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GPGPU COTS Platforms

High-Performance Computing Solutions.

abaco SYSTEMS

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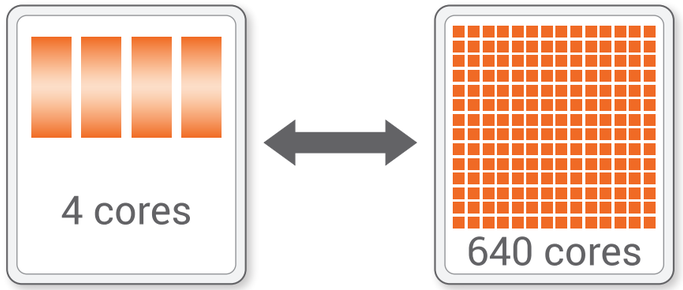
Rugged GPGPU COTS Boards for Military and Aerospace

GPGPU platforms deliver new levels of performance for size, weight and power (SWaP) constrained mission payloads.

The world of high-performance computing is undergoing a revolution, thanks to advances in General Purpose computing on Graphics Processing Units (GPGPU). The idea behind GPGPU is to use a GPU, which typically handles computation for computer graphics only, to perform parallel computation in applications that have traditionally been handled by the CPU.

A multi-GPU platform hosted by one or more CPUs is able to perform heterogeneous computing, harnessing the parallel computing power of the many-core GPUs to provide very large increases in performance with minimal programming complexity.

PARALLEL COMPUTING



Optimized for throughput computing

Additionally, programmers are helped by software development environments such as Compute Unified Device Architecture (CUDA) and OpenCL, which allow them to harness the many-core, parallel processing capabilities of the GPGPU platforms.

While greatly increasing functional capability, the GPGPU platform also delivers the performance with far less size, weight and power (SWaP). This results in significant savings in cost, risk, and time-to-market.

Lab-proven technologies ruggedized for the rough and tumble world of military applications

Now these benefits are fully available to rugged military and aerospace applications. With a full range of Abaco rugged GPGPU boards and systems, the advantages of GPGPU are no longer confined to controlled environments at universities, research centers and hospitals.

The unique partnership between Abaco and NVIDIA allows for new product development using NVIDIA GPUs based on the award-winning CUDA architecture, for military and aerospace applications.

Rugged GPGPU COTS Boards for Military and Aerospace

Development Ease

Increases in performance will be obtained in application areas such as Software Defined Radio, sonar, and medical imaging. But what is less obvious is the change in development strategy offered by GPGPU technology. The only other technology currently offering massively parallel processing capability is Field Programmable Gate Arrays (FPGAs).

Although FPGAs provide very high performance data processing, developing high-performance FPGA cores requires a very specialized skill set built on a hardware engineering background, whereas developing code for GPGPU processors is much more about software expertise. For companies with a background in multi-processor GPP/ DSP-based system architecture, the move to GPGPU will be much less disruptive than a move to FPGA processors. The processing power, system size and power consumption enabled by GPGPU are compelling factors, but the addition of programming ease makes such a system tough to match.

Typical GPGPU applications

Radar

One of the biggest challenges for today's radar systems is to provide more capability—range, number of targets, speed, and so on —while meeting ever more stringent SWaP constraints. The extra speed offered by GPGPU platforms translates directly to more area coverage and more security for the operating team.

One rack containing 72 conventional processors (18 6U boards) and producing a peak capability of 576 GFLOPS can take up four cubic feet, weigh over 105 pounds and consume over 2,000 watts. GPGPU technology can allow system designers to fit an unprecedented amount of processing power into a very compact package. The use of three 3U VPX boards can yield peak processing power of 3916.8 GFLOPS in less than 0.4 cubic feet.

Data Encryption/Decryption

There are several standards for encryption of data, including the Advanced Encryption Standard (AES). AES is the first publicly accessible and open cipher approved by the U.S. National Security Agency for top secret information, typically requiring 256-bit keys at this level. The time to encrypt a block of data increases linearly with the size of the key.

The computation load required to maintain encryption of a real-time data stream can be prohibitive. With the advent of CUDA and the addition of crucial arithmetic, bitwise logical and shift operations as well as the ability to use texture caches to index tables, GPUs are now a viable alternative to general purpose processors for data encryption/decryption. Performance gains up to 10x have been demonstrated.

