Role Of Xilinx in Modern Digital Electronics Platform

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Abstract: In the modern digital electronics platforms Xilinx plays a centric role by precursor and doyen the programmable logic technologies, especially in Field Programmable Gate Arrays (FPGAs) and adaptive System-on-Chip (SoC) solutions. The designers can able to implement complex digital systems with high flexibility with enhancing parallel processing capability and rapid reconfigurability using Xilinx devices. These particular devices provide upper hand as it is ideal for applications requiring high performance and with more adaptability as compared with digital electronics. The platforms of Xilinx support a wide range of functions like (signal processing, embedded control, hardware acceleration and real-time data handling). The solutions based on Xilinx minimise the gap between hardware and software design. Integrating Xilinx with Artificial Intelligence (A.I) and Internet of Things (IoT) makes the entire device more useful in domains related towards telecommunications, industrial automation, automotive electronics and others sectors. This paper indicates the benefits of Xilinx devices that are used for consumer electronics and securing control on data centres. It is the evolution of modern digital electronics platforms that enable scalable, energy-efficient and high-performance system design.

Keywords: Programmable logic technologies, FPGA, Real-time data handling, Hardware and software design, Energy-efficient, Modern digitals electronics

Introduction:

Xilinx, known widely as architect of modern "adaptive computing." It is the key division of Advance Micro Devices (AMD). In the year 1984 the invention of FPFA occurred, Xilinx fundamentally swap digital electronics, software-defined silicon and also moving the industry away from the concept of fixed-function hardware toward flexible system. Now a days the technology based on Xilinx serves succours as the "neural system" for many high-tech platforms that is from 5G base stations to Mars rovers.

1. The Core Innovation (From Fixed to Fluid Hardware): Before the invention of Xilinx the "hard-wired" using Application-Specific Integrated Circuits (ASICs) was the core of digital logic. In this if we want to do any update related towards the chip's function, we had to manufacture a brand-new one. On the other hand, Xilinx introduced the FPGA which can

be allowed to reconfigure for updating hardware without changing the chip's literally in the "field."

2. Key Architectural Shifts: In the year 1984 the FPGA was invented. In 2012 Zynq SoCs, launched in which combined both FPGA logic with processor based on Advanced Micro Devices (AMD) that bridging or reducing the gap that is between hardware and software. Further, the introduction of ACAPs (Adaptive Compute Acceleration Platforms) in 2019, especially designed for AI and big data. The ACAPs integrates specialized the AI engines into the programmable fabric.

3. Concept - Xilinx Role in Modern Digital Electronics Platform: Xilinx, technologies provide the users or designers to design applications that have a wide range, it enables to develop high performance, provide high flexibilities and energy-efficient digital systems. Its helps to programmed, reprogrammed and reconfigure along with design updates and adaptability to do changing according to the requirements. It supports parallel processing which makes it ideal for performing tasks which needed high speed and low latency. It also provides certain advantages in design tools (Vivado and Vitis) which is used for simplifying digital system design, verification, and deployment. Tools based on Xilinx also supports high level synthesis thus users can use programming languages such as C/C++ and Python, thus it helps them in reduction of time required for development and making digital electronics design more accessible.

