# The OpenCL™ revolution

Backed by hardware manufacturers like AMD, OpenCL™ enables DCC, CAD and simulation software to tap into the processing power of modern GPUs, opening up bold new ways of working

Revolution

Five years ago, there was just one way to speed up complex computing tasks: buy more computers. With DCC and CAD software focused around the CPU, the only way for studios to accelerate complex simulations or rendering jobs was to build huge, costly supercomputing networks.

Now there is another solution: GPU computing. Whereas even the most powerful professional CPUs typically have only four or six processing cores, modern GPUs have hundreds. By tapping into the power of the GPU for general processing tasks, even an ordinary desktop workstation can become a supercomputer in its own right.

But for that to happen, your software needs to be able to talk to the GPU – and for that, you need an API. Enter OpenCL. Originally developed by Apple, and supported by leading hardware manufacturers Intel, IBM, Nvidia and AMD, this open standard offers a powerful, flexible – and, above all, universal – way to harness the power of modern GPUs.
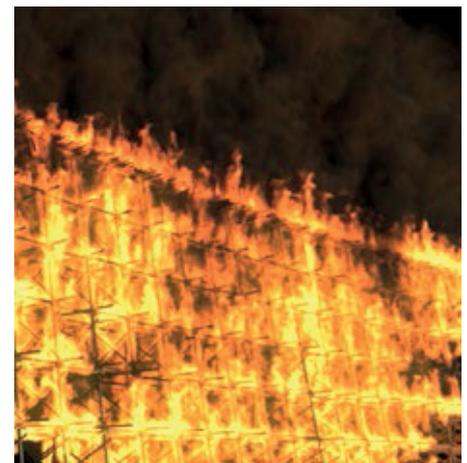
The rise and rise of GPU computing

Although most of the early media coverage of GPU computing focused on rendering, it is not the only task that can be accelerated.The GPU is an ideal platform on which to perform any operation requiring fast, massively parallel calculations, and modern software manufacturers have adopted it for everything from fluid and multiphysics simulation to image processing and compositing.

Those early adopters include some of the biggest names in the industry, such as Autodesk and Adobe – which recently selected OpenCL to power Photoshop CS6's acclaimed Mercury Graphics Engine.
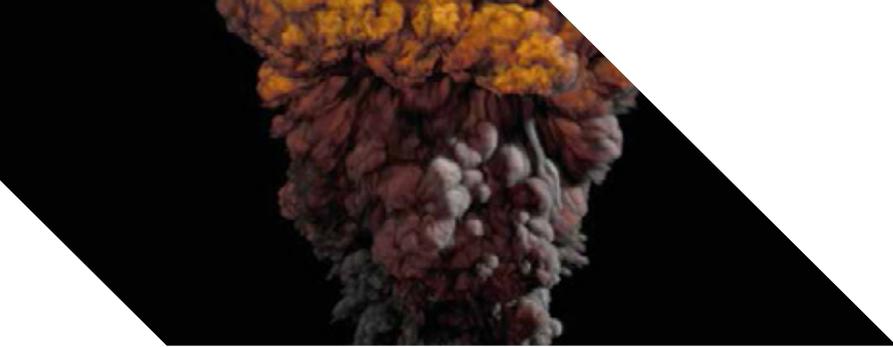
OpenCL

Studios worldwide now rely on GPU computing for time-critical tasks. Side Effects Software recently implemented OpenCL to power Pyro FX, Houdini's smoke and fire simulation toolset, previously used on blockbuster movies like The Wolfman. And the world's most widely used 3D application is now powered by the GPU. Blender's Cycles render engine, released last December, offers GPU computing options, and a GPU-accelerated version of the Blender compositor is due to follow later this year.

GPUs speed up complex tasks

For eyeon Software, the main benefit of GPU computing is simple: raw power. Eyeon was one of the first DCC software developers to support OpenCL, using it to accelerate computationally intensive tasks within Fusion, its professional compositing system.

