a new, adaptive platform that would address a variety of interdisciplinary research problems and enable UIC to maintain its leadership in deep learning and visual computing.

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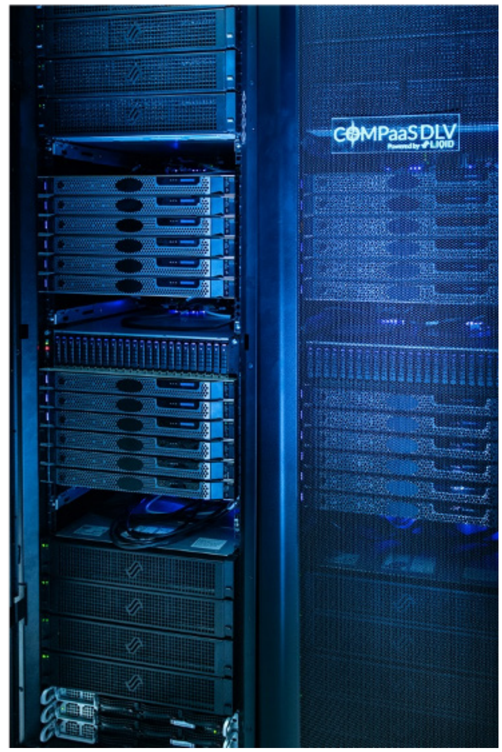
"Inflexible IT infrastructure has stalled some of our most exciting work in visual data science by limiting our ability to effectively scale to multiple GPUs and to other accelerator technologies," said Lance Long, EVL Senior Research Programmer. "Limited budgetary resources to address the problems requires us to spend significant time repurposing existing hardware as needed to address scalability and to adapt on-demand to application needs."

Solution

Led by EVL Director Brown, in 2018, a large team of research faculty from UIC's College of Engineering applied for and received a Major Research Instrumentation (MRI) grant from the National Science Foundation (NSF) for approximately $1-million to acquire a deep learning and visualization infrastructure.



EVL's COMPaaS DLV system. (Photo courtesy of Lance Long, EVL)

The design utilizes composable infrastructure architecture from Liqid. The computer's components (traditional processor, GPU, storage, and networking) are pooled so that different applications with different workflows can be run simultaneously, with each configuring the resources it requires almost instantaneously, at any time.

"EVL resources are traditionally very tailored to meet the requirements of specific applications. For example, on any given day, EVL may address everything from computational fluid dynamics, ecology and neuroimaging to natural language processing, urban engineering, robotics, visualization and visual analytics," said Long. "Liqid's composable infrastructure architecture is interesting because it allows us the flexibility to redefine cyberinfrastructure programmatically based on the applications' requirements. This enables the EVL team to create a data science platform that presents a full-stack hardware and software solution to the challenges faced by our researchers trying to deploy and scale reproducible experiments."

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Results

A non-composable architecture would limit UIC researchers to traditional cluster topology with 8 GPUs per server using specialized GPU chassis. However, many workloads do not efficiently utilize 8 GPUs or have very unbalanced resource requirements, which can vary at each step of a science workflow. Liqid composable infrastructure allows UIC to deploy a system comprised of 64 GPUs, 24 CPU nodes, NVMe storage, 100G networking and large memory pools (Intel Optane).

> "Many aspects of the composable fabric are interesting of themselves," said Renambot. "We can implement peer-to-peer GPU communications far more easily, as well as streamline remote data access activities and wide-area network applications, using the PCIe layer as internal networking fabric while pooling and deploying networking resources via composable software."
>
> LUC RENAMBOT, EVL ASSOCIATE RESEARCH PROFESSOR.

Kubernetes provides a responsive software-driven deployment architecture enabling rapid hardware discovery and job deployment. EVL engineers are working to introduce hardware composability to Kubernetes, enabling users to create containerized applications with policy-defined, reproducible hardware and software deployment. The application identifies the hardware required and directs the right amount of physical resources to handle the task.

"Liqid's architecture is designed to configure bare-metal hardware on demand. Leveraging Kubernetes's ability to detect available resources and extending the Liqid API allows us to have a container deploy only the resources – six GPUs and a 100 Gbps NIC, for example – that is required by the application," said Long.

"The Liqid system allows us to scale resources to address the problem at hand without costly delays. Because the system pushes resources to required applications, we are able to assess overall utilization and optimize, standardizing and automating hardware requirements in a fashion similar to the way we are able to do at the application level using Kubernetes," explained Long.

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Beyond enabling composability, Liqid is driving critical advancements in composable security, high-performance GPU to NVMe communication, NVMe-to-network communication and GPU-to-network communication.

"With composable infrastructure, we can get a good handle on what we need to accomplish today, while gaining a far more granular understanding of how to better tune and automate our architecture to address new problems as they emerge," continued Long.

A data visualization of a glass fissure molecular dynamics nanoscale simulation computed at Argonne National Laboratory's Leadership Computing Facility can be streamed to COMPaaS DLV over a high-performance network and simultaneously displayed with additional information on EVL's CAVE2™ hybrid reality display. (Photo courtesy of Lance Long, EVL)

The Liqid system is now being used to conduct data-intensive research into computational fluid dynamics, brain imaging techniques, streaming high-resolution data visualization to wall-sized displays and more. For EVL researchers, the future of visual data science is bright.

About Liqid

Liqid provides the world's most-comprehensive software-defined composable infrastructure platform. The Liqid Composable platform empowers users to manage, scale, and configure physical, bare-metal server systems in seconds and then reallocate core data center devices on-demand as workflows and business needs evolve. Liqid Command Center software enables users to dynamically right size their IT resources on the fly. For more information, contact info@liqid.com or visit www.liqid.com. Follow Liqid on Twitter and LinkedIn.

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