PROJECT WORK

ON

"Study of FPGA and Microprocessor for Various Applications"

FOR

INTERNSHIP

By

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VALLURUPALLI NAGESWARA RAO VIGNANA JYOTHI

INSTITUTE OF ENGINEERING AND TECHNOLOGY

An Autonomous Institute, NAAC Accredited with 'A++' Grade (CGPA: 3.73/4.0)

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CERTIFICATE

This is to certify that the project titled **"Study of FPGA and Microprocessor for various applications"** is being submitted, by **M. Bhargav (19071A1006)**, **D. Aneesha (19071A1010)**, **P. Sai Vivek (19071A1034)**, **P. Phanindra (19071A1037), A. Rahul (19071A1038)** of EIE-A in partial fulfilment of the requirement for the award of degree of **Bachelor of Technology**, to the Centre for Presencing and Design Thinking at the **Vallurupalli Nageswara Rao Vignana Jyothi Institute of Engineering and Technology** is a record of *bona fide* work carried out by them under our pedagogy. The results embodied in this thesis have not been submitted to any other University or Institute for the award of any degree.

CERTIFICATE

This is to certify that **M. BHARGAV (19071A1006), ANEESHA (19071A1010), P. SAI VIVEK (19071A1034), P. PHANINDRA KUMAR (19071A1037) AND A. RAHUL (19071A1038) of VNR VIGNANA JYOTHI INSTITUTE OF TECHNOLOGY & SCIENCES** has undergone project training from 23/11/2021 to 13/12/2021 in the Defence Electronics Research Laboratory, Hyderabad-05. The project **"Study of FPGA and Microprocessor for various applications"** is a record of the bonafide work undertaken by them towards partial fulfillment of the requirements for the award of the B. Tech Degree. They have completed the assigned task satisfactorily.

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DECLARATION

I hereby declare that the results embodied in this dissertation titled **"STUDY OF FPGA AND MICROPROCESSOR FOR VARIOUS APPLICATIONS"** is carried out by us during the year 2020 –2021 in partial fulfilment of the award of B.Tech (ELECTRONICS AND INSTRUMENTATION) from **"VNR Vignana Jyothi Institute Of Engineering and Technology".** I have not submitted the same to any other university or organization for the award of any other degree.

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A. Rahul

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Our sincere thanks are due to **Mrs. Manjula Sri**, Head of the Dept, EIE of College VNR VJIET for the encouragement and guidance provided.

DLRL PROFILE

DEFENCE ELECTRONICS RESEARCH LABORATORY (D.L.R.L) was established in the year 1962 under the aegis of Defence Research and Development Organization (DRDO), Ministry of Defence, to meet the current and future needs of tri services Army, Navy and Air force equipping them with Electronics Warfare Systems.

DLRL has been entrusted with the primary responsibility of the design and development of Electronic Warfare Systems covering both Communication and RADAR Frequency bands.

DLRL consists of large number of dedicated technical and scientific manpower adequately supported by sophisticated hardware and software development facilities. Computers and dedicated Workstations are extensively used for, design and development of sub-systems. Main software required for various types of applications is developed in-house. The quality assurance group is responsible for quality assurance of software developed for Electronic Warfare Systems.

DLRL has number of supporting and technology groups to help the completion of the projects on time and to achieve a quality product. Some of the supporting and technology groups are Printed Circuited Board Group, Antenna Group, Microwave and Millimeter Wave Components Group, Mechanical Engineering Group, LAN, Human Resource Development Group etc. apart from work centers who carryout system design and development activities.

Long-Term self-reliance in Technologies / Systems has been driving principle in its entire development endeavor to make the nation self reliant and independent.

In house Printed Circuit Board facilities provide faster realization of the digital hardware. Multi layer Printed Circuit Board fabrication facilities are available to cater for a high precision and denser packaging.

The Antenna Group is responsible for design and development of wide variety of antennas covering a broad electromagnetic spectrum (HF to Millimeter Frequencies).The Group also develops RADOMES, which meet stringent environmental conditions for the EW equipment to suit the platform.

The MMW Group is involved in the design and development of MMW Sub-systems and also various Microwave Components like Solid State Amplifier, Switches, Couplers and Filters using the latest state-of-the–art technology.

The Hybrid Microwave Integrated Circuit Group provides custom-made microwave components and super components in the microwave frequency region using both thin film and thick film technology.

In the Mechanical Engineering Group the required hardware for EW Systems is designed and developed and the major tasks involved include Structural and Thermal Engineering.

The Technical Information Center, the place of knowledge bank is well equipped with maintained libraries, books, journals, processing etc. Latest Technologies in the electronic warfare around the globe are catalogued and easily accessible.

The Techniques Division of ECM wing is one such work center where design and development of subsystems required for ECM applications are undertaken. ESM Work Centers design and development of DF Rx, Rx Proc etc. for various ESM Systems using state-art-of-the technology by employing various techniques to suit the system requirements by the end users. All the subsystems are designed and developed using microwave, and processor/DSP based Digital hardware in realizing the real time activities in Electronic Warfare

Most of the work centers are connected through DLRL LAN (Local LAN) for faster information flow and multi point access of information critical to the development activities. Information about TIC, stores and general administration can be downloaded easily.

The Human Resource Division play a vital role in conducting various CEP courses, organizing service and technical seminars to upgrade the knowledge of scientists in the laboratory.

DLRL has been awarded **ISO 9001:2015** certification for Design and Development of Electronic System of assured quality for Defence Services; utilize advanced and cost effective technology for developing reliable Electronic Warfare systems on time and continuous improvement of quality through involvement of all members.

ABSTRACT

In this project we learnt about microprocessors and microcontrollers which served as the basics for ARM with RISC and CISC instruction sets and then we studied about FPGA which we intended to program as a microcontroller using Xilinx Development Board and XPS software. After this project we understood that an FPGA is a very versatile device, and we can program it and use it as application specific or as a multi-purpose device as long as it has the required registers and ports for transfer and storage of information.

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CHAPTER 1 : Introduction

The purpose in this project is the Study of FPGA and Microprocessor for various applications. The emphasis on main topics in the project are Microprocessor, Instruction set and the types of processors as well as FPGA. It starts from the basic microprocessor to way down where FPGA is useful in our practical life. The outline of Instruction set (ISA) is represented which is part of computer that pertains to programming which is more or less machine language. This also paves a path for different types of processors and dissimilarity between them. The most common and known are RISC and CISC under which lies the Arm processor. The Arm architecture is the keystone of the world’s largest compute ecosystem. It's the widest range of microprocessor cores for almost all application markets.

