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Enabling High-Performance Graphics Processing for Military and Aerospace Applications with SOC Processors and OpenGL

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Every incremental gain in processing performance for graphics-intensive avionics applications unlocks corresponding boosts in situational awareness and responsiveness for pilots and unmanned aerial vehicle (UAV) operators. As aircraft control panels evolve to include advanced synthetic vision and video overlay capabilities displayed in photo-realistic 3D clarity, operators' intuitive understanding of the flying environment is naturally enhanced. This yields clear advantages in air transport, combat and surveillance applications while helping to provide greater overall safety.

Historically, the development of new x86 and discrete graphics processing platforms has been driven primarily by the commercial marketplace, fueled by consumer demand for ever-faster, multimedia-optimized PCs, tablets, and gaming systems – and the back-end IT and Internet infrastructure that powers the online applications and services ecosystem. As a result, the vast majority of military and aerospace display systems operate with time- and space-partitioned real-time operating systems (RTOSs) and graphics drivers that are not supported by the processor manufacturer. And unlike drivers used in consumer markets, the graphics drivers used in high-reliability environments must be rigorously designed and tested in conformance with industry-recognized safety standards and include support for the target system's RTOS.

The hard work of ruggedizing and ensuring certification conformance for processors used in mil/aero applications, therefore, typically falls to third-party specialists – and the requirements in these domains are exacting. Specialists such as CoreAVI, for example, go to extreme lengths to achieve the highest possible levels of integrity by providing **European Aviation Safety Agency** (**EASA**) and **Federal Aviation Administration** (**FAA**) certification packages to allow the processors to be used in avionics applications. In addition, the processors are made available over an extended lifespan – up to 20 years – which is far beyond the standard commercial processor lifecycle. Able to be used in these safety-critical applications, each processor is assigned a unique serial ID with lot/date information and tracked from manufacturing to use, undergoes extended temperature screening and is maintained with 24/7 security and control of environmental storage conditions for the length of production.

Packaged with specialized software drivers and conformant with applicable certification requirements, these processors are provided to customers developing the world's most advanced graphics applications and may ultimately be called upon to power an entire generation of critical avionics systems.

PARALLEL PROCESSING PERFORMANCE GAINS WITH SOCs

As these specialized, long-lifecycle processor management strategies have evolved, so too have the processors themselves. Graphics-intensive avionics systems are increasingly transitioning away from FPGA and DSP platforms in favor of more versatile, higher-performing embedded GPUs which are optimized to handle high-speed multimedia processing as well as the massively parallel processing required for tasks such as radar processing, object recognition and video manipulation. To date, these GPUs have been deployed in avionics display systems via ad hoc heterogeneous CPU+GPU chipsets, which rely on the CPU to interface with the GPU via a North Bridge connection, sending calls to the GPU to invoke code running on the coprocessor that then sends results back to the CPU. But this serial data processing approach can add memory latency, which can affect RTOS enablement while also introducing design penalties centric to power consumption and board space.

The recent introduction of the new system-on-chip (SOC) processor architecture, which features the silicon-level integration of CPU, discrete-class GPU and I/O controller on a single die, is a significant development for high-performance avionics display systems. With the SoC architecture, the CPU is tasked with scalar processing including storage, networking and memory processing while simultaneously running the operating system, applications and user interface. Meanwhile the on-die GPU offloads graphics processing using SIMD parallel processing, driving HD displays with great efficiency. Data parallel processing can be offloaded from the CPU to the GPU, freeing up the CPU for compute, memory and I/O requests. This fully optimized data path, further boosted via shared access to the memory controller, reduces processing latency and helps to improve real-time video and graphics processing performance in avionics display applications.

