TECHNICAL **BRIEF**

cadence®

Unleash the Potential of CFD

Classic CFD to High-Order Scalability

Instead of relying on expensive prototype testing or experimentation, users now have access to numerous open-source and paid computational fluid dynamics (CFD) software that can help them solve application-specific problems. Today, CFD is no longer about getting one solution at a time; it is about getting the best possible solution from multiple design test cases. For a unique customer experience, it is essential to have a CFD solution that can be leveraged to meet the complexity of problems in terms of scalability, computational resources, and automated workflow, thus transitioning the CFD game from a classic solution to a high-order approach.

Challenges Using Classic CFD

Traditional CFD technology fails to address certain challenges throughout the CFD workflow, that is, pre-processing, simulation, and post-processing. In pre-processing, the geometry cleanup tools available in the market to repair surfaces and create watertight geometries (significant in CFD analysis for heat and mass transfer between surfaces or volumes of a body) can fail in automated workflows. Similarly, the commercially available traditional meshing technologies do not cater to models with high Reynolds numbers or large eddies because of their high cell count.

As more engineers rely solely on CFD simulations for accurate predictions of product performance throughout the design cycle, it becomes essential to resolve the physics behind the application than to model it. Further, to capture all relevant flow details in models of large power generation systems or automotive applications, it is necessary to employ large compute resources to unleash the potential of CFD simulation. CFD solvers supported by heterogeneous CPU/GPU units help reduce the runtime and run heavy simulations.

A Scalable CFD Solution

The Cadence® Fidelity™ CFD Software is that next-generation scalable Cadence CFD solution that offers technology beyond the Omnis end-to-end CFD workflow and Pointwise legacy meshing. For over a decade, the CFD industry has recognized that progress in three vital areas has plateaued: numerical algorithms, modeling of turbulent and separated flow, and the exploitation of HPC assets. Fidelity CFD makes strides in all three; the two most unique aspects are the high-order solver and the first steps toward integrating the Omnis and Pointwise meshing technologies into a single, unique platform while also advancing them separately. The Fidelity high order solver promises to offer 10X the accuracy of classic flow solvers, and 3X mesh speedup using Pointwise solution within Fidelity CFD.

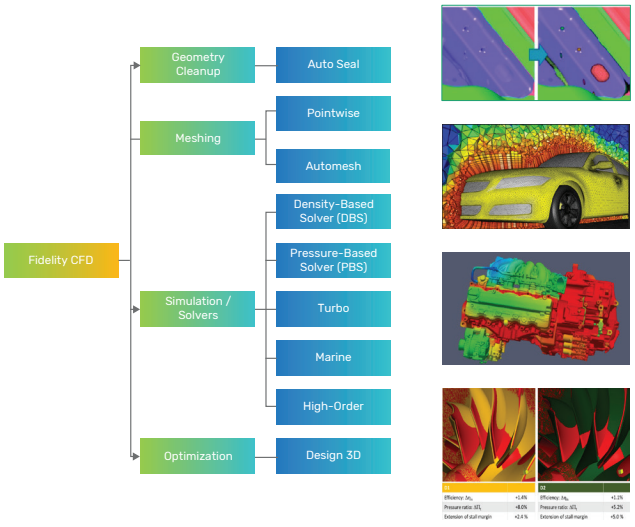

Figure 1: Flowchart of Fidelity CFD and its offerings for the entire CFD workflow

Fidelity CFD addresses unique applications in the turbo, marine, automotive, and aerospace domains, such as predictions of noise generated by separated flows in electric vehicles (EVs) or drag-dominated flows for fuel economy. This is made possible with the various CFD solutions brought together within Fidelity CFD.

Capabilities

Design demands from previously unchartered areas of engineering are pushing CFD developers to automate and enhance the flexibility of CFD technology for faster turnaround times and to compensate for limited human skillsets in resolving design challenges. Fidelity CFD, with its capabilities developed from decades of intelligent system design technology, aims to offer an unparalleled solution to handle complex CFD workflow, faster analysis using high-order solution, and meet computational requirements with vast CPU and GPU acceleration.

Advanced Handling of Complex CFD Workflow

Healing the geometry, setting the domain, grid discretization, solution initialization, and result visualization, are all parts of a CFD workflow. It is tedious to clean, mesh, and resolve geometries with intricate features and complex curvatures using a traditional CFD solution. With Fidelity CFD, one can scale and automate the entire workflow as per the design requirements and computational limitations, for an accurate and reliable solution.

Geometry Cleanup

Fidelity CFD's pre-processing solution works for a broad range of CAD formats without losing out on the prominent details of the geometry and meets the necessary user specifications. Geometry cleanup can save simulation time and is a crucial step in CFD analysis, often taking days or even weeks depending on the complexity of the geometry. With Fidelity CFD, capping holes and cavities takes a few minutes or hours, saving both time and resources towards an efficient design process.

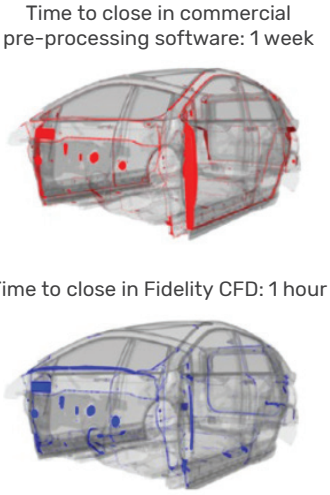

Figure 2: From CAD or STL file to watertight geometry in an hour or less than a week

High-Order Curved Meshing

An high-order meshing technique that uses high-degree polynomial curves to provide a more accurate geometry capturing than linear meshes with fewer cells is a preferred meshing technology for complex geometries. Fidelity CFD's high-order curved meshing can convert an existing linear mesh into an high-order curved mesh. It runs on thousands of CPUs and GPUs.