This paper shows the benefits of the Field Programming Gate Array (FPGAs) in industrial control applications. It’s also comprising of the FPGA performance and the design tools. Xilinx Platform Studio (XPS) is a key component of the ISE Embedded Edition Design Suite, helping the hardware designer to easily build, connect and configure systems. In this we use Xilinx XPS software to interlink the Hardware and software of FPGA. FPGA are compelling for almost any types of design.

CHAPTER 2: Microprocessor

2.1 What is a Microprocessor

A microprocessor is a computer processor where the data processing logic and control is included on a single integrated circuit, or a small number of integrated circuits. The microprocessor contains the arithmetic, logic, and control circuitry required to perform the functions of a computer's central processing unit. The integrated circuit is capable of interpreting and executing program instructions and performing arithmetic operations. The microprocessor is a multipurpose, clock-driven, register-based, digital integrated circuit that accepts binary data as input, processes it according to instructions stored in its memory, and provides results (also in binary form) as output. Microprocessors contain both combinational logic and sequential digital logic, and operate on numbers and symbols represented in the binary number system.

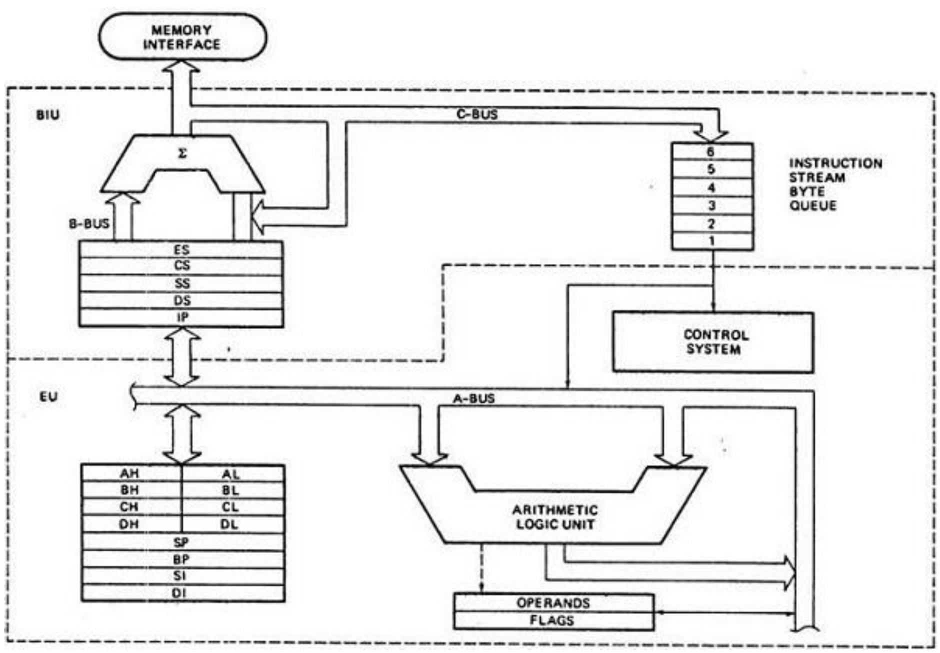

Fig 1: Architecture of 8086 Microprocessor

In simple words, the microprocessor is useful in very intensive processes. It only contains a CPU (central processing unit) but there are many other parts needed to work with the CPU to complete a process. These all-other parts are connected externally.

Microprocessors are not made for a specific task as well as they are useful where tasks are complex and tricky like the development of software, games, and other applications that require high memory and where input and output are not defined.

Do you understand? I think a bit, but it's ok, let’s understand by some daily life examples

A) Household devices: Complex home security, home computers, Video game systems and many more.

B) Transportation and Industrial Devices: Automobiles, trains, planes, Computer servers, high tech medical devices, etc.

2.2 What is a Microcontroller?

The microcontroller is designed for a specific task or to perform the assigned task repeatedly. Once the program is embedded on a microcontroller chip, it can’t be altered easily and you may need some special tools to reburn it. As per application, the process is fixed in microcontroller. Hence, the output depends on the input given by the user or sensors or predefined inputs.

The applications easily connect with concepts, so let's find out day to day life examples

e.g., Calculator, Washing Machine, ATM machine, Robotic Arm, Camera, Microwave oven, Oscilloscope, ECG Machine, Printer so on and so forth.

2.3 Microprocessor VS Microcontroller

We find it difficult to spot the difference between microcontrollers and microprocessors. Well, these two complicated terms are the soul and core of programmable electronics. A Microcontroller (sometimes called an MCU or Microcontroller Unit) is a single Integrated Circuit (IC) that is typically used for a specific application and designed to implement certain tasks. A Microprocessor is an electronic component that is used by a computer to do its work. It is a central processing unit on a single integrated circuit chip.

Generally, microcontrollers cost less than microprocessors. Microprocessors are typically manufactured for use with more expensive devices. When it comes to clock speed, there is a significant difference. This relates back to the idea that microcontrollers are meant to handle a specific task or application, while a microprocessor is meant for more complex, robust, and unpredictable computing tasks. One of the key advantages associated with microcontrollers is their low power consumption. A computer processor that performs a dedicated task requires less speed, and therefore less power, than a processor with robust computational capacity. Microprocessors are mainly used in personal computer, whereas Microcontrollers are used in washing machines and air conditioners.

The fundamental part of a computer is formed by the microprocessor, whereas the Microcontroller forms a key component of an embedded system. A microprocessor is capable of performing operations for various tasks compared to a microcontroller dedicated to performing the same task for its entire life. Having an understanding of the differences, we realize that a microprocessor can never be replaced with a microcontroller.

