DATASHEET

CharLES: Fidelity LES Solver

High-fidelity multiphysics CFD

Cadence Fidelity LES Solver, formerly Cascade CharLES, is the industry's first high-fidelity computational fluid dynamics (CFD) analysis engine that expands the applicability of large eddy simulations (LES) into the mainstream aerospace, automotive, and turbomachinery domains. Designed to scale, Fidelity LES Solver addresses the most demanding fluid dynamics challenges by accurately predicting traditionally complex problems for CFD in aeroacoustics, aerodynamics, combustion, heat transfer, as well as multiphase applications.

Predictive high-fidelity simulations require high-quality meshes. By leveraging clipped Voronoi diagrams, the polyhedral mesh generator is fast, scalable, and robust when processing most complex geometries (Figure 1). Users can easily introduce resolution where needed, run coarse simulations of complex geometries, and simulate moving geometries.

Realizing the predictive benefits of LES requires much more than just turning on time dependence and changing the turbulence model. Fidelity LES Solver combines advanced numerical methods and models, and extreme scalability in CPU-based and GPU-based high-performance computing environments.

The solver discretization is a finite volume approach based on a generalization of the discrete entropy framework for unstructured meshes that treats a variety of flow regimes, including low-speed flows, high-speed flows with shocks, and reacting flows. This approach leads to a stable, homogenous flux discretization without complex sensors, upwinding hybridization, or tuning of coefficients for stability. This unique solver discretization is combined with the latest sub-grid scale modeling and wall modeling to deliver an LES capability with remarkable robustness to grid resolution (Figure 2).

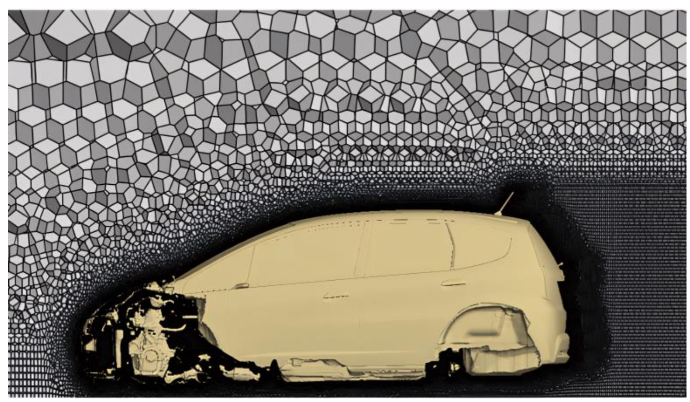

Figure 1: Full-scale Honda Fit polyhedral mesh generated by Fidelity Stitch

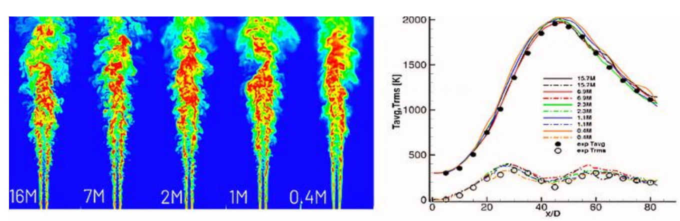

Figure 2: Sandia Flame D. Comparison between experiments and Fidelity LES Solver for different mesh sizes. Temperature contours (above) and centerline mean and rms temperature (right).

Key Takeaways

- Fidelity LES Solver expands the practical application of LES in automotive, A&D, energy, and turbomachinery industries
- Highly accurate and purpose-built for LES
- Scalable, GPU-resident solver for the fastest time to results and best price/performance

Features

Aerodynamics

Fidelity LES Solver can predict aerodynamic forces for complex geometries over a range of flow regimes from low-Mach to transonic and supersonic.

For example, it can capture changes in vehicle drag due to subtle geometric design modifications (Figure 3) and identify the onset of stall over high angle of attack airfoils on a commercial aircraft.

Aeroacoustics

Aeroacoustics predictions are relevant for a wide range of industrial applications, from supersonic jets to fan noise to combustion-acoustic interactions in gas turbines (Figure 4).

