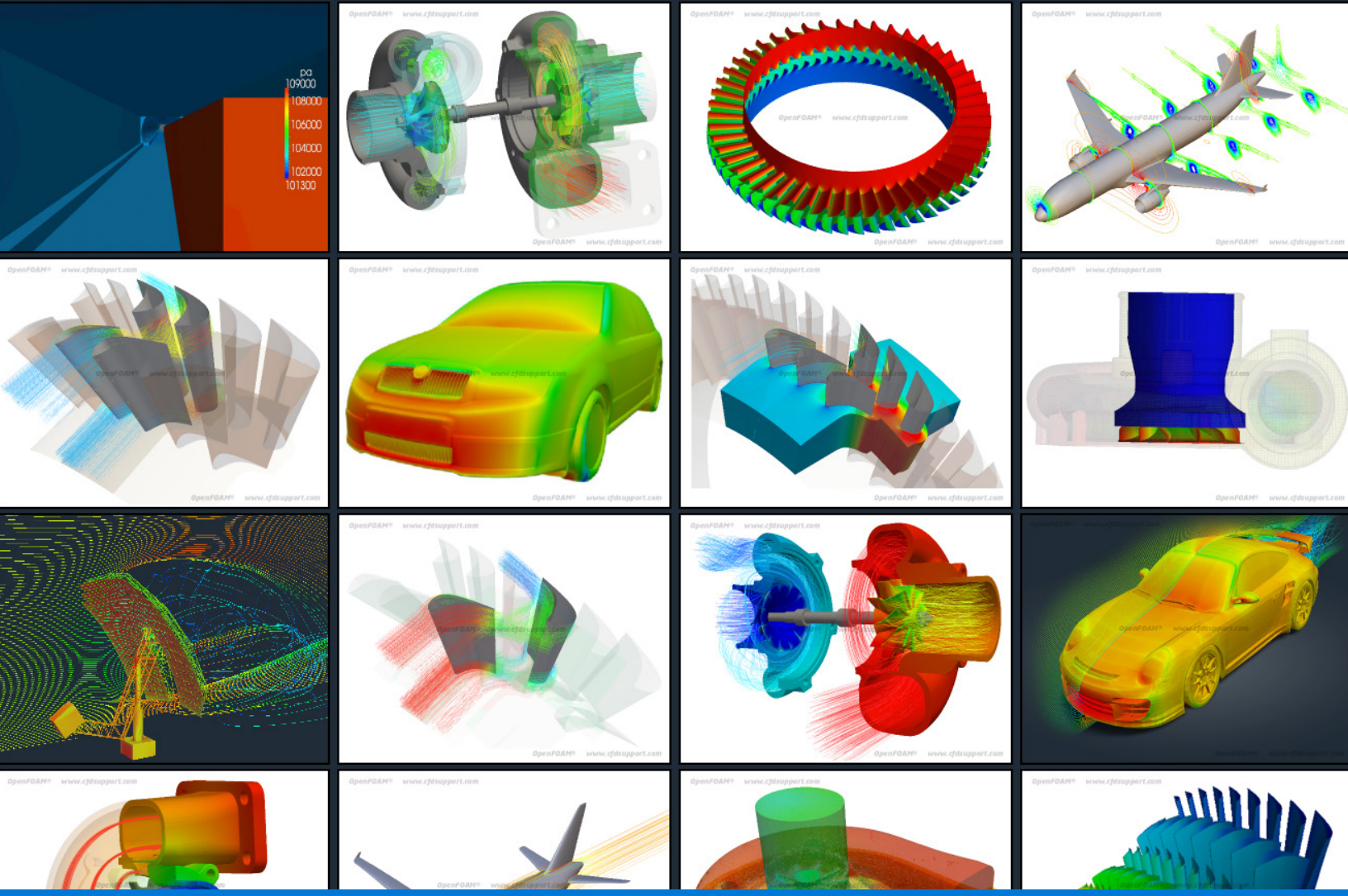


Expanding customers' computational horizons

"Three years ago, in 2013, Intel recognized the value of our HPC Cloud experiments and their contribution to the 'democratization' of high performance computing, and since then Intel has sponsored more than 150 cloud experiments and case studies from engineers and scientists. Without Intel's vision and support, the UberCloud experiments and the resulting case studies wouldn't exist today."