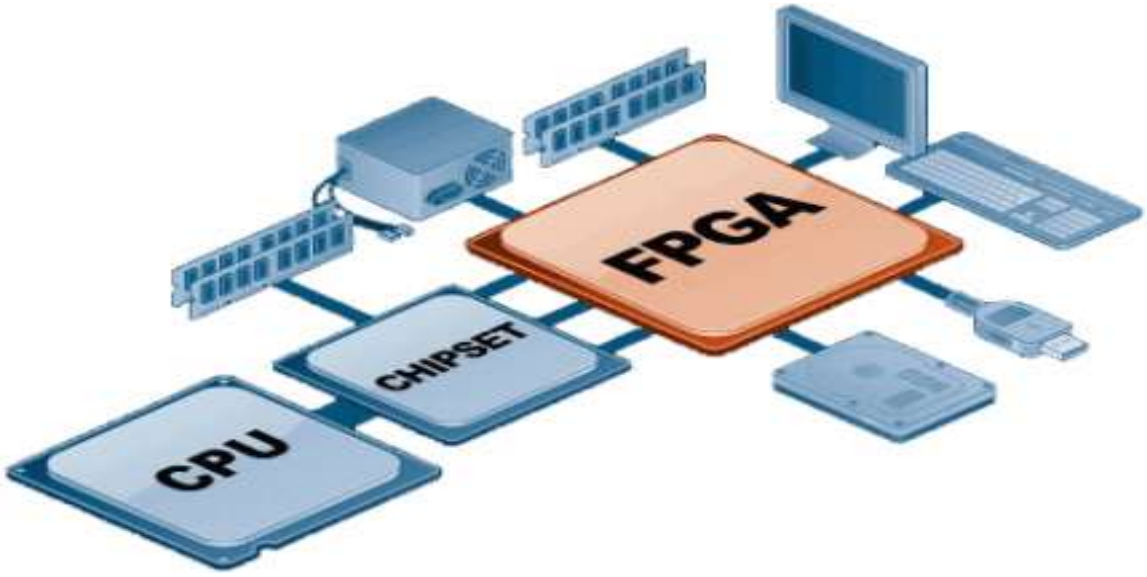


Fig1: Diagram of FPGA

Architecture of Xilinx (FPGA Architecture): The architecture of Xilinx is based on FPGA technology. The architecture is modular and scalable which allows the designers to implement complex digital circuits on a single chip. It also provides the designer to perform or execute high performance, with more flexibility and reconfigurability for modern digital systems. The components are:

a) Configurable Logic Blocks (CLBs): In Xilinx - FPGAs the CLBs are the core building blocks. Lookup Tables (LUTs) are basically used for contrivance the combinational logic such as Flip-flops / Registers for sequential logic, Multiplexers and carry logic for arithmetic operations and it also be used for programmed for implements functions based on logic such as adders, counters, multiplexers, and state machines.

b) Programmable Interconnect: It provides the suitable routing paths between CLBs, I/O blocks and other resources by programmable interconnect network. Includes switch matrices and routing channels. Allows flexible connection of logic elements and plays a key role in determining speed and performance.

c) Input/Output Blocks (IOBs): Due to this the communication is possible betwixt the FPGA kit and other external devices. It supports multiple standard I/O (LVTTL, LVCMOS, LVDS, etc.). It enables input, output and bidirectional operation. Other optional features that IOBs has pull-up resistors and signal conditioning.

d) Block RAM (BRAM): It has on-chip memory blocks for data storage. It can support dual port RAM (Random Access Memory). It is used for high-speed performance, enable quick buffering, along with lookup tables and First In, First Out (FIFOs)data processing methods.

e) DSP Slices: This block is used especially to improve or enhance the performance tasks related to arithmetic that is (i.e.) it carries out quick accumulation. It is also widely used in fast (signal and image) processing system i.e. communication systems.

f) Clock Management Resources: Clocking architecture make secure and reliable operation with high – speed. It has Phase-Locked Loops (PLLs), Mixed-Mode Clock Managers (MMCMs) which enable clock generation and phase shifting.

g) Embedded Processing System (in SoC devices): It has ARM Cortex processors which enable high-speed interconnect between processor system (PS) and programmable logic (PL). It also allows hardware–software co-design.

h) Configuration Memory: It uses Static RAM (SRAM)-based configuration memory. It stores and configure data needed towards routing and logic. It enables multiple time reprogramming and Configuration loaded at power-up.

i) High-Speed Transceivers: It is used for data-intensive applications which has multi-gigabit serial transceivers that Support standards like Peripheral Component Interconnect Express (PCIe), Ethernet and Universal Serial Bus (USB).

