Moving HPC Workloads to Oracle Cloud Infrastructure

Zenotech partnered with Oracle to obtain the performance, scalability, and efficiency necessary for performance-intensive workloads

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INTRODUCTION

Zenotech Ltd. is a Bristol, U.K.-based company that provides cloud solutions for computational fluid dynamics (CFD). Aerospace companies, automotive manufacturers, civil engineering firms, and many types of scientific organizations use Zenotech's Elastic Private Interactive Cloud (EPIC) and novel zCFD solver to run performance-intensive CDF workloads.

CFD simulations are essential across a range of industries for concept studies, product development, troubleshooting, engineering design, and physical testing. Zenotech's knowledge of CFD helps customers obtain the best possible price/performance for studying fluid flow, airflow, and other physical phenomena. Most of its customers also conduct physical tests under real-world conditions, but performing digital tests reduces overall costs. The zCFD software and EPIC cloud brokerage service power CFD jobs such as modeling airflow over aircraft, vehicles, and buildings and simulating wake interactions among large arrays of wind turbines.

"HPC simulations require special platform characteristics that we can't guarantee in a shared environment," explains David Standingford, co-founder and director of Zenotech Ltd. "When we started out six years ago, we were looking for solutions to deliver our own capability without necessarily needing to buy our own HPC infrastructure. We needed solutions to deliver our engineering capabilities without incurring the overhead of buying and maintaining the latest hardware."

Zenotech chose Oracle as a partner for high performance computing (HPC) needs, and integrated EPIC with Oracle Cloud Infrastructure (OCI) to enable customers to run CFD jobs in a scalable cloud environment. Zenotech also makes use of Oracle Cloud as part of its internal software development process.

For Zenotech, OCI delivers performance, scalability, and control that are comparable to what can be achieved with dedicated, on-premises infrastructure. OCI includes bare metal compute instances, fast local and network storage, and performance SLAs. HPC teams can spin up new cloud instances in minutes, eliminating the need to provision, build, and manage in-house compute, network, and storage systems. With elastic configurations and near limitless capacity, EPIC customers experience tremendous operational flexibility and scalability with zero up-front capital investments.

"We invested in Oracle Bare Metal IaaS because it includes some of the latest hardware available anywhere in the world. By linking directly with Oracle infrastructure, our EPIC platform gains exceptional performance—and it's easy to use all that power because we have so much control over the cloud environment" - David Standingford, Co-founder and Director, Zenotech

"Fluid dynamics simulations require a large number of nodes, each with a large number of CPUs and lots of memory," says Mike Turner, a product lead at Zenotech. "Because these jobs are divided among multiple cores and run in parallel, having a fast, low-latency network is essential to achieving the necessary performance for long-running simulations. As a small company, we don't have access to large amounts of computing capacity, so we use cloud compute services from Oracle."

According to Turner, computational fluid dynamics and computational aerodynamics consume huge amounts of computing resources. It takes a lot of capital to purchase dedicated HPC clusters with thousands of compute nodes and very large core counts, connected by low-latency interconnects, and maintaining these infrastructures requires specialized knowledge and expertise. Oracle Cloud makes all this available on demand, which brings high-end HPC capabilities to small and many midsize companies. "That's why we went to an HPC-on-demand model," he adds. "Our customers only pay for capacity when they use it. It's relatively easy to tap into Oracle's HPC cluster to run HPC applications."

THE RIGHT CLOUD FOR HPC

Zenotech turned to Oracle Cloud to help them solve fundamental problems in running HPC jobs on cloud virtual machines (VMs) in multi-tenant configurations and shared infrastructure—the popular approach espoused by the incumbent cloud vendors. "A virtualized infrastructure does not provide full access to the hardware platform," Turner explains. "HPC jobs run best when they can use 100 percent of all designated CPUs. With Oracle's bare metal servers, we control the entire machine. Oracle was the first cloud vendor to provide this type of bare metal infrastructure in its cloud offering."

Today Oracle Cloud Infrastructure gives Zenotech and its customers the flexibility of cloud provisioning and pay-as-you-go pricing, combined with bare metal control of a hardware and software stack that has been optimized for high-performance computing.

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The bare metal compute instances in Oracle Cloud Infrastructure provide Zenotech with very large-memory nodes, suitable for vast CFD meshes, connected on a predictable low-latency network that allows them to scale both within and across availability domains. "What we really like about the bare metal offering from Oracle is that there is very little technology between us and the hardware," Standingford adds. "It's easy for us to use that power because we have so much control over the hardware layer."

