Remote Sensing using enParallel Technology

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Abstract

This White Paper is offered to describe the many uses that the *ePX Supercomputing Technology* (ePX-ST), from enParallel Inc., can offer to solve many signal processing problems, which may be currently causing loss of SIGINT due to a lack of resources for smart processing at various points in the data-collection and processing chain.

In contradistinction to standard Graphics Processor Unit (GPU) coprocessor use models, the *ePX* GPU-based supercomputing technology is grounded in two fundamental objectives: (1) an acceleration of complete applications, and (2) a generic applicability to broad classes of algorithmic kernels.

Increasing the processing intelligence closer to the sensor, or at an existing classification/thinning/mining point, is a challenge to be effected in a cost effective form-factor, while retaining a scalability of processing power that tracks technological in silicon advances. Furthermore, custom ASIC solutions have a long development cycle, which may not take advantage of R&D costs from commercial ventures. GPUs offer such fast development advances, which can tracked for upgrades at an attractive cost.

The flexibility offered by the ePX-ST is one that adapts to the algorithm needs, rather than an algorithm having to be "shoe-horned" into ASIC/FPGA design constraints., which usually compromise an algorithm's performance and scalability. Furthermore, the conversion from algorithm design/simulation to implementation in an ePX-ST platform offers many benefits in development costs, performance penalties, and algorithm tailoring based on deployment evaluations.

ePX-ST: Introduction

The *ePX* supercomputer processing model is distinguished by optimal scheduling against CPU/GPU Processing Array (C/GPA) processing resources. In particular, algorithmic kernels are dynamically mapped to GPU instances (scheduled) based upon: (1) GPU-element availability and (2) opportunistic Single Instruction/Multiple Data instruction pipeline reuse. A scheduler that focuses on these two resource allocations will yield the highest possible acceleration efficiency.

An ancillary requirement is C/GPA-based supercomputing must be performed within context of standard Windows/Unix/Linux operating system environments. In particular, no assumption is made of a parallelizing compiler, or explicit operating system, runtime support for parallel-process scheduling and management. This generalization is motivated by a goal to accommodate supercomputing applications, and applications development, in a generic personal computing (PC) environment, while preserving all existing application code-base.

In other words, the inclusion of ePX-ST is agnostic to the PC network, thus maximizing the existing code development and application environment.

Algorithm Classes

The most fundamental, and revealing, example of the application for ePX-ST is that of a single transform, and the best known being the Fast Fourier Transform (FFT). In this instance, the "butterfly" is a well known multiplication/add structure that is equally repeated for a number of inputs that depends on the radix chosen for the FFT, usually a power of two. As such, the variations in the computations are data-addressing variations, which are also quite systematic. This regularity exploits the optimization inherent in the ePX-ST metrics for C/GPA utilization. Other well-known transforms fall into this category, such as the DCT which is used in many image compression applications.

However, many other digital signal processing (DSP) applications can be accelerated with high efficiency by the ePX-ST technology.

Many algorithms of importance to data conditioning, thinning and mining involve a linear optimization formulation. The linear optimization involves the solution of a matrix equation,

$$\mathbf{x}=\mathbf{A}^{-1}\mathbf{b}$$

in some instances, for a large matrix $\mathbf{A}$. Matrix inversion algorithms do not offer such a regularity of computational kernel found in the FFT, or DCT, transform. However, many applications admit a numerical approximation, exceeding the performance requirement to be levied on the solution $\mathbf{x}$, which can be exploited via the ePX-ST. One classic example of this linear optimization problem is the Wiener Filter, to conditions received signals in communication systems. Other applications include image deblurring, network optimization, smart antennas, pattern recognition and data-ranking algorithms (e.g., Google Matrix Problem).

The FFT also has very appealing feature, which is the processing of input data samples that remain static for the duration of the transform. Other algorithms do not offer this consistency due to signal conditioning/manipulation, and features extractions. Indeed, some algorithms may require a simple sequence of steps involving different types of algorithm kernels and data structures. Such instances can also be solved through the proper allocation of C/GPA and PC network configuration.

The convergence of many DSP algorithms to Linear Algebra formulations implies a greater ease for ePX-ST platform acceleration. Decompositions of these algorithms into systematic computational kernels make previous custom design have a highly efficient acceleration in a C/GPA environment.

Applications

The ease of extension from a PC to a supercomputing platform, without dramatic increases to power and size requirements, implies that DoD networks can traffic with greater efficiency for SIGINT of interest. That is, data thinning can happen closer to the sensor, where a PC is already in place, or one can easily be installed. In such a scenario, the PC can effect many data classification algorithms, which may require signal conditioning, prior to forwarding for further processing.

Contact

Due to the flexibility offered by the ePX-ST enhancement of a PC-based C/GPA platform, and the many algorithms utilized for a myriad of DoD applications, enParallel recommends a more specific evaluation, at the generic algorithm specifications, to demonstrates the performance gains and/or systems requirements to meet processing speeds. The staff at enParallel can identify ePX-ST computational structures that easily exploit the resources in a C/GPA for many algorithms and their applications, when specified at a generic level.

For further discussions please contact

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