"With hundreds or even thousands of cores available [on the GPU] we can implement more complex FX algorithms," says Joanne Dicaire, Executive Vice President of Sales and Marketing.

"Deep volume fog, for example, takes approximately 40 minutes per frame to render in a 3D renderer. As a GPU version, Fusion's deep volume fog renders at 10 frames per second or faster with full raycasted self-shadowed lighting. This is unprecedented for a compositing application."

OpenCL opens up new ways of working

Cutting computation time from days to minutes means that VFX facilities can take on jobs that would have been impossible using the CPU alone: something eyeon has witnessed at first hand.

"We are working with studios to develop new tools and workflow enhancements, together with GPU and OpenCL optimisations," says Dicaire. "For Roland Emmerich's film Anonymous, we worked with Uncharted Territory to develop the 3D volume fog system. The budget and time constraints meant the visual effects could not have been done in any other way."

But it isn't just visual effects that benefit from the power of the GPU. In the engineering world, DEM Solutions has adopted OpenCL within EDEM, its simulation platform for the analysis of bulk particle handling and manufacturing operations.

"The power of the GPU enables us to visualise very large systems. Because of that, we're able to get insight into the behaviour of bulk materials in ways it would be impossible in physical systems," says DEM Solutions CEO John Favier.

"We not only have to simulate large numbers of objects, but extract engineering results from the simulation. Without the GPU, we just wouldn't be able to do that analysis in a practical timeframe."

OpenCL is hardware-agnostic

Robert Jamieson, ISV Manager at AMD says "When using GPU computing the speed improvements can be dramatic. The linear nature of the GPU means it can compute lots of data sequentially which means it can improve certain parts of applications with increases of 5X in performance. As OpenCL works on multiple platforms and multiple types of hardware it is a safe platform to develop on. As OpenCL is a "open" standard it makes it a consistent API to implement and update".

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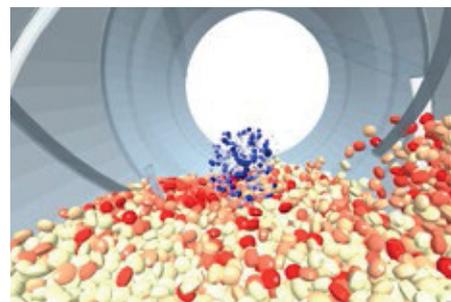
Write once, run anywhere

OpenCL code is compiled at run-time, rather than precompiled in advance and stored in a binary format inside the executable.

Although this presents its own challenges for developers, the advantage is that the code can support new hardware right away: something that Chaos Group discovered with V-Ray RT, the GPU-accelerated interactive preview within V-Ray, its industry-standard rendering software.

"V-Ray RT GPU ran without problems on Nvidia's new Kepler GPUs right after they were released, whereas software that relied on CUDA had to wait until the CUDA toolkit was updated in order to compile a Kepler-compatible version," says Vladimir Koylazov, Chaos Group's CTO and Co-Founder.

Mobile developers back OpenCL

"We wish everyone would latch on to OpenCL: it would make software development much easier," agrees John Melonakos, CEO of AccelerEyes. The company develops libraries for accelerating C, C++, Fortran, Python and MATLAB code on GPUs.

According to AccelerEyes, over half its customers develop code on their PCs before deploying it to a workstation or cluster. This can make it difficult to develop for proprietary APIs. For example, Apple does not currently offer a Nvidia GPU in its MacBook Air and 13"

AccelerEyes customers are also becoming increasingly interested in the possibilities offered by mobile computing on tablets and smartphones: a market in which OpenCL has been widely adopted.

According to the company's blog: "OpenCL has quickly become the most pervasive way to do GPU computing on mobile devices, including smartphones and tablets. Companies like ARM, Imagination Technologies, Freescale, Qualcomm and Samsung are all enabling their mobile GPUs to run OpenCL code. There are more mobile devices sold each year than there are PCs, so this is a huge community that is beginning to put its support behind OpenCL."