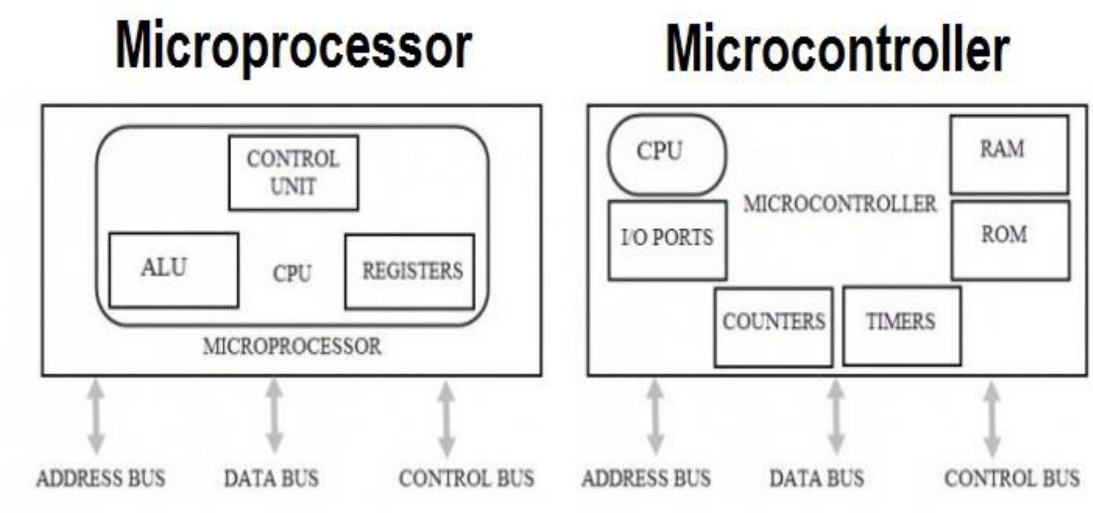

Fig 2: Internal structure of Microprocessor and Microcontroller

2.4 Advantages and Disadvantages of Microprocessor

Advantages of Microprocessor

The microprocessor is that these are general purpose electronics processing devices which can be programmed to execute a number of tasks.

- Compact size.
- High speed.
- Low power consumption.
- It is portable.
- It is very reliable.
- Less heat generation.
- The microprocessor is very versatile.

Disadvantages of microprocessor

- The main disadvantages are its overheating physically.
- It is only based on machine language.
- The overall cost is high.
- The large size of PCB is required for assembling all components.
- The physical size of the product is big.
- Overall product design requires more time.

CHAPTER 3 : Instruction Set

3.1 Instruction set

The instruction set, also called ISA (instruction set architecture), is part of a computer that pertains to programming, which is more or less machine language. The main job of the CPU is to execute programs using the fetch-decode-execute cycle (also known as the instruction cycle). The instruction set provides commands to the processor, to tell it what it needs to do. The instruction set consists of addressing modes, instructions, native data types, registers, memory architecture and exception handling, and external I/O.

Examples of instruction set

ADD - Add two numbers together.

COMPARE - Compare numbers.

IN - Input information from a device, e.g., keyboard.

3.2 Instruction set flow

In a program, each machine code instruction takes up a slot in the main memory. These slots (or memory locations) each have a unique memory address. The program counter stores the address of each instruction and tells the CPU in what order they should be carried out.

The processor checks the program counter to see which instruction to run next.

The program counter gives an address value in the memory of where the next instruction is.

The processor fetches the instruction value from this memory location.

Once the instruction has been fetched, it needs to be decoded and executed. For example, this could involve taking one value, putting it into the ALU, then taking a different value from a register and adding the two together.

Once this is complete, the processor goes back to the program counter to find the next instruction.

This cycle is repeated until the program ends.

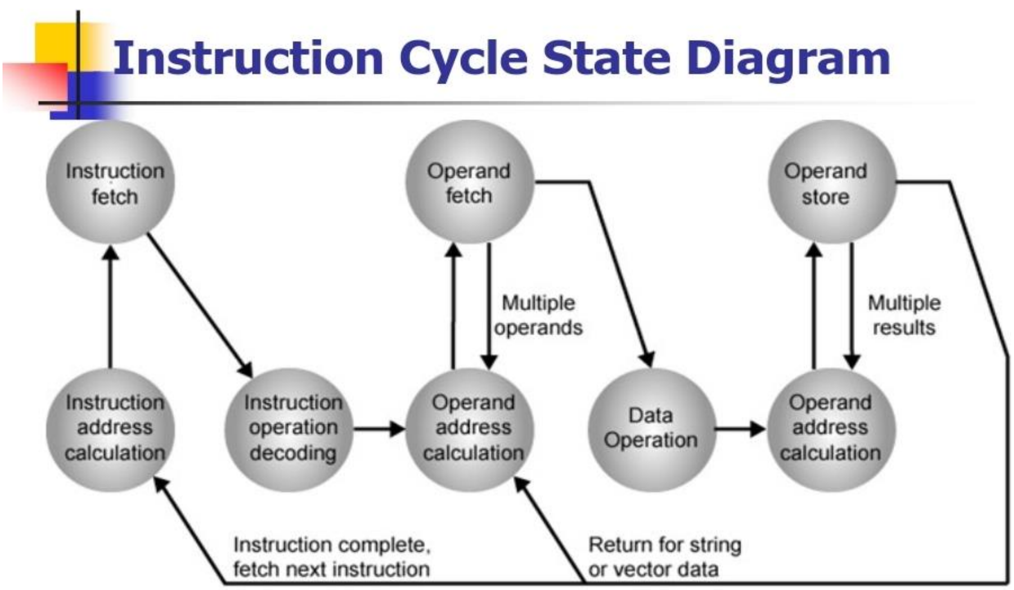

Fig 3: Instruction Cycle State Diagram

3.3 Types of instructions

The 8086 microprocessor supports 8 types of instructions –

- Data Transfer Instructions
- Arithmetic Instructions
- Bit Manipulation Instructions
- String Instructions
- Program Execution Transfer Instructions (Branch & Loop Instructions)
- Processor Control Instructions
- Iteration Control Instructions
- Interrupt Instructions

CHAPTER 4: Types of Architecture

4.1 Von Neumann architecture

The Von Neumann architecture. The “classical” von Neumann architecture consists of **main memory**, a central-processing unit (CPU) or processor or core, and an interconnection between the memory and the CPU. Main memory consists of a collection of locations, each of which is capable of storing both instructions and data.

4.2 Harvard Architecture

Harvard Architecture is the digital computer architecture whose design is based on the concept where there are separate storage and separate buses (signal path) for instruction and data. It was basically developed to overcome the bottleneck of Von Neumann Architecture.