Fig2: Architecture of FPGA

EDK Concept: The Xilinx (FPGA) is a tool specially designed as Embedded Development Kit (EDK) that can be used as a tool which is retinue us to design the complete embedded processor system that can be implemented in Xilinx device with Intellectual Property (IP). Embedded systems are itself a complex one and it is difficult to combine the hardware and software according to the requirement, so to overcome such difficulties and challenges EDK, Xilinx - FPGA is used. The foundation or base of Xilinx FPGA logic design is Integrated Software Environment (ISE). The ISE is needed to be installed to run the EDK. To operate the hardware portion in Embedded Processor System (EPS) we need Xilinx Platform Studio (XPS) or Graphical User Interface (GUI) on the other hand to deal with software, Software Development Kit (SDK)is integrated.

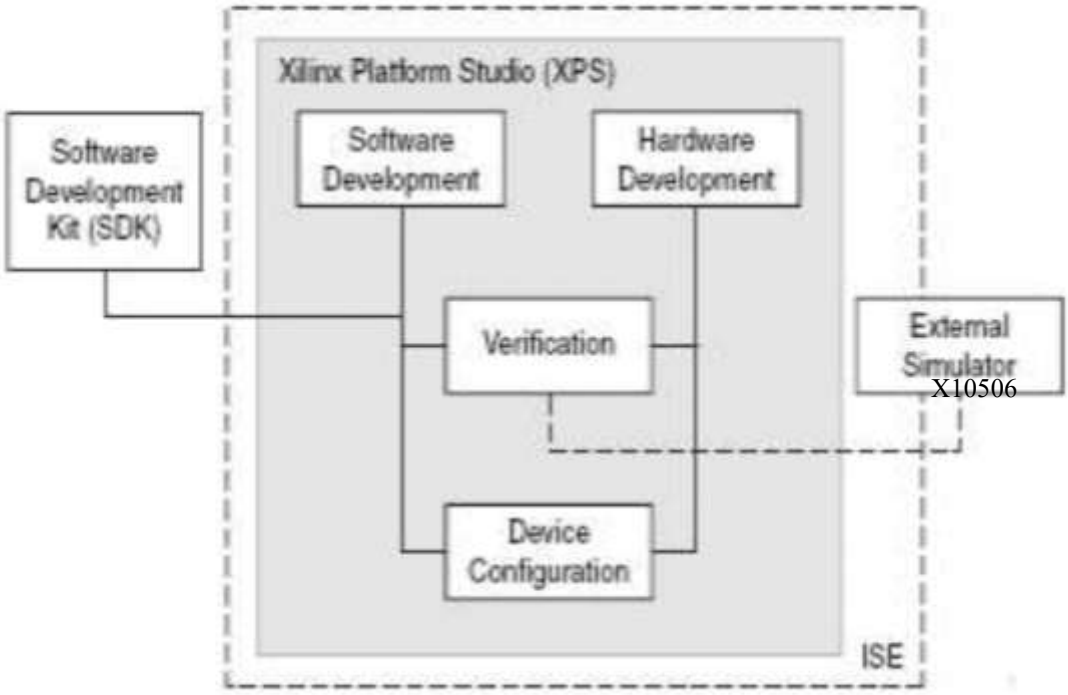


Fig3: EDK Tool – Flow Block Diagram

Base System Builder (BSB): BBS used to establish the efficient and quick response in work designed which can be customize as per the need. While using BSB lots of time can be saved because it automates and configure the processor design on the basis of hardware and software platform according to the requirements. It allows the users to select the type of board i.e. supported board or custom boards (Micro Blaze or Power PC).

