

Visual Simulation Laboratory

Lee A. Butler

U.S. Army Research Laboratory

Christiaan Gribble

Applied Technology Operation
SURVICE Engineering

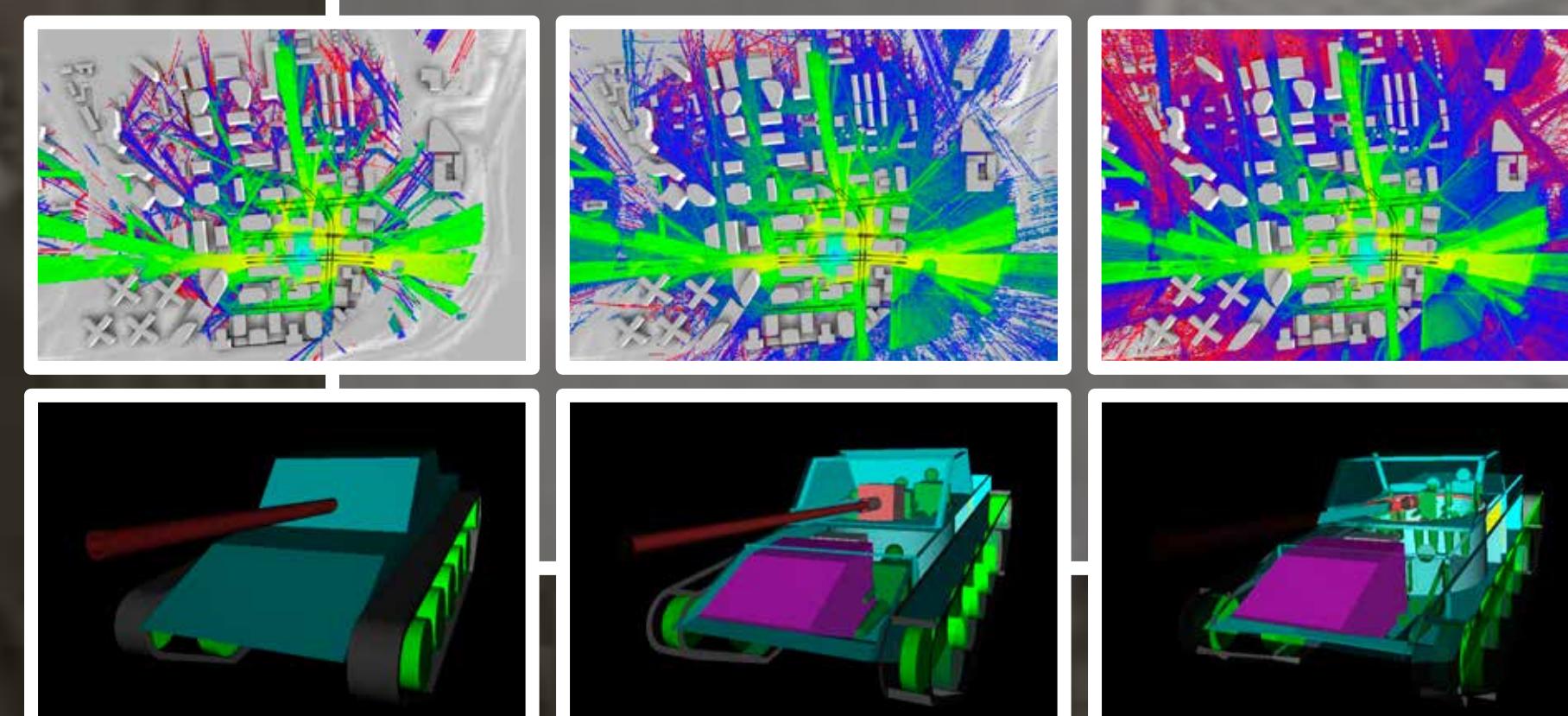
Mark Butkiewicz

Applied Technology Operation
SURVICE Engineering

Overview

The Visual Simulation Laboratory (VSL) is an ongoing, open-source framework developed by the U.S. Army Research Laboratory and its collaborators to bring the power of GPU computing to a variety of DoD application domains. VSL is designed to transform legacy workflows into immersive, end-to-end physics-based simulation and analysis tools.

In the new generation of high-performance simulations, visuals must lead the user toward understanding as the simulation progresses. By exposing the user to the process and progress of the simulation, cognition proceeds in tandem with simulation. In this approach, simulation and analysis overlap, allowing the simulation to be driven by the user. This overlap improves understanding of not only the outcome, but of its origin as well, which together improves confidence in the results. Finally, users can identify critical outcomes more quickly and thereby refine the next stimulation step accordingly. We call this approach cognition-driven simulation (CDS), and it enables a new class of physics-based simulations that require substantial computational horsepower.



Computational pipeline

The simulation pipeline starts with a set of geometry and a notion about the scenario to be computed. These elements define a pattern for sampling the geometry, which typically results in camera parameters for the graphics pipeline. Geometry is sampled using ray tracing, depth peeling, or other computational means to drive the simulation forward. These actions alter simulation conditions, which are displayed interactively, and the next stage of simulation begins.