USING EPIC FOR HPC

Zenotech's EPIC service is a gateway to high-performance computing resources. This unique HPC solution enables clients to run their jobs in Oracle's cost-effective, efficient, scalable HPC cloud platform. Users can easily login to the EPIC environment, upload their data to the cloud, then follow a few simple steps to set the parameters, such as how many cores they wish to use and how long they expect the job to run. An online dashboard lets them launch and control each job, monitor spending, and govern core usage.

EPIC customers tap into Oracle Cloud Infrastructure to run HPC workloads on cloud compute clusters that include up to 30 Oracle Bare Metal servers, each with 52 cores, 768 GB of RAM, and either local SSD storage or SSD block volumes. Customers can add storage and compute capacity on demand. When jobs complete, the users can scale the cluster down to avoid costs associated with resources that are not being actively used. Due to the elastic nature of the service, customers can configure and launch simulations on demand, and then halt jobs and delete their data at any time.

Most of Zenotech's customers have infrequent or unpredictable computing demands, so it doesn't make sense to maintain so much capacity in their own data centers. Zenotech partnered with Oracle to allow these customers to utilize large compute clusters with ample storage resources on an on-demand basis. Zenotech's knowledge of the infrastructure helps customers get the most out of each HPC test and simulation. "The software is ready to go on the Zenotech portal," says Standingford. "Oracle Cloud helps us make it as easy for them as we possibly can."

Customers can use the EPIC dashboard to monitor these simulations and allocate costs to specific jobs run in Oracle Cloud—something that Standingford says is not particularly easy to do with other systems. "Oracle's adoption-based model is less expensive if you use enough of it, plus you open yourself up to all sorts of other process improvements like training, integration, and metering the cost of your engineering services—not to mention always having as much power as you need for any given task," he explains. "Our customers are not constrained, and they don't pay for more capacity than they use."