Combustion

Turbulent combustion underpins much of our modern energy economy. Power generation, aviation, aerospace, and automotive technologies all depend on how well we mix reactants, release their energy, and manage their byproducts. Making these processes cleaner, safer, and more efficient is crucial to navigating the future of our planet.

Heat Transfer

Accurate heat transfer predictions require careful attention to the local state of the boundary layer, the presence of flow separation, and reattachment, and transition to turbulence.

The control of boundary layer grid size made possible by Fidelity's Voronoi-based meshing technology, combined with the Fidelity LES Solver's advanced numerical methods and wall modeling, can yield actionable results for absolute heat flux predictions (Figure 6).

GPU Acceleration

Fidelity LES Solver provides solver advancements to the numerical scheme and leverages GPU compute, enabling massive LES simulations, such as the accurate simulation of a realistic aircraft in landing configuration, in 12 hours, on just two GPU nodes.

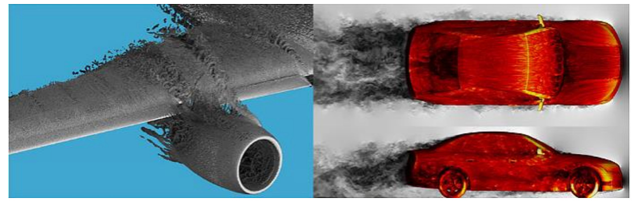

Figure 3: High-fidelity CFD simulation of a commercial aircraft targeting predictions of maximum lift and stall characteristics and separation patterns (left) and the external aerodynamics of a car (right) with Fidelity LES Solver

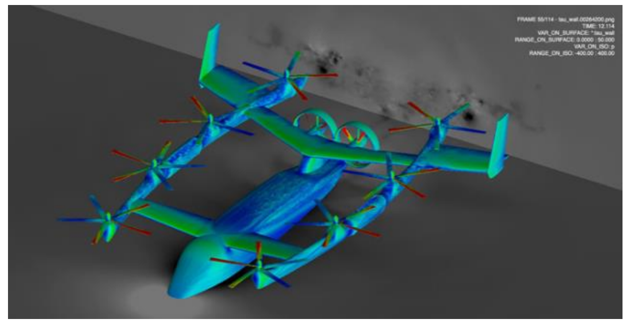

Figure 4: Aeroacoustics of an eVTOL air vehicle, the pressure field, and shear stress at cruise conditions

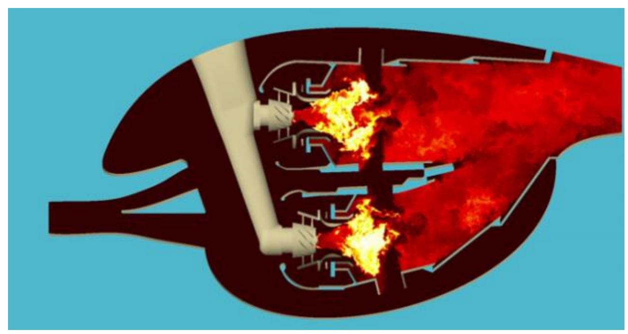

Figure 5: Fidelity LES Solver simulation of NASA E3 aviation combustor targeting predictions of linear heat transfer, durability, and exit temperature profiles

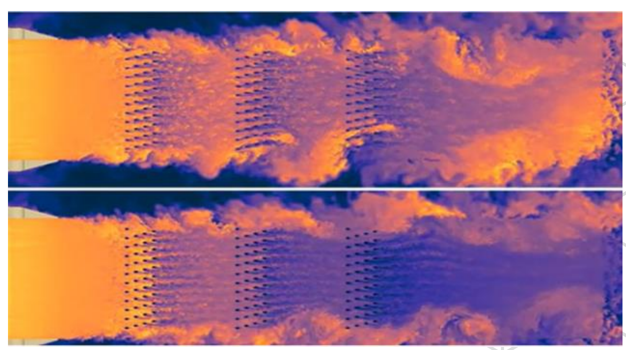

Figure 6: Conjugate heat transfer predictions of a square jet exhausting over a film-cooled deck from the AIAA Propulsion Aerodynamics Workshop. 2022 AIAA Propulsion Aerodynamics Workshop