OpenCL cuts development time

The time saved in not having to develop new code for each hardware platform on which you want your software to run can also be significant – something that optical and lighting simulation specialist OPTIS discovered with THEIA-RT, its real-time visualisation system.

"Time saved on kernel development enables us to spend more time on tasks like developing a nice UI and adding new raytracing features such as advanced caustics and global illumination. Thanks to the time saved by using OpenCL, we had advanced GI ready three months earlier than we had planned," says Nicolas Dalmasso, co-founder and COO at SimplySim, part of the OPTIS Group.

"With the GPU, things that used to take a day can now be done over lunch, things that used to take a lunchtime can now be done over a coffee break, and if it used to take a coffee break ... now you don't get your coffee break."

John Melonakos, CEO and co-founder, AccelerEyes

A new way to think about computing

With its combination of write once, run anywhere functionality and widepsread industry support, OpenCL is opening up new ways for CAD, DCC and simulation software developers to tap into the power of modern GPUs.

Autodesk is currently implementing GPU support within Maya, its industry-standard 3D animation software. Its latest technology preview, on show at Siggraph, shows OpenCL in use to accelerate Maya Fluids simulations, bringing a speed boost of 5-10 times over pure CPU-based computation.

For Bruce Hickey, Autodesk's Software Development Manager, the work is part of an ongoing collaboration with the industry: one that will ultimately change the way in which both software and hardware are developed.

"The way that animation is done right now is really quite freeform," he says. "We're working with production companies to agree that there's a certain order in which operations have to be carried out. If we can codify that, it will help us see the full potential of the hardware."

And for that, a close relationship with hardware manufacturers like AMD is essential. "We have a very tight connection with AMD's backend team," says Hickey. "We're happy to provide the feedback to enable them to get the last ounce of performance out of their technology."

It's a sentiment shared by Autodesk Media & Entertainment Product Manager Kamal Mistry: "The performance we are seeing is incredible!" he says. "Calculations happen in real time and frame rates stay high, even when working on complex visual effects. I can't wait to see the improvements with the next generation of AMD FirePro™ cards and how the software will truly sing."

"OpenCL allows Maya to get to the GPU compute performance of AMD's FirePro cards, and the performance we are seeing is incredible! Calculations happen in real time and frame rates stay high, even when working on complex visual effects"

Kamal Mistry, Product Manager, Media & Entertainment, Autodesk

Which software uses OpenCL?

CAD, DCC and simulation tools that use OpenCL to tap into the power of GPU computing.

Developer	Software	Key tasks accelerated	Speed Boost[a]
eyeon Software	Fusion	Compositing[b]	>1,000
OPTIS	THEIA-RT	Final-quality rendering	50-100
AcceleReyes	Jacket	Executing MATLAB code	3-100
DEM Solutions	EDEM	Simulation of particulate materials	5-10
Chaos Group	V-Ray	Preview rendering[c]	5-10
Autodesk	Maya[d]	Fluid simulation Blend Shape deformation	5-10 3-5
Side Effects Software	Houdini	Fire and smoke simulation[e]	2
Adobe Systems	Photoshop[f] Premiere Pro[f]	Painting and image processing[g], Video editing and processing[h]	No figures available No figures available
Blender Foundation	Blender	Final-quality rendering[i] Compositing[j]	No figures available No figures available

(a) Typical speed boost over CPU alone on current-generation hardware, as quoted by developer (b) Particularly 3D rendering, deep volume tools, camera defocus and 2D image processing (c) Via V-Ray RT GPU
(d) Technology preview only: not in current commercial release (e) Via Pyro FX toolset (f) CS6 edition only (g) Particularly Crop, Puppet Warp, Liquify, Adaptive Wide Angle, Lighting Effects, 3D rendering
(h) Scaling, deinterlacing, blending modes, colour space conversions, some effects (i) Via Cycles render engine (j) Particularly camera blurs, vector blur, depth of field and advanced dilate-erode algorithms.

AMD