Field Programmable Arrays with Cloud Computing

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1 Summary

Field Programmable Gate Array (FPGA) is programmable hardware for accelerating the small number of dedicated functions. The fact that all FPGAs still programmed with a conventional HDL programming language. When implementing programs is time-consuming and *CPU*. We will see some facts on migrating to a third party i.e. cloud can affect the cost. FPGAs are implemented in more general IoT connectivity and specific computation datapaths. FPGAs can communicate with the external environment using the physical pins connection. FPGAs are used generally as northbridge, southbridge, network card and dedicated computing engine. FPGAs are getting more acceptance over ASIC(*Application Specific Integrated Circuits*) from vendors due to there programmability and increasing the speed of the clock. The fabrication technology, in connection speed, lower power consumption with larger programmable areas. [1]

2 Synthesis in Cloud

In modern System-on-Chip architectures, the general-purpose microprocessor runs at a higher frequency than the FPGAs. The flexibility of FPGAs can accelerate various functions for communication outside. Previously FPGAs did not provide the facility to upgrade without rebooting the device. Now the partial configuration is a way to upgrade the FPGA device without restart to be done for the device. Chips vendors provide the Integrated development environment to implement. The development process of the embedded system is classified into hardware development and software development. Hardware development is implementation of the HDL code but not the electronic part, while software development is the implementation of the application written in a high-level language to execute it on the hardware design.

[1] Note: This article is simplified and reproduced from [1]. A copy is maintained in Inaam's repository for quick reference only.

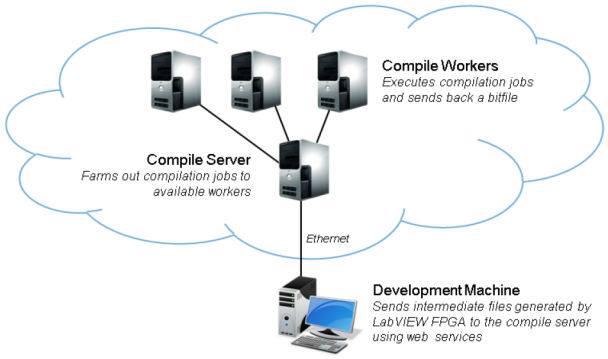

Figure 1: FPGA Cloud Service

Development and testing of hardware architecture are time-consuming which depends on the size of FPGA, the complexity of code we have given and bitstream that is programmed. Functional validation of the system is on simulation but many cases require actual validation; for those cases, developed hardware architecture needs to put in an actual system. If an error occurs or it does not work as intended, then a system engineer needs to repeat the whole process from beginning. This is difficult and time consuming. There are methods for improving the speed of design. Those companies have FPGA as a primary market that has their dedicated computing farms and development members but those companies which do time to time development can not be easily implemented.Figure1 below shows LabView FPGA compile cloud.

FPGA development is still considered inaccessible for average consumer-oriented companies. Large companies such as Intel and Microsoft have deployed FPGAs in their cloud products.Lab VIEW is offering *"LabView FPGA Compile Cloud Service"*. They are using Linux based servers which provide the multiple compilers one time. Such a Singapore-based company founded in 2009, develops a cloud platform that enables semiconductor chip designers to shorten product *time to market* and reduce development costs. Development of FPGA design consists of several compilation cycles. Standard cloud services where one can run a Virtual Private Server can overcome the limitations of a small number of workstations. Amazon has been launched the FPGA cloud service in 2016 which is affordable for small workstations and motivating the developers to build and test the FPGA designs rapidly.Another company, named NGCodec worked with Amazon to test the new F1 instances. NGCodec implemented its product called RealityCodec for VR/AR processing using F1 instances within a month of development. FPGAs have more adventage over GPU because they give their encoding task to CPU but GPUs do there encoding by themselves.

IaaS(Infrastructure as a service) is a computing platform that provides virtualized computing resources on the Internet. IaaS is one of three main categories

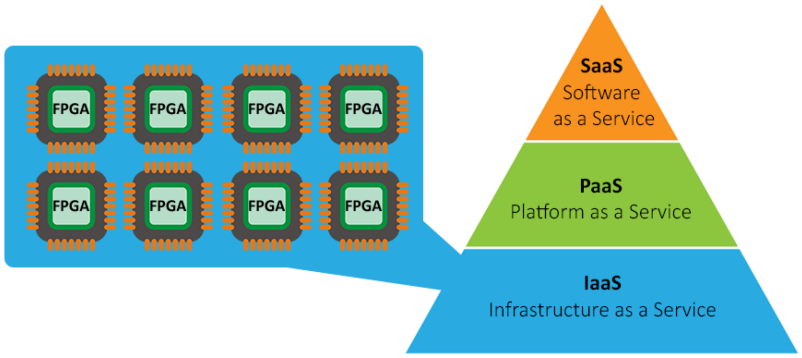

Figure 2: FPGA Cloud Service

Steps	**Time**
Synthesis	7.5 x $10^3 s$
Place and Route	9.9 x $10^3 s$
Bit Steam Generation	0.21 x $10^3 s$
Total Time for Standard Machine	17.61 x $10^3 s$
Lab view FPGA Compile Time	14.26 x $10^3 s$
Dedicated Linux Based FPGA Compile Worker	11.97 x $10^3 s$

Table 1: Compilation Time Comparison

of cloud services(Software as a Service, Platform as a Service). Figure 2 shows a hybrid IaaS-FPGA. Amazon, Google, Rackspace and Microsoft are companies provide IaaS. When the demand for infrastructure is high or, new companies do not possess the capital to invest in hardware. Cloud supply resources on-demand manner. When certain software is tested, it will release resources for the next software application. For example, the design of the FPGA based PCI communication slot implements encryption for point to point communication. Implementation requires a softcore processor, PCIe communication core, DMA, reconfigurable auxiliary components, and timers. Evaluation of implementation on standard computer system shown in Table 1 compares Implementation on a standard workstation with "*8GB RAM and an Intel Core i7 @ 2.6 GHz, 3720, 4 cores and 8 Threads*" to Xilinx Kintex 7 FPGA chip and Vivado IDE as the development environment. Xilinx Kintex 7 has the best price-performance ratio on the market with 478k logic cells, VCXO component, AXI IP and AMS integration. The FPGA chip also has 32 times 12.5G GTs, 2,845 GMACs, 34Mb BRAM and DDR3-1866.

A company can not accept substantial implementation time and invest in hardware to decrease overall implementation time and borrowing resources from the third party is an excellent opportunity. An equal amount of investment on private hardware resources company can buy cloud sources with 10x speed up(based on the above application time comparison).

3 Conclusion

FPGA based solutions are becoming more popular. Companies with limited resources of FPGAs can get cloud service from the third party and decrease their implementation time and cost of purchasing newer FPGA hardware and a team for FPGA development. Higher processing speed by cloud servers lessens the time of compilation and allows multiple compiles at the same time. A good comparison of results is given for one application in this paper. Server-side cloud management is a high-performance reconfigurable system and implementation of compilation techniques on the grid of FPGA by an intelligent system to decide the efficient plan for renting out resources and incorporating some source-level optimizations on the code will get improved FPGA datapath performance. So companies can easily program their hardware resources.

References

[1] L.A. Dumitru,S. Eftimie ,R. Ciprian "Using Clouds For Fpga Development A Commercial Perspective" published in Journal of Information Systems Operations Management