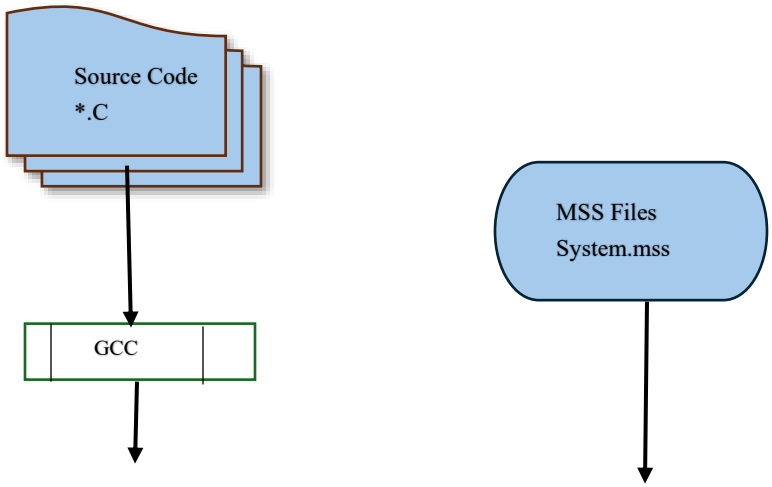
- **Processor – Selecting and Configuring:** The Micro Blaze or Power PC are of following types
  - Architecture
  - Reset Polarity
  - Speed Grade
  - Reference Clock Frequency
  - Package
  - Device Type
  - Processor – bus clock Frequency
  - Cache Setup
  - Floating Point Unit (FPU)Setting
  - Processor Configuration for debug

Intellectual Property Interface (IPIF): The EDK uses the IP i.e. known as IPIF library that is used for implementing the common function for various processor peripherals. The main purpose of IPIF is to create or identify the IP that are required. The IPIF function is to optimize, verify and highly parameterized the interface along with providing a set of simplified bus protocol. This is generally known as IP Interconnect (IPIC) and easy to work with as compared with On-Chip Peripheral Bus (OPB) or Processor Local Bus (PLB) bus protocol directly. The below diagram shows the relationship among the bus, IPIF, IPIC and the user logic.

EDK Simulation Basics: To perform simulation the hardware model of embedded system requires platform design based on Verilog HDL or VHSIC Hardware Description Language (VHDL). To execute the ELF file the model block, include RAM(BRAM). EDK can be generated of choice which are based on

- A behavioural model
- A post – synthesis structural model
- A complete post – place and routine, timing – accurate model

Software Development Kit (SDK): The Xilinx Platform Studio (XPS) maintain the complete analogous details and description related to software system in the Microprocessor Software Specification (MSS) file. To compile the software, it has Executable and Linkable Format (EFL) file i.e. GNU Compiler Collection (GCC). The SDK is designed in such a way that it can facilitate the embedded software applications. SDK consists a project directory that can source files of C/C++.



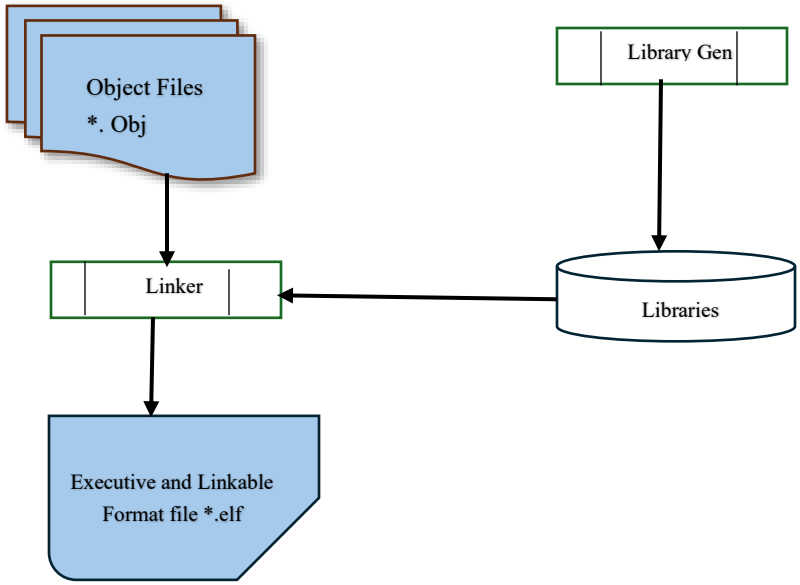


Fig3: Different Stages of ELF file Generation

Xilinx Micro-processor Debugging (XMD): It is basically a utility based on software design that is used for facilitates the debugging software that we used to create for Xilinx kit operational uses. XDM helps to verify the system that could be use the microprocessor based in Xilinx kit. To run or execute the programs through hardware board the XDM use the cycle – accurate Instruction Set Simulators (ISS). The ISS is uses to interact with XDM i.e. it interacts with the debug (host) software and the target processor which we use.