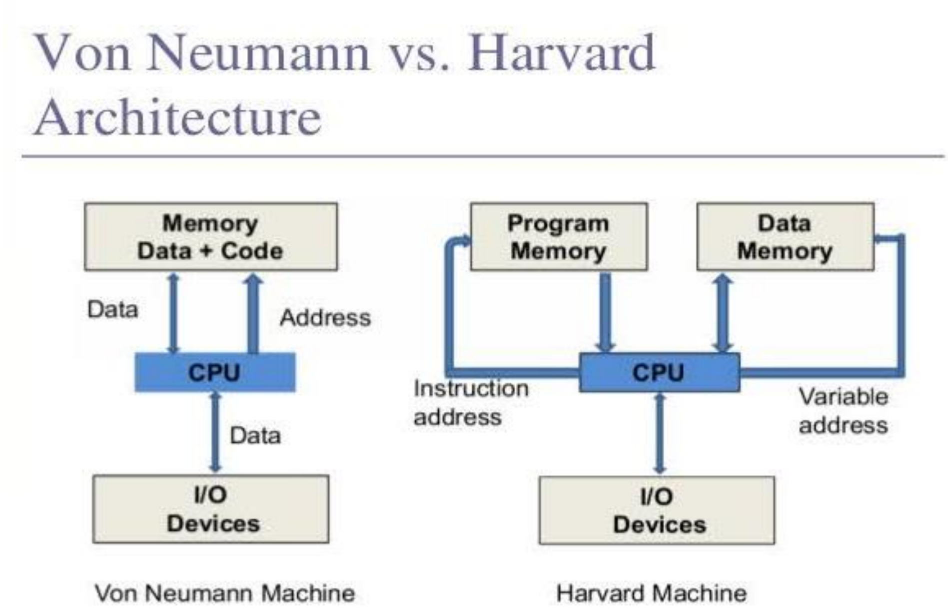

Fig 4: Block diagram of Von Neumann and Harvard Architecture

4.3 DIFFERENCE BETWEEN VON NEUMANN AND HARDVARD ARCHITECTURE

VON NEUMANN ARCHITECTURE	HARVARD ARCHITECTURE
It is ancient computer architecture based on stored program computer concept.	It is modern computer architecture based on Harvard Mark I relay based model.
Same physical memory address is used for instructions and data.	Separate physical memory address is used for instructions and data.
There is common bus for data and instruction transfer.	Separate buses are used for transferring data and instruction.
Two clock cycles are required to execute single instruction.	An instruction is executed in a single cycle.
CPU cannot access instructions and read/write at the same time.	CPU can access instructions and read/write at the same time.
It is used in personal computers and small computers.	It is used in micro controllers and signal processing.

CHAPTER 5: RISC and CISC Processor

5.1 RISC Processor

RISC stands for **Reduced Instruction Set Computer Processor**, a microprocessor architecture with a simple collection and highly customized set off instructions.

Each instruction cycle requires only one clock cycle, and each cycle contains three parameters: fetch, decode and execute.

The RISC processor is also used to perform various complex instructions by combining them into simpler ones.

Examples of RISC processors are SUN's SPARC, PowerPC, Microchip PIC processors, RISC-V.

5.2 RISC Architecture

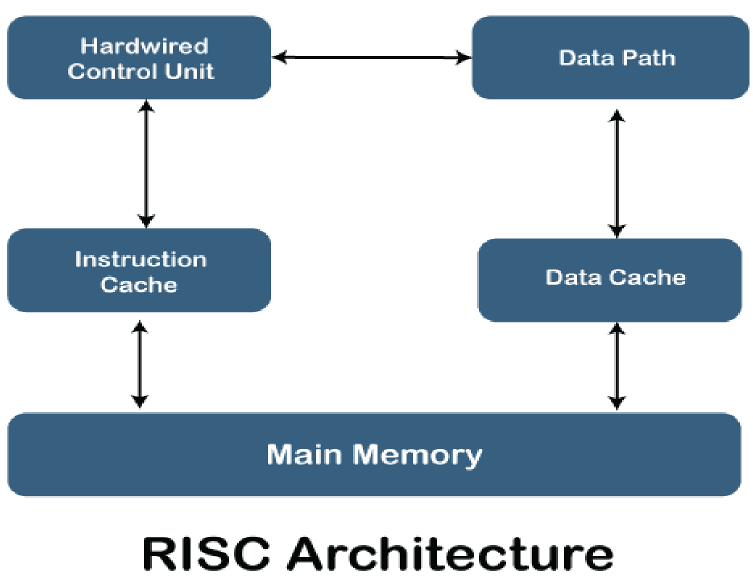

Fig 5: Block diagram of RISC Architecture

5.3 Advantages and Disadvantages of RISC Processor

Advantages of RISC Processor

1. The RISC processor's performance is better due to the simple and limited number of the instruction set.
2. It requires several transistors that make it cheaper to design.
3. RISC allows the instruction to use free space on a microprocessor because of its simplicity.
4. RISC processor is simpler than a CISC processor because of its simple and quick design, and it can complete its work in one clock cycle.

Disadvantages of RISC Processor

1. The RISC processor's performance may vary according to the code executed because subsequent instructions may depend on the previous instruction for their execution in a cycle.
2. Programmers and compilers often use complex instructions.
3. RISC processors require very fast memory to save various instructions that require a large collection of cache memory to respond to the instruction in a short time.

5.4 CISC Processor

The CISC Stands for **Complex Instruction Set Computer**, developed by the Intel.

So, CISC approaches reducing the number of instructions on each program and ignoring the number of cycles per instruction.

CISC chips are relatively slower as compared to RISC chips but use little instruction than RISC.

Examples of CISC processors are VAX, AMD, Intel x86 and the System/360

5.5 Characteristics of CISC Processors

1. The length of the code is shorts, so it requires very little RAM.
2. CISC or complex instructions may take longer than a single clock cycle to execute the code.
3. Less instruction is needed to write an application.
4. It provides easier programming in assembly language.
5. Support for complex data structure and easy compilation of high-level languages.
6. It is composed of fewer registers and more addressing nodes, typically 5 to 20.
7. Instructions can be larger than a single word.
8. It emphasises the building of instruction on hardware because it is faster to create than the software.

5.6 Advantages and Disadvantages of CISC Processor

Advantages of CISC Processor

1. The compiler requires little effort to translate high-level programs or statement languages into assembly or machine language in CISC processors.
2. The code length is quite short, which minimises the memory requirement.
3. To store the instruction on each CISC, it requires very less RAM.
4. Execution of a single instruction requires several low-level tasks.
5. CISC creates a process to manage power usage that adjusts clock speed and voltage.
6. It uses fewer instructions set to perform the same instruction as the RISC.

Disadvantages of CISC Processor

1. CISC chips are slower than RSIC chips to execute per instruction cycle on each program.
2. The performance of the machine decreases due to the slowness of the clock speed.
3. Executing the pipeline in the CISC processor makes it complicated to use.
4. The CISC chips require more transistors as compared to RISC design.
5. In CISC it uses only 20% of existing instructions in a programming event

5.7 CISC Processors Architecture

The CISC architecture helps reduce program code by embedding multiple operations on each program instruction, which makes the CISC processor more complex.