Wolfgang Gentzsch, Co-founder & President, The UberCloud, Inc.

CFD support offers six packaged Computational Fluid Dynamics (CFD) products for running complex simulations of gas and fluid flows around objects. Running its products on desktop workstations took too long, often days for especially complex simulations. But with the help of UberCloud, a Microsoft partner, it tapped the high performance computing (HPC) power of Microsoft Azure HPC clusters to reduce run times to hours.

Microsoft

Anyone driving today's cars enjoys the benefits of Computational Fluid Dynamics (CFD) but may not know it, as CFD likely saves them money on fuel. That's because carmakers use CFD analyses to ensure that air flows over and around the car as efficiently as possible to reduce drag and improve gas mileage.

CFD is also used in a wide range of other disciplines and industries, such as aerospace, astrophysics, chemicals, medical research, meteorology, oil exploration, polymer processing, and power generation. At its heart, CFD provides scientists and engineers the mathematical tools to explore how fluids or gases flow around physical objects as well as the interactions of those fluids and gases with the objects' surface.

"Democratizing" access to supercomputing

At one time, CFD's complex mathematics, physics, and software engineering demands required access to supercomputing resources like those available in high performance computing (HPC) centers at large research institutions and corporations. CFD was largely out of reach for smaller companies and individual researchers.

In 2009, two Ph.D. graduates in CFD studies—Jiří Šimonek and Luboš Pirkl—decided to form a company called CFD support, Ltd. based in Prague, Czech Republic, with a mission to "democratize" the technology, using open source CFD technologies as much as possible. "We want to help smaller companies and individual researchers gain access to the tools and HPC parallel-processing power they need to perform CFD analyses on their own," says Pirkl.

Šimonek and Pirkl have adopted OpenFOAM (Open source Field Operation And Manipulation) as their company's core CFD platform. OpenFOAM is a C++ toolbox for the development of customized numerical solvers, plus pre- and post-processing utilities for solving continuum mechanics problems, with special applications for CFD. Using OpenFOAM, CFD support specializes in serving the CFD analyses needs in the turbomachinery, automotive, and aerospace industries.

Cutting days of computations to hours

CFD support offers six packaged CFD products, each available as a natively compiled Linux or Windows application. The company also provides services that include training, consulting, and support. "While our software products can be used on powerful workstations," Pirkl explains, "the workstations can still take the better part of a day to conduct the needed mathematical computations on relatively simple, straightforward analyses."

He adds, however, that more complex problems can take days. The more complex the problem and the longer its CFD calculations require, the fewer iterations are likely to be run, which can limit the boundaries of innovative research initiatives.

"But with access to the parallel-processing architectures of HPC resources, researchers can expand those boundaries considerably," Pirkl says.