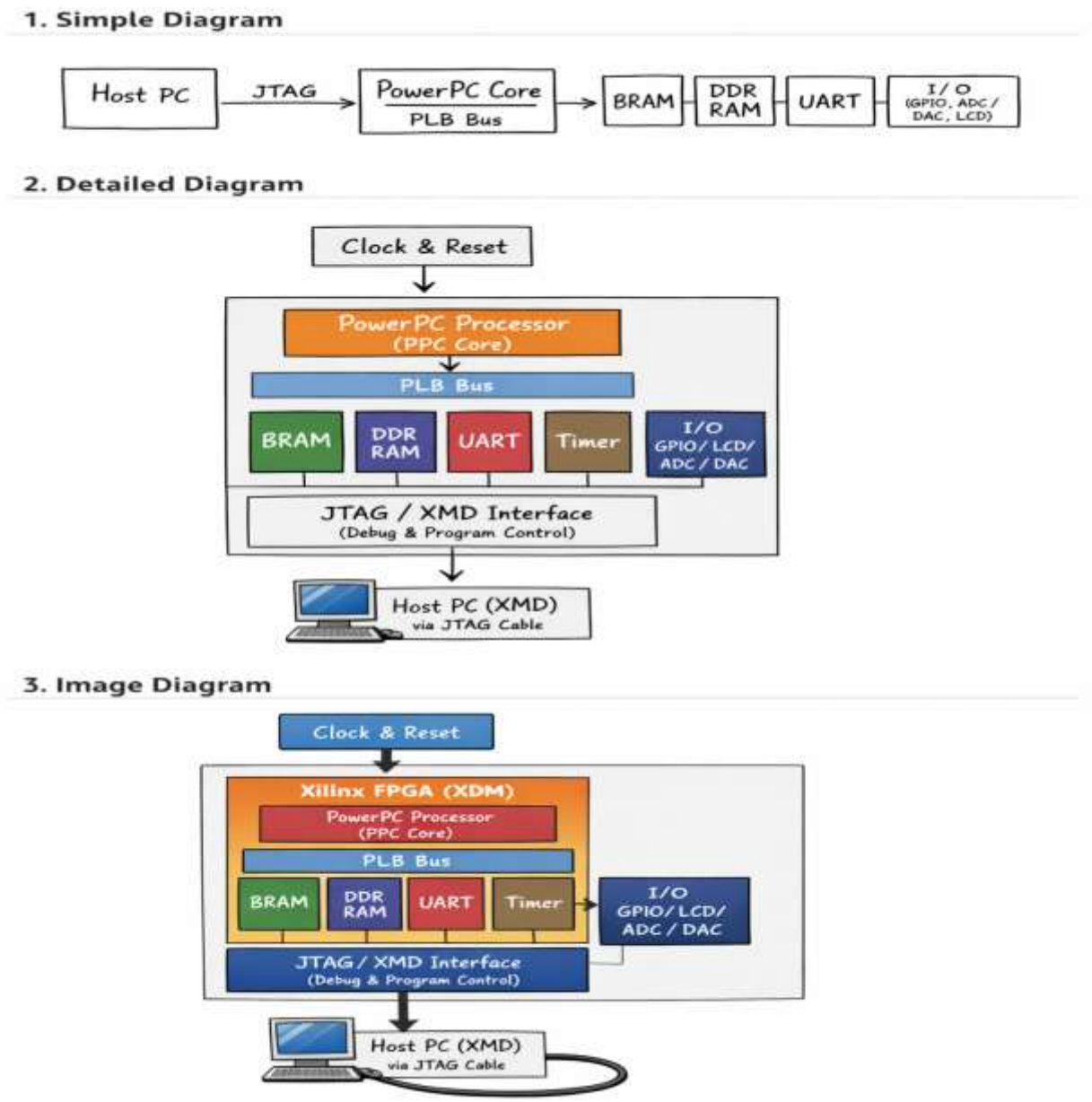


Fig4: Different Diagram of XMD

User Machine Interface (UMI): This interface refers about the know and how of using this FPFA kit i.e. human (peoples or uses) that interacts with Xilinx kit which is based on I/O, control, H/S ware and monitoring. The FPGA kit physically connect devices such as (different sensors, display board, switches) with the kit based on logic interface module.

