The Future of CFD

Computational fluid dynamics (CFD) is a key design tool for engineers today. But time-consuming, costly physical testing is still a regulatory requirement in many industries, including aviation and automotive. For digital certification to fully replace physical tests, CFD needs massive compute power and innovation to deliver accuracy equal to physical tests.

CFD is the mainstay for engineers to improve product designs and rapidly develop viable prototypes. CFD simulations predict the interactions between fluids, solids and gases, and provide a virtual equivalent to physical testing.

AWS is helping CFD experts go from conceptual design to full design in the shortest possible time with the least expense.

Growing GPU power and demand

2-3x
GPU acceleration can deliver 2-3x speedup over CPU-based codes

100+
GPUs needed for real-world CFD accuracy

33.6%
GPU market growth rate forecast, 2020-2027[2]

GPUs accelerate CFD

GPUs have the potential to rapidly accelerate CFD compared to CPUs. Many popular CFD codes are now becoming GPU-optimized. As more workloads are adapted to GPUs, organizations need GPU clusters and HPC infrastructure that:

- **Scales massively** as CFD workloads grow
- **Offers flexible access** enabling you to use CPUs today and quickly switch to GPUs when you need them
- **Removes high up-front costs** of replacing traditional servers

ML/DL transforms CFD

Machine learning (ML) and deep learning (DL) are delivering the potential for a disruptive technology in CFD, making it possible to train models that then predict new geometries in seconds and at low cost. To leverage ML and DL organizations need:

- **High-performance GPUs** like the ML-focused AWS Trainium and AWS Inferentia or Amazon EC2 P4d and G5 instances to train ML models
- **Fast access to training data** as provided by Amazon FSx for Lustre and Amazon S3
- **Model building, training, and deployment tools** such as Amazon SageMaker, AWS Batch and AWS ParallelCluster

Cloud CFD creates value beyond cost savings

Cost savings (TCO)
Infrastructure cost savings/avoidance from moving to the cloud

Staff Productivity
Efficiency improvement by function on a task-by-task basis

Operational resilience
Benefit of improving SLAs and reducing unplanned outages

Business agility
Deploying new features/ applications faster and reducing errors

The evolution so far

1967: First 3D models
Douglas Aircraft develops **Panel Methods** to simulate ship hulls and aircraft fuselages.[1]

1990: Commercial unstructured 3D flow solvers
The release of **Fluent, STAR-CD** and others start the rise of 3D unstructured commercial CFD codes.

1994: First HPC cluster
NASA builds the first HPC cluster, **Beowulf,** to solve parallelizable problems faster with commodity grade computers.

2008: CFD in the cloud
AWS introduces the **C1** compute-optimized instance, making HPC more accessible.

2018: C5n with high-speed networking
Cloud HPC is transformed by the introduction of **Elastic-Fabric Adapter (EFA)** that provides low latency and high-bandwidth network adapter which together with the **AWS Nitro System** allows customers to scale to thousands of cores.

2020: Large GPU clusters in the cloud
The introduction of **Amazon EC2 P4d UltraClusters** combine 4,000+ NVIDIA® A100 tensor core GPUs and petabit-scale networking to allow GPU-enabled codes to scale out and distributed ML/DL models to train on large datasets.

2021: Amazon EC2 HPC instances
AWS introduces the first HPC optimized Amazon EC2 instance; **Hpc6a** that offers **up to 60% better price/performance** over comparable x86 instances.

How AWS is building the future of CFD

AWS offers the most advanced and comprehensive set of services and infrastructure available in the cloud today. The flexibility of AWS infrastructure means that you can adopt new CFD technologies, or grow and shrink your infrastructure, as your workloads demand.

AWS ParallelCluster
Easily deploy and manage HPC clusters with an AWS-supported open source management tool. You can scale resources automatically and migrate existing workloads with little to no modification using popular schedulers such as SLURM.

Amazon EC2 HPC Instances
Get high performance Amazon EC2 HPC instances with Elastic Fabric Adapter providing the best price/performance for HPC workloads in the cloud, to help scale out your CFD simulations to tens of thousands of cores at the lowest possible cost.

Amazon EC2 P4d Instances
Train ML models in the cloud with P4d instances powered by the latest NVIDIA® A100 Tensor Core GPUs. P4d instances are the only instances in the cloud to offer up to 400 Gbps networking with EFA. P4d instances provide up to 60% lower ML training costs and an average of 2.5x better performance compared to P3 and P3dn instances.

AWS Inferentia
Part of our vision to make DL an everyday tool for developers, AWS Inferentia is a high-performance ML inference chip, custom designed by AWS. It's designed to drive down the total cost of inference and make it easy to integrate machine learning into CFD.

Use the latest CFD technologies now

AWS allows you to run your simulations faster and run more of them simultaneously with no queues. It's easy to leverage leading technologies and run popular codes from our growing ecosystem of partners.

intel. NVIDIA. AMD

CFD Direct Ansys TotalCAE

arm SIEMENS ZENOTECH

rescale CONVERGE CFD SOFTWARE onscale

Get started at aws.amazon.com/hpc/cfd

1 https://ui.adsabs.harvard.edu/abs/1967PrAvS...8...1H/abstract
2 https://www.alliedmarketresearch.com/graphic-processing-unit-market