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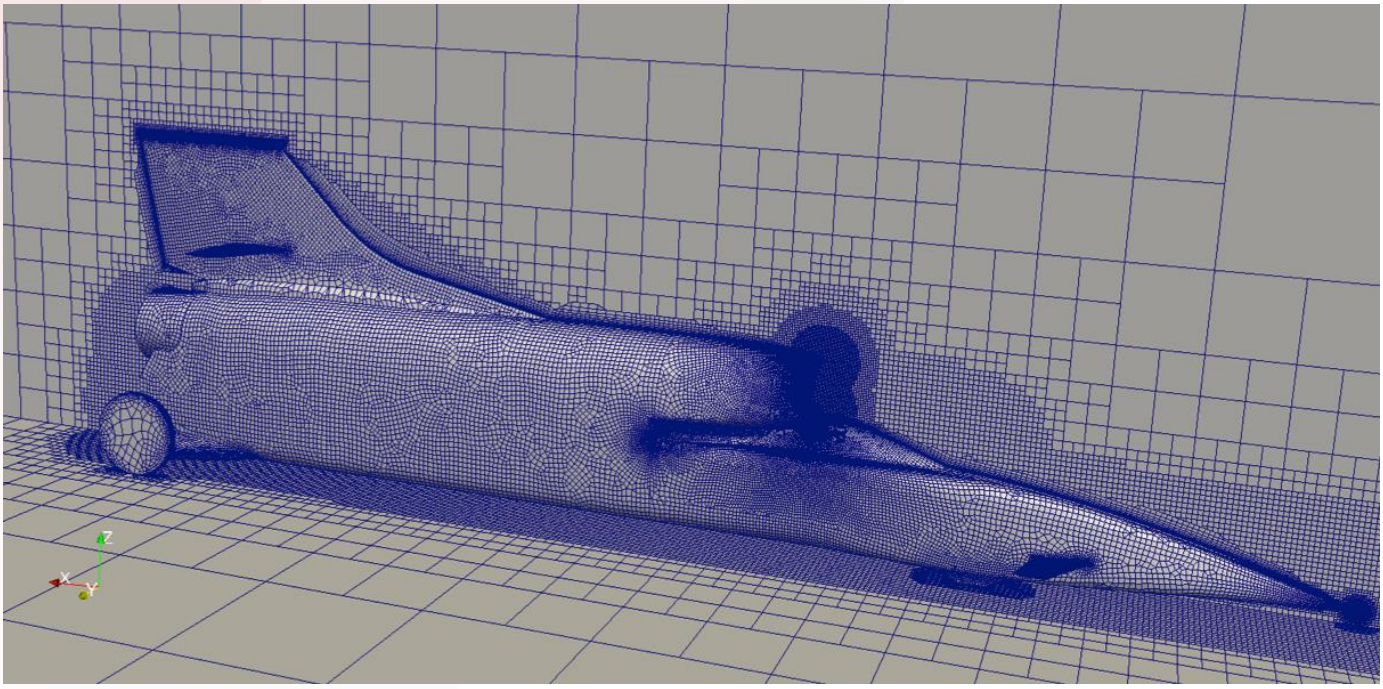
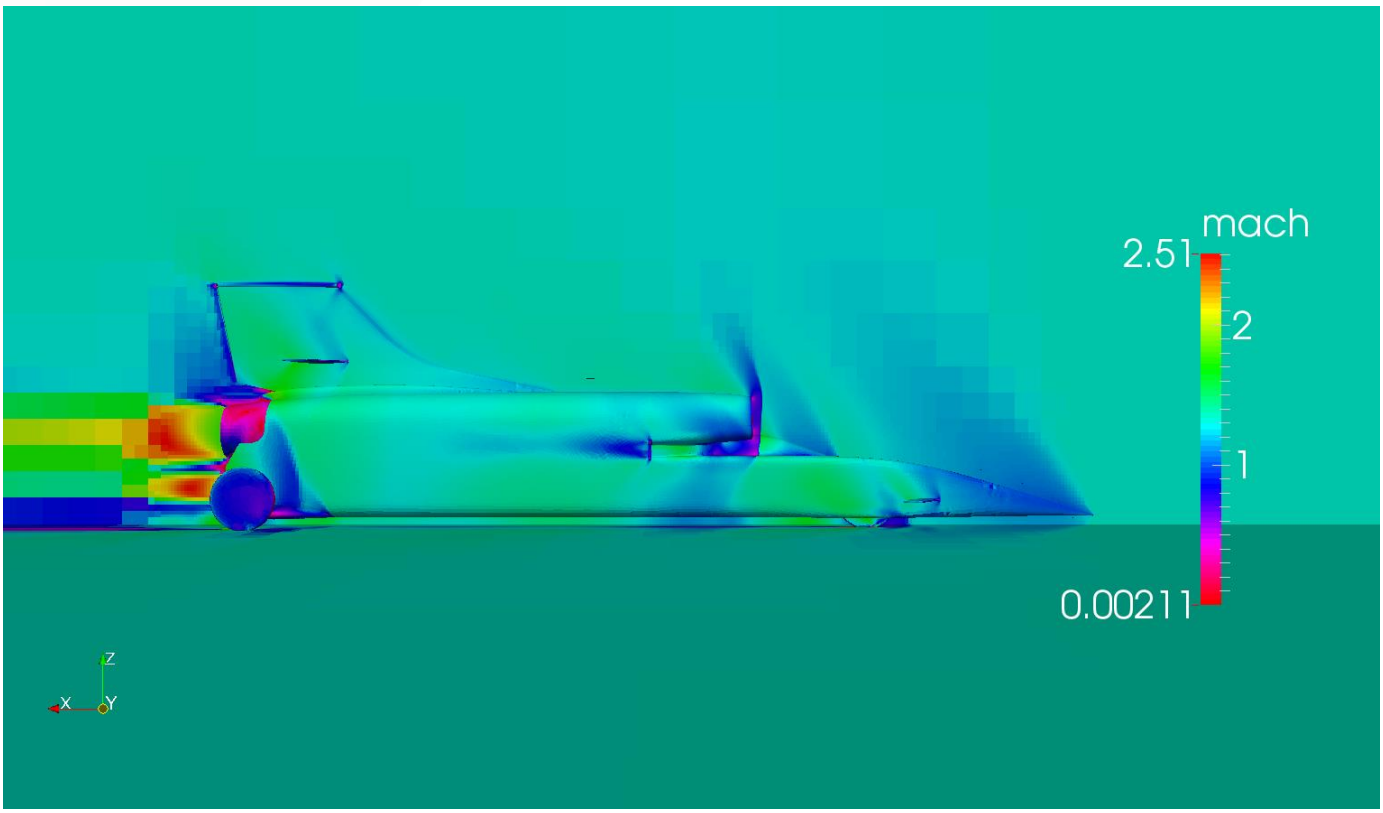
INDUSTRIAL APPLICATIONS OF CFD

EPIC has been widely used in schools throughout the U.K. as part of an engineering challenge to design a supersonic car known as the Bloodhound, with the goal of creating a vehicle that that can travel at speeds of up to 1,000 mph. Schools compete to improve the speed of the Bloodhound by using CFD to design shapes and contours that minimize air friction or drag over the vehicle, as shown in the following images:



A CFD mesh used to model airflow around a supersonic vehicle.