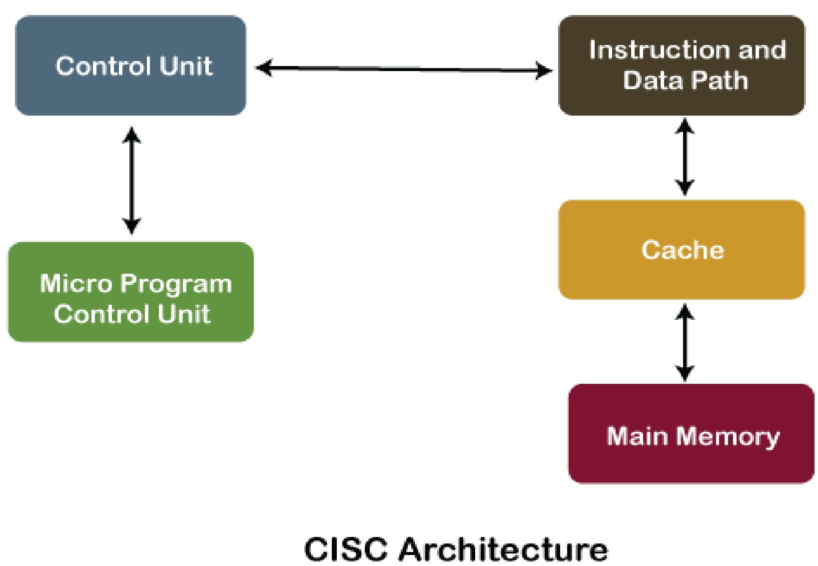

Fig 6: Block diagram of CISC Architecture

CHAPTER 6: ARM Processor

6.1 What is ARM

The "R" in the acronym "Arm" stands for another acronym: Reduced Instruction Set Computer (RISC).

ARM is a family of reduced instruction set computing architectures for computer processors, configured for various environments.

Bits : 32-bit, 64-bit

Design : RISC

Type : Register-Register

Registers : General purpose register and Floating-point register

ARM (generally) works better in smaller tech that does not always have access to a power source, while Intel focuses more on performance, which makes it the better processor for larger tech. But ARM is also making great strides in the tech industry and is expected to far surpass Intel by some experts soon on performance.

6.2 Why ARM is only on RISC but not on CISC

Although CISC reduces usage of memory and complexity, it requires more complex hardware to implement the complex instructions.

RISC uses a small and highly optimized set of instructions which are generally register to register operations. As it uses less space due to reduced instruction set,

This makes to place extra functions like floating point architecture units on the same chip.

6.3 ARM Buses

Advanced High-Speed Bus (AHB) / Advanced System Bus (ASB) and the Advanced Peripheral Bus (APB).

APB: The Advanced Peripheral Bus (APB) is used for connecting low bandwidth peripherals. It is a simple non-pipelined protocol that can be used to communicate(read or write) from a bridge/master to a number of slaves through the shared bus.

The APB consists of a single bus master called the APB bridge, which acts as a slave on the AHB. Thus, the bridge is the interface between the high-performance bus and the low-frequency peripherals. The peripheral devices on the APB are the slaves.

AHB/ASB: The AHB was a new addition to AMBA in revision 2.0. It was added to accommodate high-performance designs. Some of the new features added were split transactions, single-cycle bus master handover, single-clock-edge operation, and wider data bus configurations.

AHB is a bus interface suitable for high-performance synthesizable designs. It defines the interface between components, such as masters, interconnects, and slaves.

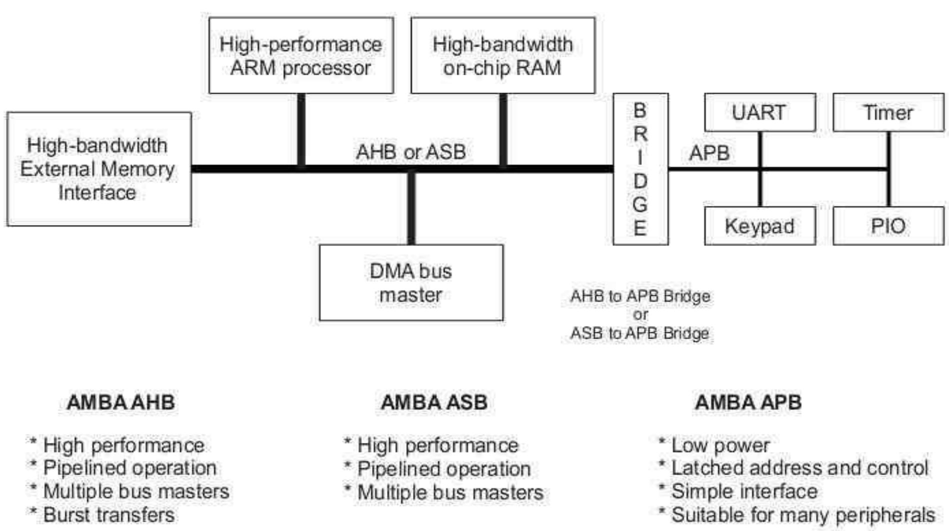

Fig 7: Internal structure of ARM Bus

6.4 Advantages and Disadvantages of ARM Processor

Advantages of ARM Processor

01. **Created at a low cost**– Because it does not require expensive equipment to manufacture, the A-R-M Processor is incredibly inexpensive. In comparison to other processors, it is produced at a far lower cost. As a result, they are well-suited to the production of low-cost mobile phones and other electronic gadgets.

02. **Power consumption is low**– The power consumption of AMP Processors is lower. They were created to perform at lower power levels. They even use fewer transistors in their design. They have several other qualities that make this possible.

03. **Work more quickly**– ARM only does one operation at a time. This speeds up the process. It has a smaller latency, which means it responds faster.

04. **Feature of multiprocessing**– ARM processors are designed to work with multiprocessing systems, which use many processors to process data. The first AMP processor, the ARMv6K, had the potential to handle four CPUs in addition to its hardware.

05. **Improved Battery Life**– The battery life of ARM processors is better. This can be seen while administering devices with and without ARM processors. Those who worked using ARM processors worked for longer periods of time and were discharged later than those who did not.

06. **Circuits Made Simple**– Because A-R-M processors contain basic circuits, they are highly compact and may be employed in small devices (several devices are becoming smaller and more compact due to customer demands).