Current VSL applications

VSL provides a framework in which to research, develop, and deploy highly efficient simulation and analysis code for a variety of physics-based simulation and analysis domains using CDS. Current examples include:

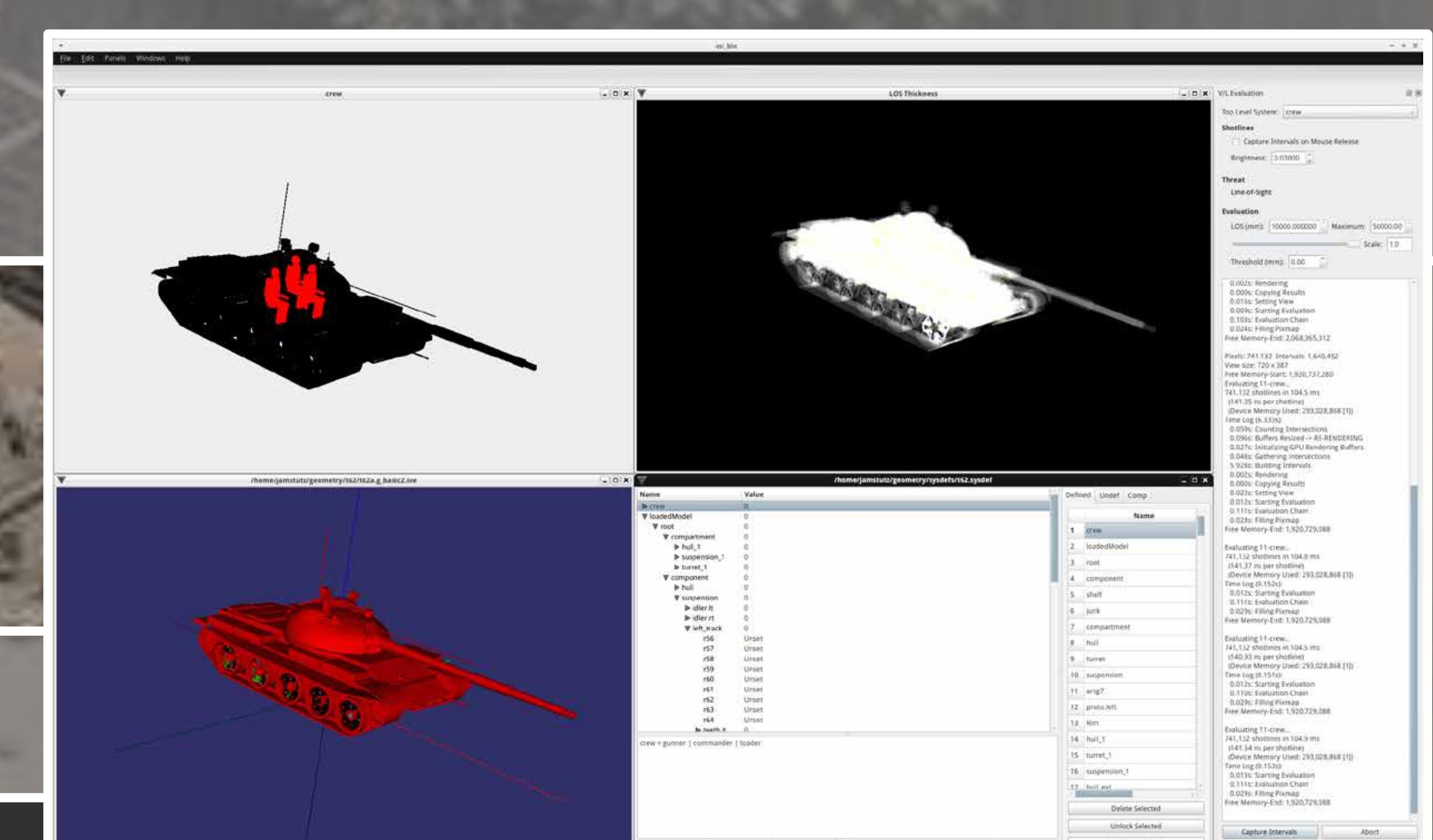
- Computational Fluid Dynamics:** VSL has already tested a prototype capability in which SURVICE Engineering's Apollo CFD engine was integrated and demonstrated to run a simulated blast interactively on desktop-class hardware.
- Live-Fire Testing:** VSL has been used to support the design of live-fire testing on several DoD programs, saving hundreds of thousands of dollars by enhancing the shot selection process and eliminating expensive tests that would not have produced anticipated results.

By leveraging advances in GPU computing, VSL brings high-performance simulation and analysis tools to the analyst's desktop.



RF propagation	General	Ballistic
Environment, wavelength	Geometry, scenario	Target, threat
Antenna patterns	Sampling	Engagement patterns
	Geometry intersection	
	Intervals	
Reflection, diffraction	Interaction	Penetration
Attenuation, signal/noise	Consequences	Damage, fragmentation
Information bandwidth	Implications	Systemic function
	Visualization & simulation steering	

CDS scenarios with VSL. Geometry is sampled, which alters conditions of the simulation. Both computational mechanism and results are displayed interactively, driving the next stage of the simulation forward.



Leveraging GPU computing

Executing complex simulations that normally take hours or days to compute at interactive rates requires thousands of cores executing simultaneously. In addition, these cores must be programmed optimally to process massive amounts of data and display results to users.

VSL adapts software and hardware typically used in rendering to other physics-based simulations. For example, VSL leverages high-performance ray tracing, depth peeling, and other computer graphics techniques to create an engaging analysis experience.