Situational Awareness

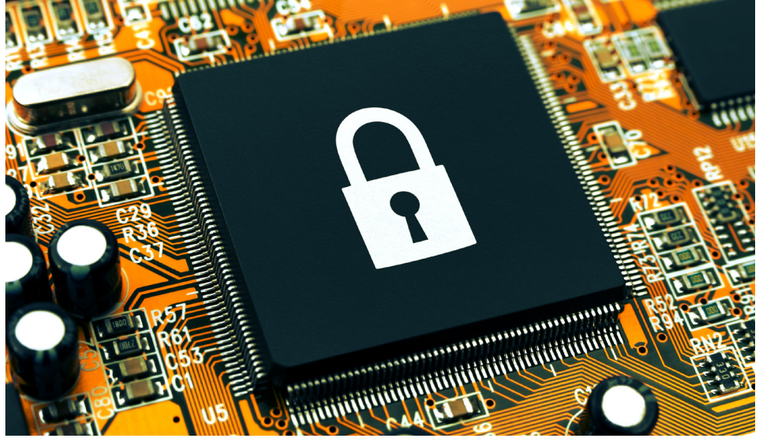
Surveillance of large areas has historically been achieved by using an array of sensors connected to a bank of monitors, with separate or multiplexed displays for each video stream. Such arrangements present the operator with a confusing array of disparate video feeds, require a great deal of space, and consume a large amount of power. In a dynamic, real-time scenario, there is also a danger of information overload for an operator attempting to interpret such large volumes of imagery.

Interrelationships between sensors is not always obvious, and important contextual visual information can be overlooked. Many such systems rely on the operator for "event" detection, but large volumes of information, coupled to the effects of stress and fatigue, can significantly reduce operator effectiveness. Abaco's image processing subsystem overcomes these issues and greatly improves the performance of surveillance assets and their operators. We offer a previously unattainable level of situational awareness to platforms such as armored vehicles, aircraft, remote unmanned platforms and security and surveillance systems

IED Detection

Improvised Explosive Devices (IEDs) are a major cause of injuries and fatalities among ground troops. A number of techniques for automated detection of IEDs are used, and all of these require processing a high volume of data. The effectiveness of the solution depends on how fast the algorithm can reliably operate on that data. GPGPU technology is proving to be a highly effective solution for such high throughput computations.

Ground Change Detection relies on realtime image processing, and may be applied to sensors mounted on ground vehicles or UAVs. The system needs to



apply image registration and stabilization, and moving object extraction, before comparison with normalized geo-referenced data, all while dealing with lighting and legitimate scene changes.

Ground Penetrating Radar (GPR) allows construction of a 3D model of the ground, identifying any suspicious objects or changes from normalized data. GPR can be applied to ground mobile or airborne systems. In addition, behavioral modeling— based on live sensor imagery, possibly combined with wide-area surveillance data—can be used to identify hostile intent and potential threats, giving operational forces time to assess the risk and take appropriate defensive actions.

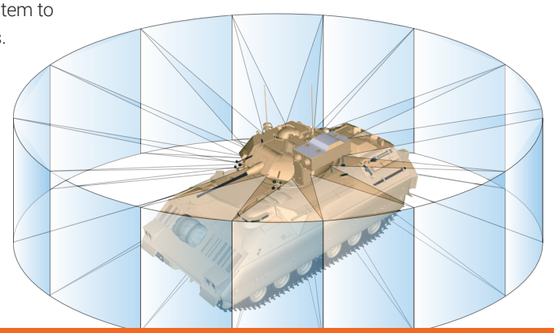
Target Tracking

GPGPU-based video trackers and image processors are at the heart of target tracking systems where they provide the highest performance solutions in the smallest, fully ruggedized hardware packages.

Target detection and target acquisition processes identify objects within an area of the video image display that meets the user-defined target criteria. A range of detection algorithms is built into the system to meet situational requirements.

When one or more targets have been detected, the tracking system can enter automatic or manual tracking mode. Automatic target acquisition may be prioritized by using several different factors, such as target nearest to the boresight or the largest target. If a system is in autotrack mode, the video tracker automatically tracks the selected target and can control almost any type of pan-and-tilt or gimbal system to track the target.

GPGPU-based automatic video trackers feature a wide range of proven high performance detection and tracking algorithms that can be tailored to the operational scenario, including centroid, phase correlation and edge detection. Algorithms may be combined to meet particularly demanding tracking scenarios.