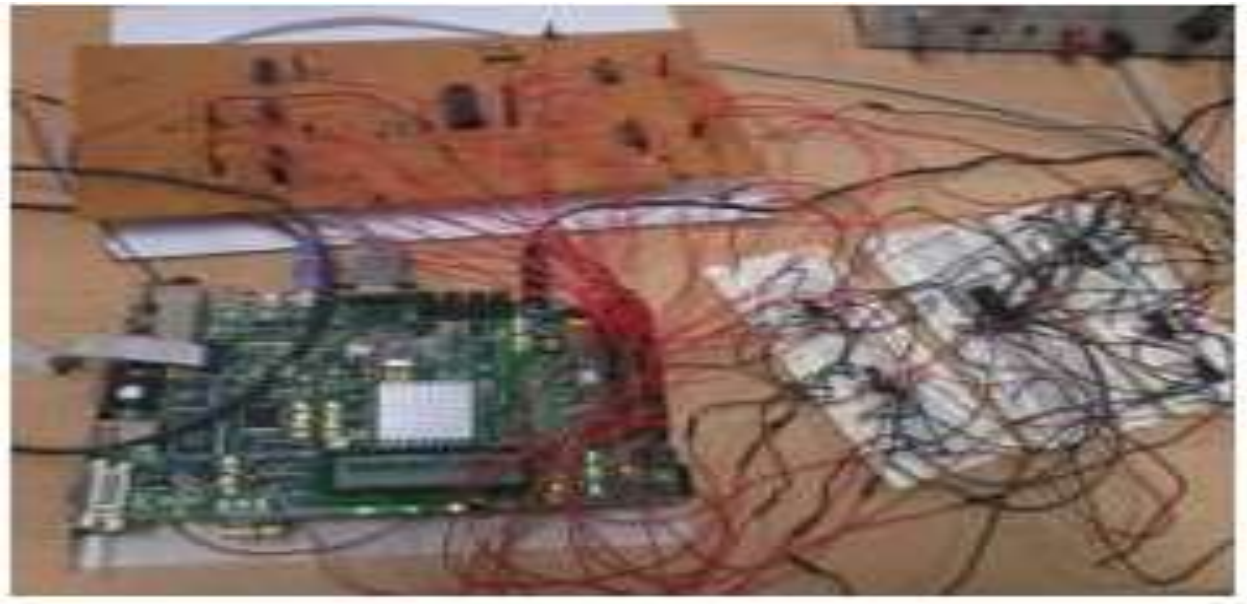


Fig5: User Machine Interface

Scope: The system based on Xilinx – FPGA, which is now become a part of AMD i.e. AMD Adaptive Computing has a good impact and scope in near future as it is expanding very fast and giving desired output. The FPGA is also becoming one of the key accelerators in case of AI which can be used as an interface based on AI (drones, camaras and other machineries) for surveillance activities. It is also used in electric vehicles. It has enormous scope in telecom industries (based on 6g wireless systems). It can give output on real time frame. It can be used in radar, LiDAR and others. It can be affective in medical image processing and diagnosis.

Conclusion: The concept based on the architecture of Xilinx (FPGA) configure, integrates and combine the logic, I/O, memory and others in a single chip. It also enables us to perform, execute and run the complex digital electronics system which is based on modern trends with high scalability, and adaptability. It was introduced in 1984 and even now it is widely used. It is user friendly and can be reconfigure according to the needs. The integration of H/S system is easy and can be easily modify.

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