Disadvantages of ARM Processor

1. Some processors have speed limitations, which could cause issues.
2. In the case of A-R-M processors, scheduling instructions are problematic.
3. The programmer's instructions must be carried out correctly. This is because the execution of A-R-M processors determines their overall performance.
4. Programmers with a high level of expertise are required for the A-R-M processor. This is due to the significance and difficulty of the execution.

6.5 Applications of ARM Processor

Consumer electronic gadgets such as smartphones, tablets, multimedia players, and other mobile devices such as wearables all employ A-R-M processors. They require fewer transistors because of their restricted instruction set, allowing for a smaller die size for the integrated circuitry (IC).

CHAPTER 7: FPGA

7.1 What is FPGA

A **field-programmable gate array** (**FPGA**) is an integrated circuit designed to be configured by a customer or a designer after manufacturing – hence the term *field-programmable*. The FPGA configuration is generally specified using a hardware description language (HDL), similar to that used for an application-specific integrated circuit (ASIC). Circuit diagrams were previously used to specify the configuration, but this is increasingly rare due to the advent of electronic design automation tools.

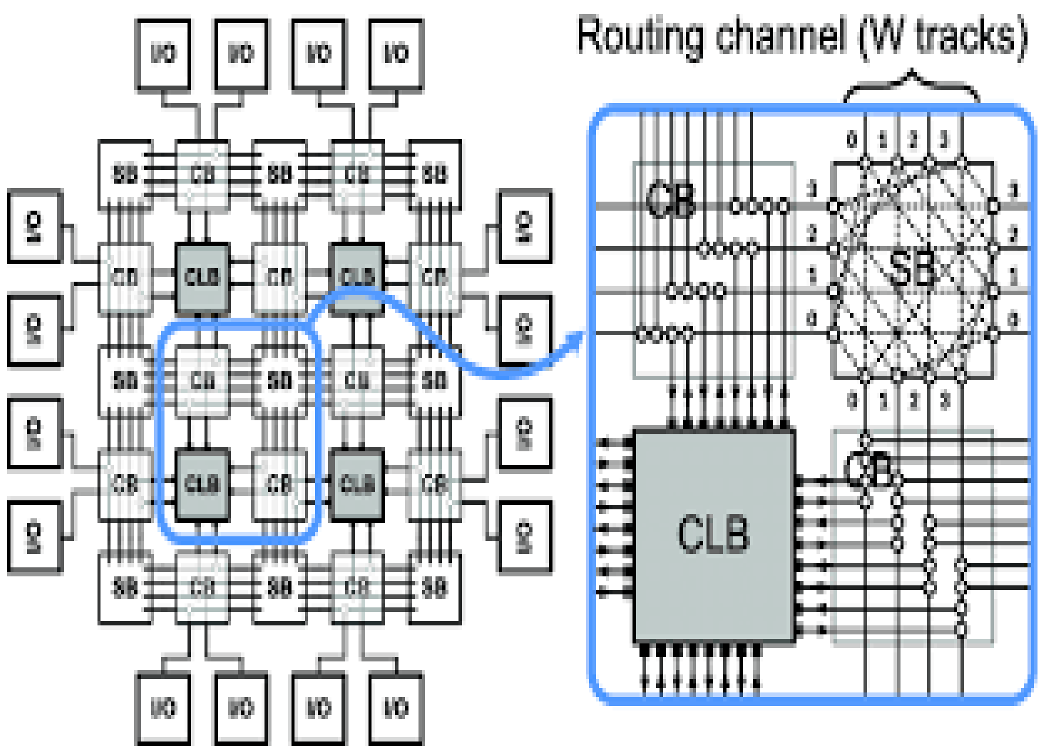

Fig 8: Internal structure of an FPGA

7.2 Xilinx, Inc.

It is an American technology company that is primarily a supplier of programmable logic devices. The company invented the field-programmable gate array (FPGA). It is the semiconductor company that created the first fabless manufacturing model.

7.3 Virtex-5 family

The Virtex series of FPGAs have integrated features that include FIFO and ECC logic, DSP blocks, PCI-Express controllers, Ethernet MAC blocks, and high-speed transceivers. In addition to FPGA logic, the Virtex series includes embedded fixed function hardware for commonly used functions such as multipliers, memories, serial transceivers and microprocessor cores.[153] These capabilities are used in applications such as wired and wireless infrastructure equipment, advanced medical equipment, test and measurement, and defense systems.

The Virtex-5 LX and the LXT are intended for logic-intensive applications, and the Virtex-5 SXT is for DSP applications. With the Virtex-5, Xilinx changed the logic fabric from four-input LUTs to six-input LUTs. With the increasing complexity of combinational logic functions required by SoC designs, the percentage of combinational paths requiring multiple four-input LUTs had become a performance and routing bottleneck. The six-input LUT represented a tradeoff between better handling of increasingly complex combinational functions, at the expense of a reduction in the absolute number of LUTs per device. The Virtex-5 series is a 65 nm design fabricated in 1.0 V, triple-oxide process technology.

Block Diagram

Figure 1-1 shows a block diagram of the ML50*x* Evaluation Platform (board).