A CFD rendering depicting Mach 1.3 airflow for the Bloodhound SPEED baseline configuration. Students can assess the impact of design changes on shock waves and aerodynamic loading.

Auto manufacturers conduct similar airflow simulations to improve the performance, stability, and comfort of consumer vehicles. As automobiles move towards electric engines, wind noise becomes more noticeable, so automotive engineers use computational fluid dynamics to streamline protruding parts such as side-view mirrors. EPIC helps them design optimal shapes that deliver less noise to the cabin interior.

REDUCING COSTS AND BOOSTING EFFICIENCY FOR THE CLEAN ENERGY INDUSTRY

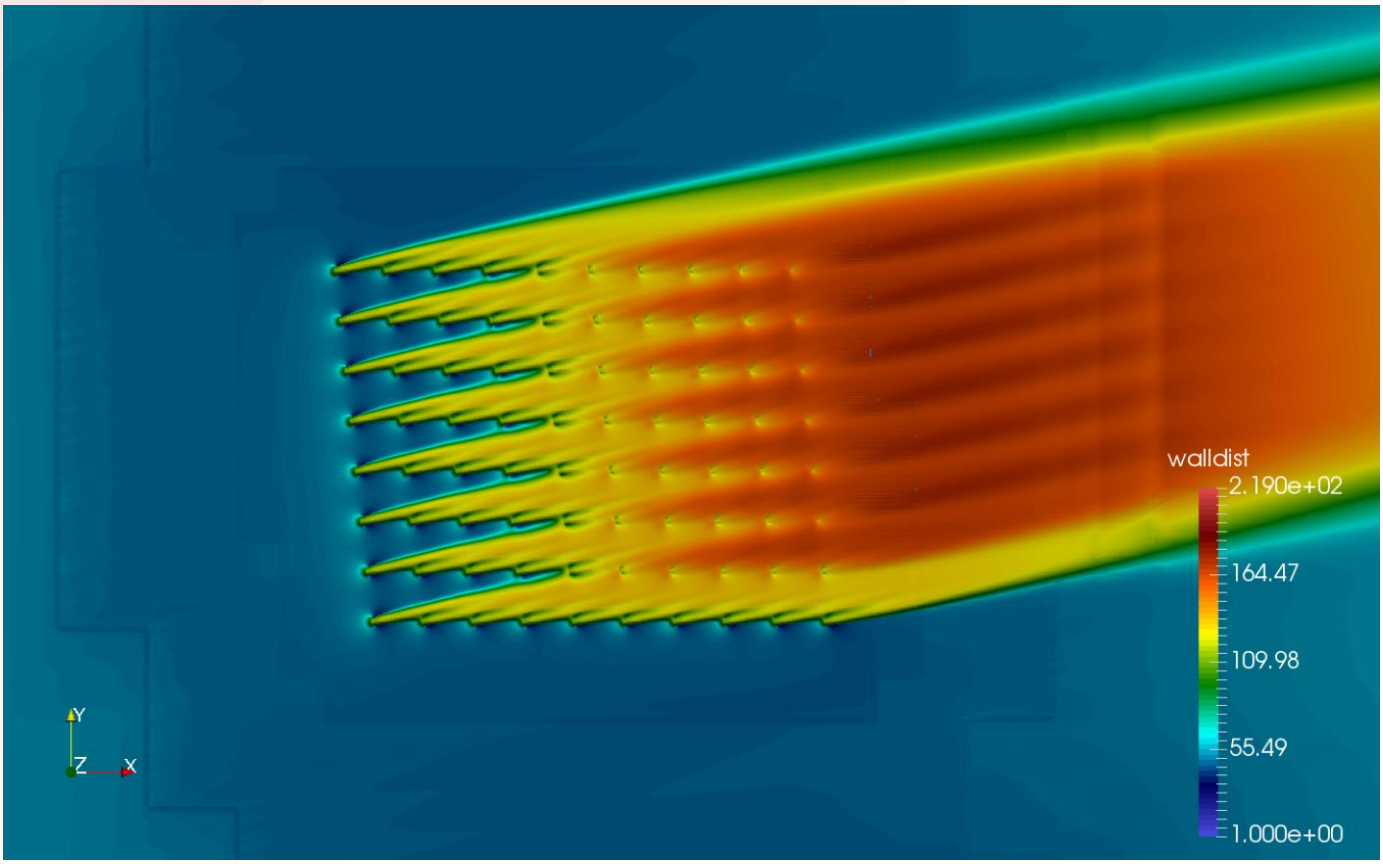
For a wind array off the coast of Denmark, Zenotech used Oracle Cloud Infrastructure to study the wakes created as wind moves through a large area populated by hundreds of turbines. They began by dividing the area into a mesh of cells, 100 kilometers wide by 100 kilometers long by eight kilometers high. This yielded an 80,000 cubic kilometer area comprised of 50 million cells. They iterated their simulation workload on Oracle Cloud over 100,000 times to model the pressure, velocity, turbulence and several other physical variables for a range of wind speeds and directions through each cell. They used these simulation results, representing the evaluation of approximately 35 trillion equations, to create a representation of expected wind wake patterns.