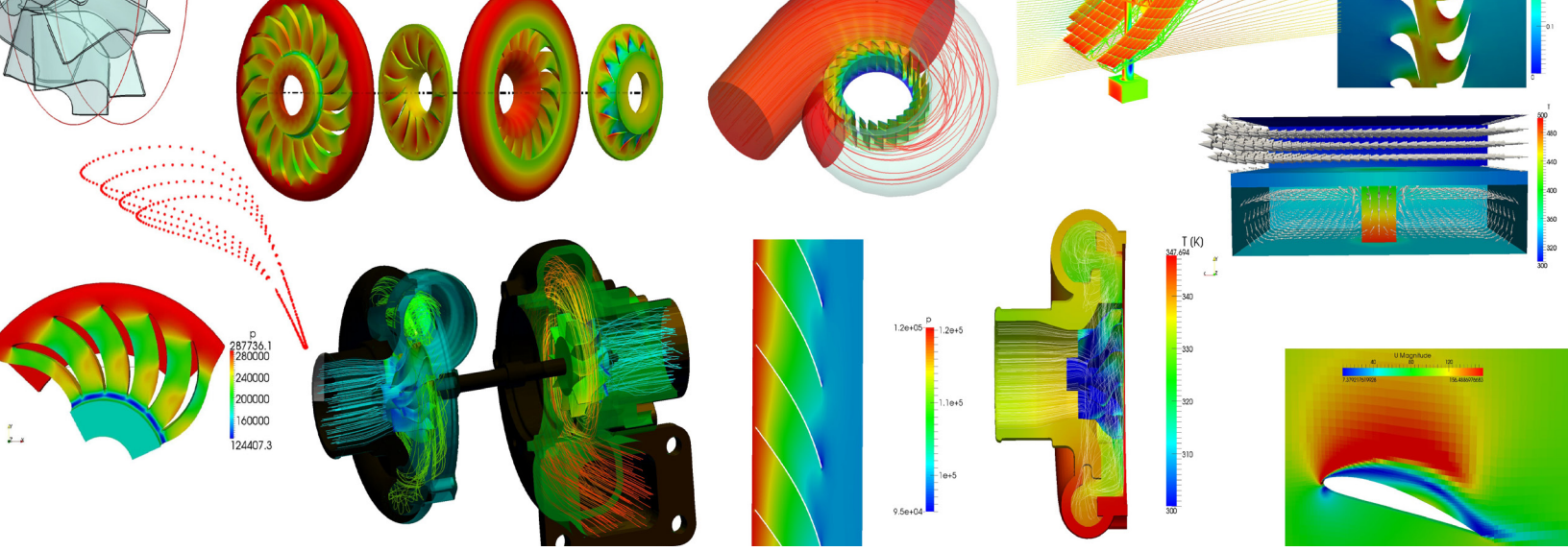
> ***"The Azure cloud solution based on Intel Xeon processors together with the use of UberCloud Containers provides excellent performance advantages for Turbomachinery CFD users who want to obtain higher throughput or analyze larger, more complex models."***
>
> Luboš Pirkl, Co-founder & Managing Director, CFD support Ltd.

> ***"We envision a future where game-changing innovations in advanced industries and scientific disciplines can come from anywhere, not just the major research institutions and large corporations with HPC resources of their own. UberCloud, Microsoft Azure, and Intel have leveled CFD's playing field, so anyone with an interest and a problem to solve can work on it."***
>
> Luboš Pirkl, Co-founder & Managing Director, CFD support Ltd.

Customer Name: CFD support Ltd.
Industry: Information Technology
Country or Region: Czech Republic
Customer Website: www.cfdsupport.com
Employee Size: 6
Partner Name: UberCloud

Customer Profile
CFD support, Ltd., based in Prague, Czech Republic, provides software, tools, and training for researchers using complex computational fluid dynamics (CFD) in their investigations.

Microsoft



"And by extending our customers' computational horizons, we're enabling them to increase the chances of making fundamentally important discoveries with the potential to make enormous changes in the world we live in."

To help its customers gain access to those HPC resources, CFD support turned to Microsoft and Intel partner UberCloud, founded by Wolfgang Gentzsch and Burak Yenier in 2012. Based in Silicon Valley, UberCloud is an online community and marketplace where engineers, scientists, and their service providers discover, try, and buy HPC number-crunching power and software as a service, among many other technology offerings from its extensive catalog of providers. Intel provided UberCloud with early support and completed a number of R&D projects together.

"Three years ago, in 2013, Intel recognized the value of our HPC cloud experiments and their contribution to the 'democratization' of high performance computing, and since then Intel has sponsored more than 150 cloud experiments and case studies from engineers and scientists," says Gentzsch, who is now UberCloud's president. "Without Intel's vision and support, the UberCloud experiments and the resulting case studies wouldn't exist today."

Opening up cloud-based HPC to scientists, researchers, and engineers

"We started UberCloud to fill a need for scientists, researchers, and engineers to easily access these kinds of technologies that they could apply toward their most computationally demanding problems," Gentzsch recalls. "Until then, cloud-based resources like the ones now available in the UberCloud Marketplace were almost exclusively enterprise-oriented."