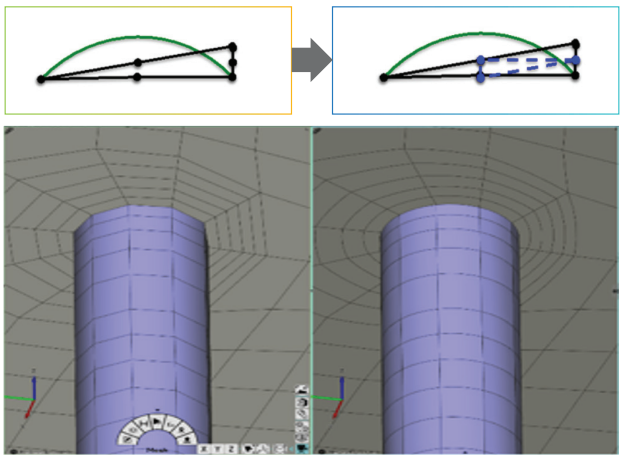

Figure 3: Interpolating linear mesh to mesh for reduced cell count, reduced memory requirements, and unprecedented accuracy

Scale-Resolving Simulations

With scale-resolving simulations (SRS) in Fidelity CFD, users have full flexibility in choosing the turbulence model, depending on available computational resources and the required level of accuracy. Fidelity CFD SRS is expected to expand offerings from traditional turbulence model coverage of Reynolds averaged Navier Stokes (RANS), Unsteady RANS (URANS), and large eddy simulation (LES) to include LES-wall-resolving LES (LES-WRLES) and direct numerical simulation (DNS), thus increasing the accuracy of simulation results.

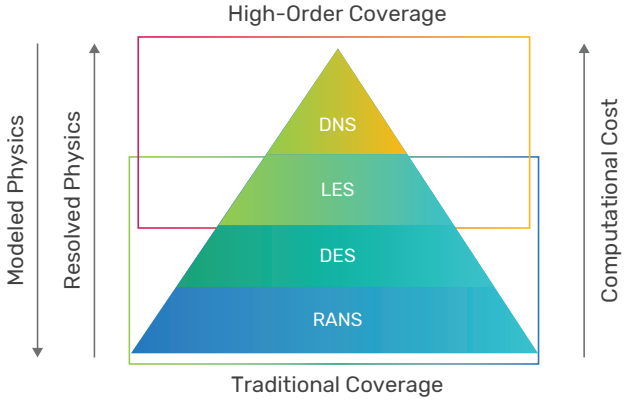

Figure 4: Expanding Fidelity CFD turbulence modeling from traditional to high-order coverage

Faster Analysis with High-Order Solution

The high-order solution offers accuracy beyond standard simulation methods by capturing real-world physics with minimum assumptions. Any numerical method with a third order of accuracy or higher is considered high-order. The high-order product comprises the high-order meshing technology, high-order solvers, and high-order post-processing, which automatically generates data from the simulation results. It only takes a minute to set up an high-order project from an existing Omnis project, and in this case, it requires no specific expertise. Users can reduce the high-order solution time by initializing the simulation with a less computationally expensive solver before opting for the high-order solver.

The high-order solver has a code architecture to extend that scales on large CPU and GPU infrastructures. The numerical properties in the high-order solver make it well-suited for SRS and cover the whole spectrum of turbulence modeling from RANS to DNS. Using the high-order solver, users can get up to 10X the accuracy of standard flow solvers. For a fixed accuracy, the high-order solver uses fewer degrees of freedom than traditional methods, and it can achieve a more accurate solution at a fixed cost.

Integrated End-to-End Platform

Single interface for entire CFD workflow

- Geometry Cleanup > Meshing > Solving > Post-Processing > Optimization

Advanced automated meshing technologies

- Address geometry complications, speedup meshing by 3X, and achieve unprecedented accuracy of simulations.

Domain-specific solvers

- Built-in templates that are aligned to industry standards

Best-in-class API

- Full flexibility to integrate external solvers or analysis workflows

Summary

Cadence Fidelity CFD software makes a huge leap in CFD technology by advancing numerical algorithms, SRS, and HPC using the same commercial code. It offers an integrated CFD platform that simplifies the approach from standard CFD technology to high-order solutions. Users now have vast flexibility in choosing the right CFD technology based on the solution requirements and turnaround time. Fidelity CFD promises to either reduce run time at the same accuracy or to improve accuracy using the same runtime.

Additional Resources

Webinars

Hybrid Conformal Meshing for Wind Farm CFD Applications

Designing a Radial Gas Turbine 20X Faster with CFD

High-Order Mesh Generation Using Fidelity Pointwise

Blog Posts

Illinois Blower Increases Fan Performance by 44% with Fluid Dynamics Simulation

Automate Mesh Generation Workflow for Complex Geometries

Pipistrel Reduces by 6% the Energy Consumption of an Electric Aircraft Through Propeller Optimization

Articles

The Best Methods for Mesh Interpolation

How an Aircraft Wing Works: Understanding Applied Aeronautics

Flow Behavior in the Transition Flow Regime

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