"CFD is a very computationally intensive process," Turner explains, "and the key to making it useful involves keeping the computation time as short as possible—to get the entire job down to days or even hours. That means scaling the job across a large number of computers."

"Oracle has established performance-enhancing capabilities at the network level. OCI keeps our application performance steady, even when we scale out among availability domains, which is very important when we need to estimate job run time." – Mike Turner, Product Lead, Zenotech

In the case of the wind array, Zenotech knew that three days into the job they would have the same latency that they had at the outset. "That is very helpful from an administrative point of view," Turner says. "It keeps our application performance steady, even when we scale out among availability domains, which is very important when we need to estimate job run time. In this case, it took a network of 650 cores eight days of processing, and the performance was steady throughout."

Zenotech is using computational fluid dynamics to reduce the cost of offshore wind energy by predicting wake interaction effects in large wind turbine arrays.



Simulation of the wake interaction effects and airflow around the whole Horns Rev wind farm using zCFD.

Studying wind interactions at this scale is vital to the industry—and extremely important to the future economic viability of the power industry. The increased certainty in wind farm performance resulting from better modelling reduces the risk of financing these projects, leading to better loan terms (a reduction of approximately 25 basis points or 0.25 percent). A wind farm will last for at least 20 years, and typical loan terms are 10 to 15 years. There are currently seven offshore wind farms under construction in the UK, so the potential impact of improved simulation using OCI in this country alone could be over £100 million.

POSITIONED FOR THE FUTURE

By offering a combination of the software that does these simulations along with HPC hardware, on-demand, through OCI, Zenotech makes it easy for any company to run HPC simulations and performance-intensive workloads. "For some jobs, we get better performance on Oracle Cloud Infrastructure than we do on a specialist HPC cluster," Turner says. "Oracle recognizes the special needs of HPC workloads, with instance types that are tuned for this type of computing. In addition to its high-performance bare metal servers, Oracle has established a low-latency, high-speed cloud network that is both predictable and reliable," he adds. "We can flex our cluster depending on demand."

Turner appreciates the high-end capabilities of Oracle Cloud Infrastructure, such as being able to utilize Nvidia GPUs and consume Kubernetes as a cloud service. He says combining Oracle's managed Kubernetes service with bare metal cloud servers has enabled Zenotech to streamline its testing timelines, and thereby deliver results more quickly. "We like the managed Kubernetes services that reside on top of the Oracle Cloud Infrastructure," he confirms. "The EPIC CFD is very CPU-intensive, and it runs very well on the Nvidia P100 and V100 GPUs."

"Oracle recognizes the special needs of HPC workloads, with instance types that are tuned for this type of computing . . . HPC workloads that were formerly run only on supercomputers are now running quite well on cloud infrastructure." – Mike Turner, Product Lead, Zenotech

Based on these and other advanced capabilities, Zenotech is gradually moving its application development activities, as well as its internal HPC projects, to Oracle Cloud Infrastructure. “Oracle releases new capabilities all the time, and it’s nice to always have access to them,” Turner concludes. “New GPUs, more memory, faster networks—we can leverage all these things as they become available. HPC workloads that were formerly run only on supercomputers are now running quite well on cloud infrastructure. It’s brilliant.”

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Integrated Cloud Applications & Platform Services

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