CS 527 : Parallel Computer Architecture

Group - 2

Report on Architecture Study

Topic - Accelerators

Group Members

Abhishek Kumar	180101003
Aniraj Kumar	180101007
Munindra Naik	180101045
Ritik Mandloi	180101066

About

Accelerators are a piece of specialized hardware circuitry that implements various functions in order to perform a set of operations with higher performance or greater energy efficiency than a general-purpose microprocessor.The use of accelerators by software to speed up various operations is known as ***hardware acceleration.***

Accelerators are used to significantly improve the performance of certain workloads. They improve the execution of a specific algorithm by allowing greater concurrency, having specific datapaths for their temporary variables and reducing the overhead of instruction control in the fetch-decode-execute cycle.

Examples of hardware acceleration include bit blit acceleration functionality in graphics processing units (GPUs), use of memristors for accelerating neural networks and regular expression hardware acceleration for spam control in the server industry, intended to prevent regular expression denial of service (ReDoS) attacks. The hardware that performs the acceleration may be part of a general-purpose CPU, or a separate unit called a hardware accelerator, though they are usually referred with a more specific term, such as 3D accelerator, or cryptographic accelerator.

Design Goals

Accelerators are used to improve performance of the system for which the hardware should be designed in such a way that we can get optimum performance with viable manufacturing cost for production. For feasibility of the hardware we need to consider following points which helps to improve the design of the hardware for their optimum performance ,viz,-

- **Low Energy Consumption** - Lower energy requirement by hardware may significantly reduce the cost in operating the system which results in favoring of certain architecture over other already existing architectures of accelerator

- **Increased Parallelism -** With increase in parallelism, the system can run more process simultaneously with the help of accelerators resulting in better performance by the system

- **Better utilization of area -** With better utilization of area , more units of accelerators or processors can be embedded on the chip which can be used to increase parallelism in the system and increase efficiency

- **SpeedUp -** The accelerator should be designed in such a way that it is better in terms of computations of data if compared with any already existing architecture which is used in the industry otherwise there is no use of the design

- **Better Real-time Performance -** The accelerator should be compatible with host processor so that the host processor can utilize the accelerator to achieve real-time performance

Salient Features

The development and advancements related to the field of accelerators, has made them quite an obvious choice over any other technology for many applications such as graphics rendering, complex mathematical calculations, satellite image processing, target recognition in UAVs and many more. The important features because of which accelerators are used and preferred in real life for many applications are as follows, viz, -

- **Reduced Power Consumption -** Accelerators use less power when compared to any general purpose processor when they both perform the same set of tasks. This feature of accelerators seems to be very useful for mobile systems which depend upon their battery life for their power requirement, with less energy requirement their battery life will increase which can be used to perform more computation and stay on for a longer period of time as compared to a powerful general purpose processor which may take to perform same tasks with same time but higher power requirement.

- **High Performance -** With accelerators along with the host processor, the system can perform more efficiently and take less time when compared to just the host processor as complex and difficult workloads are performed by the accelerators on behalf and the host processor can perform other tasks which increases the throughput of the system which makes the system interaction smooth and faster.

Technology Used

Accelerators are actually a structural unit which is connected to the host processor of the system which helps it to perform tasks more efficiently and faster by performing certain workloads for the host processor or general purpose processor instead of host because of which the host processor can perform other tasks simultaneously. The accelerators are needed to be built and attached to the host processor on the circuit board.

For building or implementation of accelerators can be done in the following ways ,viz, -

- **Specialized Processor** or **Coprocessor -** It is a separate processor that uses hardware optimized for the intended types or type of logic. In other words, these processors perform computation which is beneficial over a domain, like GPU is designed to render graphics over the interface which involves calculations over floating point numbers which can also be used for scientific computing. These are generally large in quantity and performance at a low frequency but as they are large in quantity they divide the work and perform the same work as a general processor in less time and less energy consumption.

- **FPGA (Field Programmable Gate Array) -** It is a processor that is designed to be configured by the user after manufacturing. They can be programmed to be suited for a range of different logic functions, depending upon the task. They can be considered as integrated blank circuits, with great capacity for parallelism, which can be adapted or modified to solve complicated tasks in a performative way. FPGA is made up of thousands of Configurable Logic Blocks (CLBs) surrounded by a system of programmable interconnects, called a fabric. The CLBs are primarily made of Look-Up Tables (LUTs), Multiplexers and Flip-Flops which help in implementing complex logic functions.

- **ASIC(Application Specific Integrated Circuits) -** These processors are optimized specifically for running a single task. There is never any intent for the processor to be used for anything other than exactly what they are designed for. They employ strategies such as optimised memory use and the use of lower precision arithmetic to accelerate calculation and increase the throughput of computation. They are generally used over workstations which have a specific computation in their operation, which in case will be used frequently by the system.

The difference in the case of ASIC is that the circuit is permanently drawn into silicon whereas in FPGAs the circuit is made by connecting a number of configurable blocks.