Among UberCloud's many computing resource providers is Microsoft, featuring its Azure cloud platform with a wide range of robust, ever-expanding features and capabilities. Among those is on-demand access to world-class, parallel-processing supercomputing. Users can take advantage of a back-end network with a latency of less than 3 microseconds for its message-passing interface (MPI) and non-blocking 32 gigabits per second (Gbps) of throughput. This back-end network includes remote direct memory access (RDMA) technology on Windows and Linux that enables parallel applications to scale to thousands of cores.

The Microsoft Azure HPC cloud service provides UberCloud customers, such as CFD support—and, by extension, CFD support's own customers—with access to superfast, high-memory CPUs. For example, the Azure A8 and A10 compute-intensive instances tap the compute power of Intel Xeon E5-2670 CPUs with 8 cores running at 2.6 gigahertz (GHz) and 56 gigabytes (GB) of DDR3 memory, running at 1600 megahertz (MHz). The Azure A9 and A11 instances double the performance with Intel Xeon E5-2670 CPUs that have 16 cores running at 2.6 GHz and 112 GB of DDR3 memory, running at 1600 MHz.

"Clearly these kinds of HPC resources like what Microsoft Azure offers can cost millions of dollars in upfront capital investment to build, then more millions in annual operating expenses to run," says Gentzsch. "But, with Microsoft Azure's HPC offering based on Intel Xeon processors, users like CFD support and its customers can tap into all that compute power at a tiny fraction of the cost, paying only for what they use."

Choosing Microsoft Azure HPC resources from UberCloud

Through the UberCloud Marketplace's catalog of HPC service providers, CFD support could choose from seven Azure-optimized HPC options, including OpenFOAM running on CentOS v6, the

latter an open source operating system compatible with Red Hat Enterprise Linux.

To assess the quality and value of this option for its own customers, CFD support used the Microsoft Azure HPC for a trial run of a baseline CFD analysis of a radial fan blade using its own Turbomachinery CFD software. "We chose Microsoft Azure based on Intel Xeon processors because of its turnkey OpenFOAM software container and available parallel-processing architecture," says Pirkl. He notes that UberCloud's software containers would help streamline users' hardware and software setup, simplifying what would otherwise be a complex process and saving considerable time.

Gentzsch explains software containers with the analogy of how standardized, multimodal shipping containers revolutionized the world's transportation of physical goods. "Before containerization, loading and unloading cargo were time-consuming and costly, while ports were extremely congested," he says. "But thanks to containerization, today's global logistics are much faster and costs much lower. Software containerization promises to do the same."

Pirkl ran the trial with UberCloud's Microsoft Azure HPC resources and was delighted to discover how easy and transparent it was to use. "The browser-based, remote desktop interface was extremely responsive, robust, and without any significant delays," he says. "Running our Turbomachinery CFD software on Azure was as transparent as if we were running it on our own local workstation."

A key outcome from Pirkl's "experiment" (as UberCloud calls its customers' discrete computing activities) was the development of a computational performance scale of its Turbomachinery CFD software given the number of identical Intel Xeon cores used. For example, a baseline simulation using the software with two cores required 16.30 hours, while 32 cores took just 2.96 hours. This way, users can determine in advance what their tradeoffs are between what their compute costs will be and the time required for Turbomachinery CFD to do its work.

"The Azure cloud solution based on Intel Xeon processors together with UberCloud containers provides excellent performance advantages for Turbomachinery CFD users, who want to obtain higher throughput or analyze larger, more complex models," Perkl says, summarizing his experience with the trial.

By making access to CFD computational technologies available for smaller companies and researchers, CFD support and UberCloud open the door for even greater innovations and breakthrough insights in advanced industries like aerospace and automotive, helping to solve complex technical problems and make the world a better place to live.

"We envision a future where game-changing innovations in advanced industries and scientific disciplines can come from anywhere, not just the major research institutions and large corporations with HPC resources of their own," Pirkl says. "UberCloud, Microsoft Azure, and Intel have leveled CFD's playing field, so anyone with an interest and problem to solve can work on it."

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Luboš Pirkl, Co-founder & Managing Director, CFD support Ltd.

Software

- **Microsoft Azure**
- **Microsoft Azure High Performance Computing (HPC)**

Microsoft