The consolidation of CPU, GPU and I/O controller onto a single chip naturally streamlines system size and accelerates design cycles while lowering bill of materials (BOM) costs through a reduction in board layers and components. Low-power SOCs such as the AMD Embedded G-Series SOC platform can also help enable fanless designs, further driving down system costs, reducing system noise and weight, and improving system reliability by helping to eliminate the failure points inherent to moving parts. Other key SOC features include enterprise-class error-correction code (ECC) memory support and a variety of power/performance options, including the ability to scale power/performance dynamically for greater power management control by clocking the CPU and GPU up or down as needed.

EASE OF PROGRAMMING WITH OPENGL

In order for designers of graphics-driven avionics systems to most effectively take advantage of the increases in parallel processing power provided by SOCs, their programs must be written in a scalable fashion so as to run on the widest possible range of systems without coding modification. Open development tools like OpenGL and its variants are playing a major role in this effort.

OpenGL, the cross-platform open API for hardware-accelerated rendering of 2D and 3D computer graphics, is a natural complement to SOCs' parallel processing capabilities, introducing the ability to run sophisticated, massively parallelized algorithms to render stunningly crisp graphics and video for high-performance visualization applications such as primary flight displays and mission computer systems. OpenGL can also take advantage of SOCs' native hardware acceleration capabilities, which helps maximize processing performance while minimizing strain on the CPU.

The OpenGL SC (Safety-Critical) profile is specifically defined to meet the unique needs of safety-critical markets such as avionics – it simplifies certification processes, ensures a deterministic approach, enables a small footprint for real-time environments, and can facilitate the porting of legacy safety-critical applications while accommodating the FAA-mandated DO-178C certification process for ensuring reliable graphics drivers for instrumentation, navigation and controls.

Meanwhile, OpenGL ES (Embedded Systems) is emerging as the leading software interface and graphics library for rendering sophisticated 3D graphics on embedded avionics devices, exploiting the full programmability of shaders by giving developers the ability to write vertex and fragment shaders, and implement advanced rendering techniques such as per-pixel lighting, particle systems and projective texturing.

THE NEW FACE OF AVIONICS PLATFORMS

The accelerating adoption of OpenGL and its variants reflects a growing interest among the mil/aero developer community in promoting the development of open standards for avionics systems. The Future Airborne Capability Environment (FACE) Consortium, managed by The Open Group and promoted by the U.S. Naval Air Systems Command (NAVAIR), is indicative of this trend. The FACE technical standard is designed to standardize approaches for using open technologies and interfaces within avionics systems, and promotes software portability, interoperability and reuse. Like OpenGL, FACE ultimately aims to speed the delivery of technical innovation into the field and lower implementation costs via a highly flexible, open standard model.

Using open development tools such as OpenGL to unlock the full potential of new SOC-based avionics systems, designers are equipped to achieve new levels of parallel processing performance that can enable significant gains in graphics and visualization capabilities. This performance advantage can be sustained – and often improved, with performance headroom to spare in many implementations – over a 20-year lifecycle with the proper long-term processor management and supply strategies in place.

About CoreAVI

Core Avionics & Industrial Inc ("CoreAVI"), a Channel One company, provides "program ready" embedded graphics and video processors to mil-aero and high reliability embedded systems manufacturers. A worldwide provider of AMD graphics processors and SoC products, CoreAVI's products includes 20+ year supply management, temperature-screened versions of the AMD Radeon™ graphics processors and embedded graphics, video and OpenCL drivers to enable AMD Radeon™ graphics support for real time operating systems. CoreAVI's program support includes FAA DO-254 and DO-178C (up to Design Assurance Level A) certification evidence for safety critical environments.

About AMD

AMD is a semiconductor design innovator leading the next era of vivid digital experiences with its groundbreaking AMD Accelerated Processing Units (APUs) that power a wide range of computing devices. AMD Embedded Solutions give designers ample flexibility to design scalable, x86- based, low-cost and feature-rich products, and drive energy conservation into their systems without compromising application performance or compatibility, graphics performance or features. For more information, visit www.amd.com/embedded-systems.