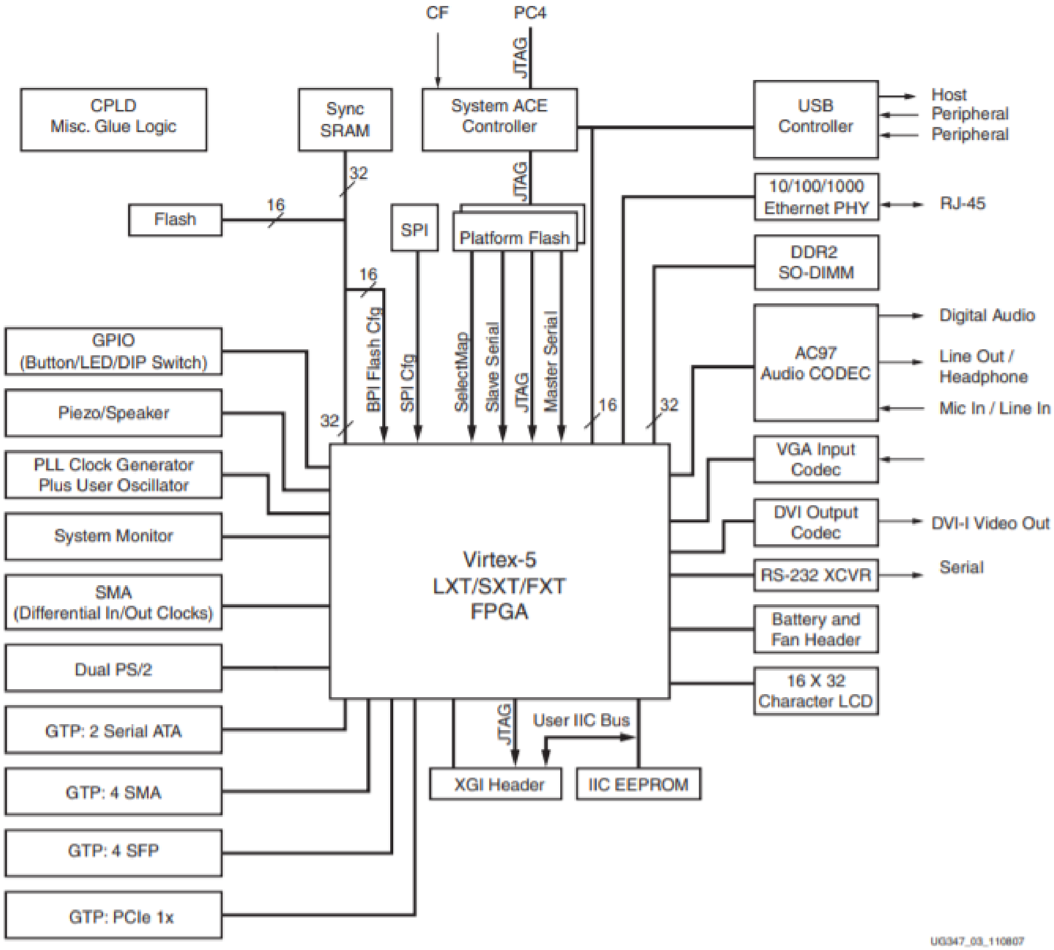

Figure 1-1: **Virtex-5 FPGA ML50*x* Evaluation Platform Block Diagram**

Fig 9: Block diagram of ML507 Evaluation Platform

CHAPTER 8: Xilinx Platform Studio

8.1 What is XPS?

Xilinx Platform Studio (XPS) is a key component of the ISE Embedded Edition Design Suite, helping the hardware designer to easily build, connect and configure embedded processor-based systems; from simple state machines to full-blown 32-bit RISC microprocessor systems.

8.2 Xilinx Development Board

Production, deployable accelerator cards from Xilinx and partners. Learn More. Evaluation Boards. Development/Evaluation boards and kits offer all the components of hardware, design tools, IP, and pre-verified reference designs to enable evaluation and development across markets and applications.

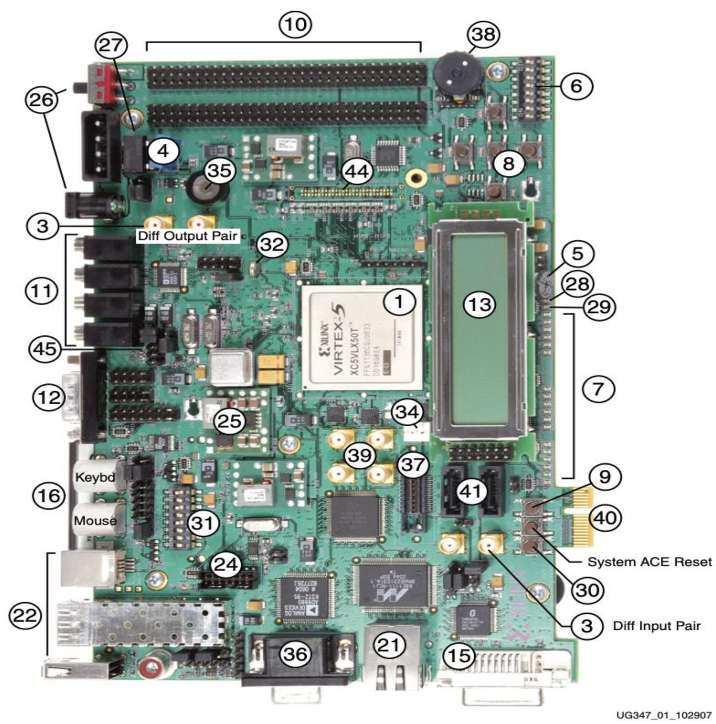

Figure 1-2: **Detailed Description of Virtex-5 FPGA ML505 Components (Front)**

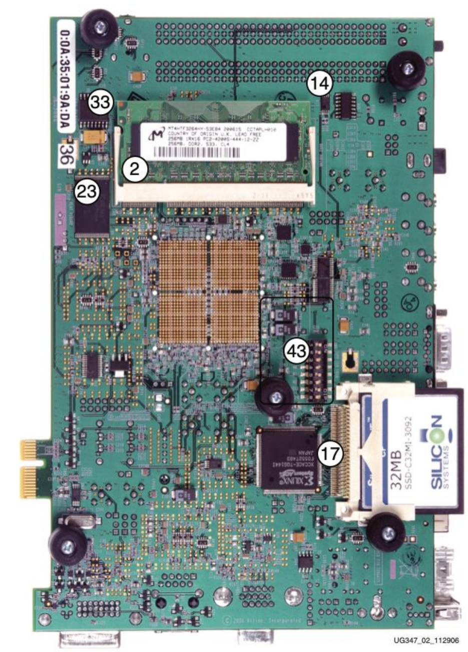

Figure 1-3: **Detailed Description of Virtex-5 FPGA ML505 Components (Back)**

Note: The label on the CompactFlash (CF) card shipped with your board might differ from the one shown.

Fig 10: Vertex-5 FPGA ML505M Development Board i) front ii)back

CHAPTER 9: Xilinx ISE Design Suite 14.7

9.1 Create the Basic Project

- Open XPS by selecting "Start->Xilinx ISE Design Suite 14.7->Xilinx Platform Studio".
- From the dialog box, select "Base System Builder wizard" and OK.
- You will be asked to specify which folder to place the project. Click "Browse" and create a new folder for the project. Click "OK".