Abaco Platforms

GVC1000

Rugged, Low SWaP Graphics and Vision Computer

Rugged, mission ready system for graphics applications based on the new NVIDIA Jetson TX2 SoM. Optimized for SWaP-C, the GVC1000 is designed for deployment in harsh, constrained environments that require significant computing capability, including autonomous unmanned vehicles and robotic systems. Two 10Gb Ethernet ports for multiple camera inputs. Two MilCAN/CAN ports to receive vehicle data. Comprehensive USB provision for peripheral attachment. With internal storage of up to 128 GBytes of solid state disk, there's almost no limit to how much mission- and moving map data that can be accessed – fast. ImageFlex provides an easy to use framework to enable rapid development of high performance image processing and graphics applications.

GRA113

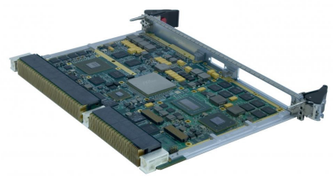
NVIDIA 'Maxwell' CUDA Capable Graphics Processor

The GRA113, a 3U VPX graphics board, employs the 640-core NVIDIA Maxwell GPU to bring desktop performance to the rugged military and aerospace market. In addition to meeting increased demand for graphics rendering performance, the GRA113 is also a rugged implementation of a CUDA Compute Capability v3.0-capable GPU. The GRA113 supports the 16-lane PCI Express implementation, providing the maximum available communication band width to a CPU such as the Abaco SBC341.

XMCGA8

Designed from the ground up for safety-critical applications DO-254 / DO-178

XMC featuring AMD/CoreAVI GPU graphics. The AMD/CoreAVI chip set features parts that have been temperature screened and qualified, and is supported by the necessary low level operating system graphics drivers (OpenGL) for VxWorks® 6.9 and VxWorks 653 safety-critical applications and will be supported for up to 20 years. Certifiable artefacts available from CoreAVI that can support a DAL A system design making the development of systems more affordable. Also available inside FORCE2 graphics computer with QorIQ host processor.



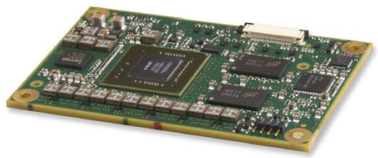
IPN252

Intel and NVIDIA processors

The 6U OpenVPX IPN252 GPGPU Multiprocessor combines an Intel Core i7 processor with a 640-core NVIDIA Maxwell GPU to deliver up to 1.4 TeraFLOPS of performance from a single chassis slot, delivering unprecedented performance in a range of demanding, data-intensive digital signal processing applications such as intelligence, surveillance and reconnaissance (ISR), high performance airborne radar, synthetic aperture radar (SAR) and ground moving target indicator (GTMI).

mCOM10-K1

COM Express, NVIDIA Tegra K1



Based on the NVIDIA® Tegra® K1 system-on-chip (SoC), Abaco Systems' Mini COM Express module delivers 326 GFLOPS of performance in a 10 Watt budget, well beyond the performance typically associated with COM Express, to SWaP-constrained environments. The mCOM10-K1 is ideal for applications where very high performance in data-intensive applications, rugged reliability in harsh environments and very compact size need to be combined.

Software

AXIS ImageFlex

ImageFlex is an image processing and visualization toolkit enabling rapid development of high performance image processing and visualization applications aimed at size, weight and power (SWaP) sensitive applications. It is focused on high performance GPU processing and graphics.

FEATURE SUMMARY

Visualization framework API:
- Image creation and management
- CPU to GPU data movement
- 2D “overlay” drawing

Image processing API:
- Image manipulation
- Lens distortion correction.
- Complex image morphing
- Image fusion
- Image stabilization

Interoperability API:
- CUDA interoperability
- OpenCL interoperability

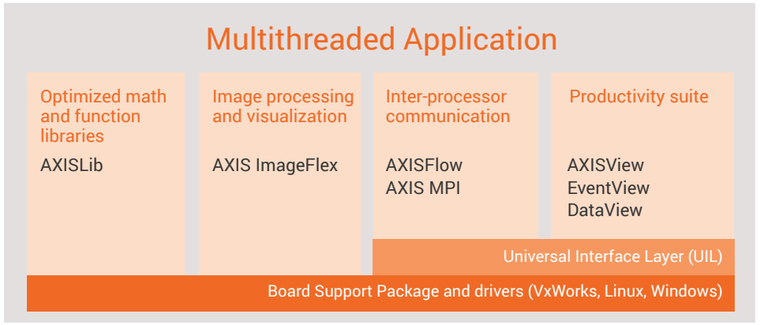
Custom extendibility:
- Easy creation of custom OpenGL “shader”
- 2D & 3D Matrix computation functions

Abaco quick start application examples:
- “Basics” example, showing all key functionality
- “SkyBox” example for spherical situation awareness
- Image fusion example
- Image stabilization example
- OpenCV and OpenVX interoperability examples

CUDA

CUDA is a parallel computing language created by NVIDIA that exploits the massively parallel characteristics of NVIDIA’s ubiquitous silicon. CUDA is taught in universities worldwide and used in many R&D labs, so a large number of programmers are available and there is a wealth of web-based resources.

Integrated Software Modules



CUDA software development tools:
- NVIDIA C Compiler and debugger for parallel GPU code
- CUDA Visual Profiler
- CUDA SDK with examples of best-practice guides
- Parallel Nsight® IDE

Advanced libraries that include:
- NVIDIA Performance Primitives (image and video)
- Image processing: ArrayFire and OpenVPX
- Math and signal processing: cuFFT, cu BLAS, cuSPARSE, cuSOLVER, CUDA Math Library
- Deep learning: cuDNN, TensorRT

C for CUDA extends C by allowing the programmer to define C functions, called kernels, that when called are executed N times in parallel by N different CUDA threads, as opposed to only once like regular C functions. A kernel is defined using the __global__ declaration specifier and the number of CUDA threads for each call is specified using a new <<>> syntax.

OpenCL

Abaco GPGPU products also support Open Computer Language (OpenCL), the first open language for writing programs that execute across heterogenous architectures such as CPUs, GPUs, and FPGAs.. It includes a C-type language for writing kernels, defines APIs, and provides parallel computing using task-based and data-based parallelism. There are now a wide variety of open source and third party libraries and tools for OpenCL development.

OpenCL development tools:
- Compilers and debuggers from NVIDIA, Intel, AMD and Xilinx
- GPUSTATUSMonitor

Open source libraries:
- Image processing: ArrayFire and OpenVPX
- Math and Signal processing: cIFFT, cIBLAS, cISPARSE

OpenGL

OpenGL is supported on all Abaco GPU platforms. It is a standard specification defining a cross-language, cross-platform API for writing applications that produce 2D and 3D graphics. The shader language, introduced in OpenGL 1.4, also allows for OpenGL to be used for a level of compute particularly tailored to image processing applications such as image fusion

The AXIS Multiprocessing software suite facilitates the development of complex applications over multiple clusters of GPU platforms.

AXISFlow provides a communications API for multi-threaded/multi-core/multiprocessor communications.

AXISView provides a set of GUI tools enabling system visualization, application instrumentation, debug and monitoring.

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CUDA software development tools:
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- SDK with best-practice guides
- Parallel Nsight®

Advanced libraries that include:
- NVIDIA Performance Primitives (image and video)
- Basic Linear Algebra Subprograms
- VisionWorks, OpenCV
- cuDNN, TensorRT for deep learning

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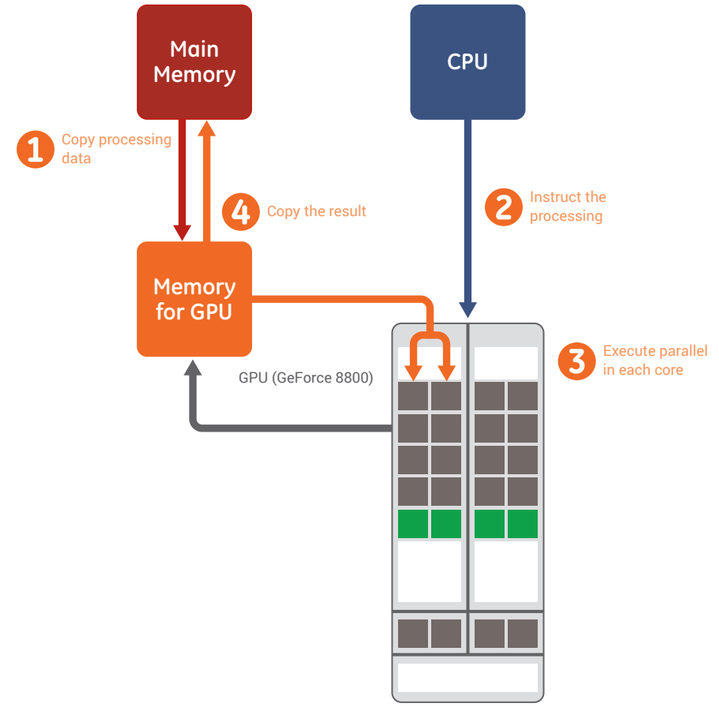
PROCESSING FLOW ON CUDA



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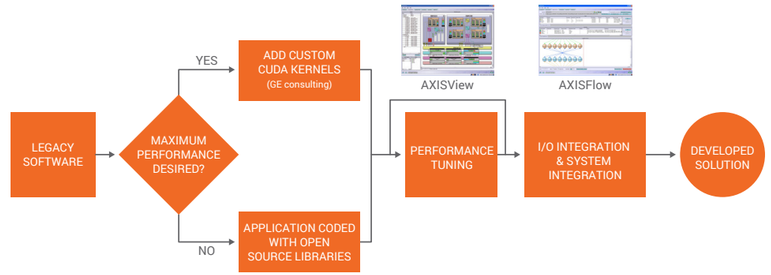
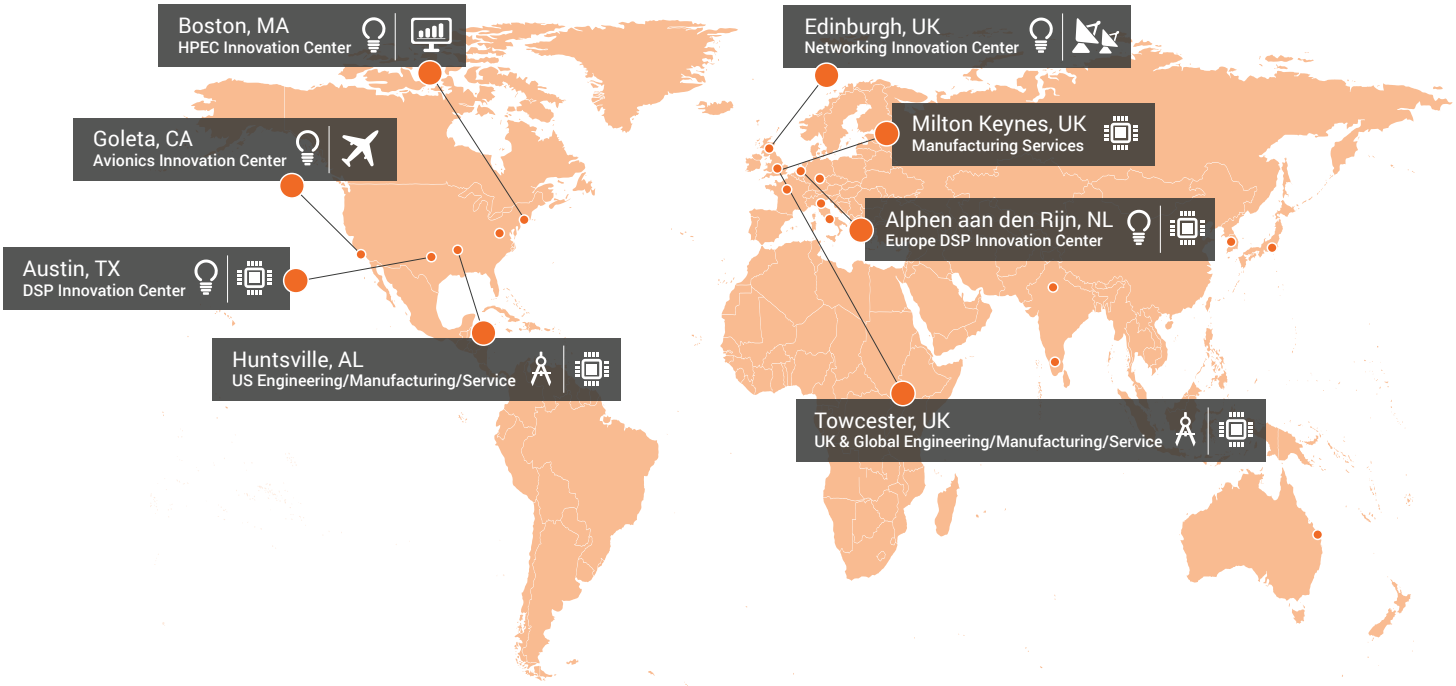
GPGPU COTS Platforms

Abaco GPGPU-empowered platforms can be easily implemented to either adapt to your legacy applications or to accommodate your new applications.



Global coverage



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Americas: **866-OK-ABACO or +1-866-652-2226** Asia & Oceania: **+81-3-5544-3973**

Europe, Africa, & Middle East: **+44 (0) 1327-359444**

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