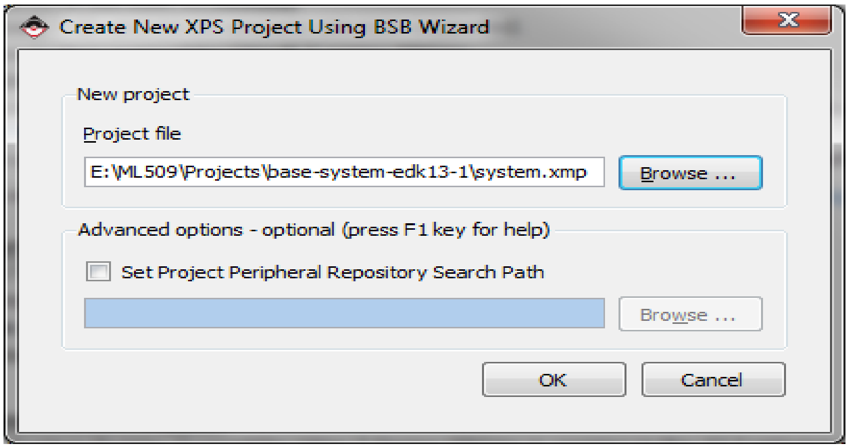

Fig 11: Creating New XPS project

- The first page of the wizard will ask us to choose between using a Processor Local Bus (PLB) or an Advanced Extensible Interface (AXI). As we are using the Virtex-5, we have to select a PLB system, but if you are working with a Virtex-6 or a Spartan-6 you are better to go with the AXI system.

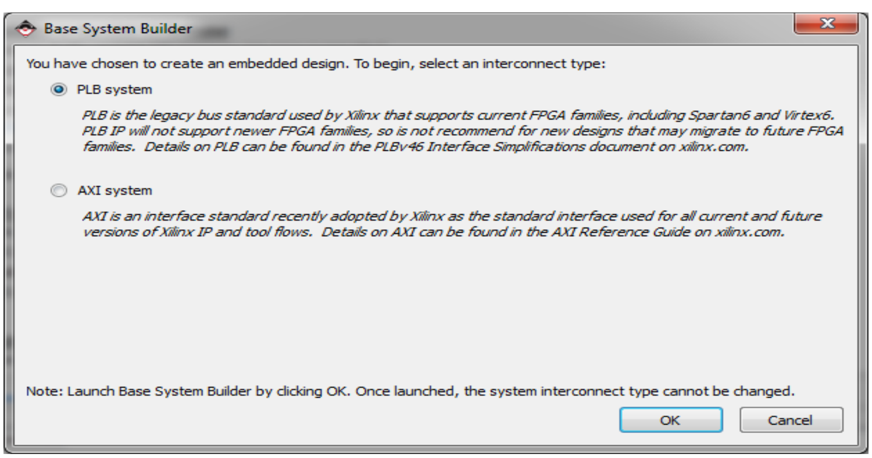

Fig 12: Selection of interconnect type

- We are given the choice to create a new project or to create one using the template of another project. Tick “I would like to create a new design” and click “Next”.

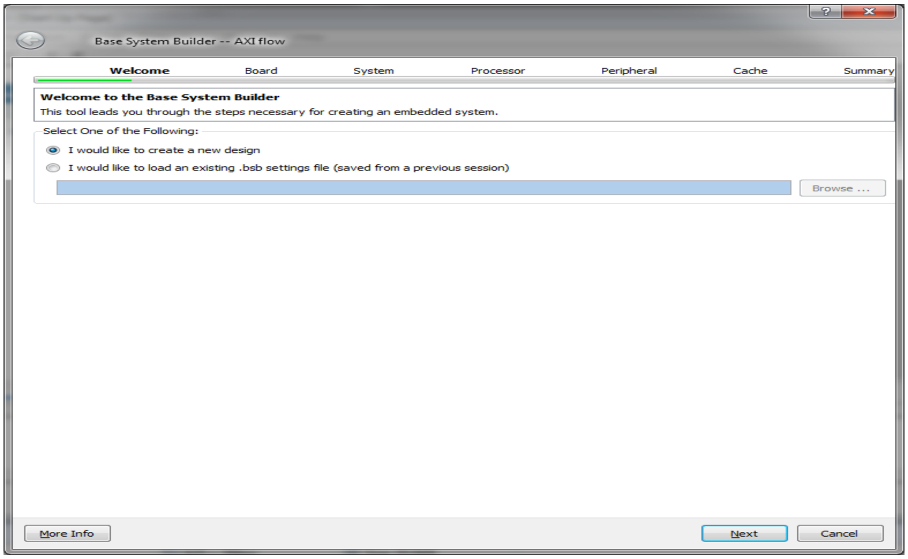

Fig 13: Welcome window of XPS software

- On the “Select Board” page, select “Xilinx” as the board vendor. Then select the board you are using (eg. “Virtex 5 ML505 Evaluation Platform”). Select “1” as the board revision. Click “Next”. (Note: If you are using the XUPV5 (ML509) board, select “Virtex 5 ML505 Evaluation Platform” instead.)

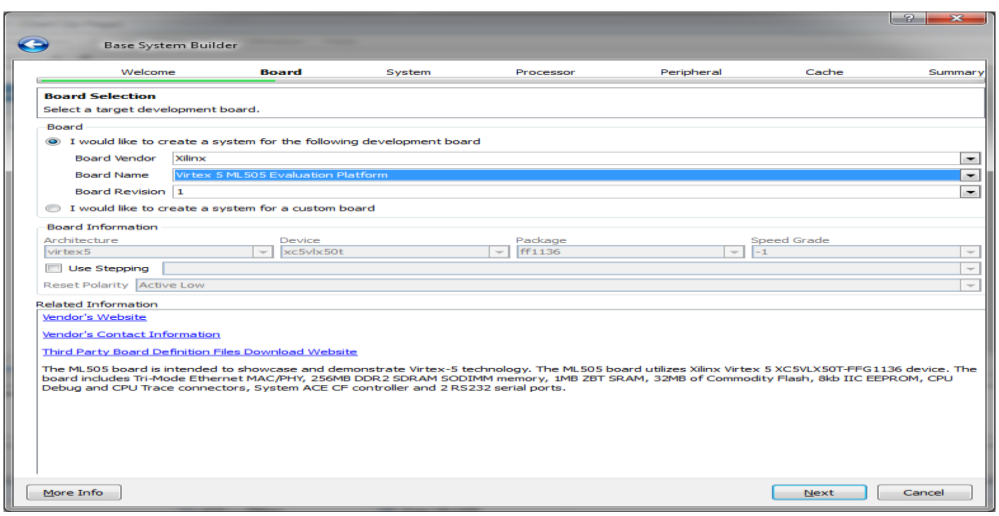

Fig 14: Selecting a target development board

- On the “Select Board” page, select “Xilinx” as the board vendor. Then select the board you are using (eg. “Virtex 5 ML505 Evaluation Platform”). Select “1” as the board revision. Click “Next”.

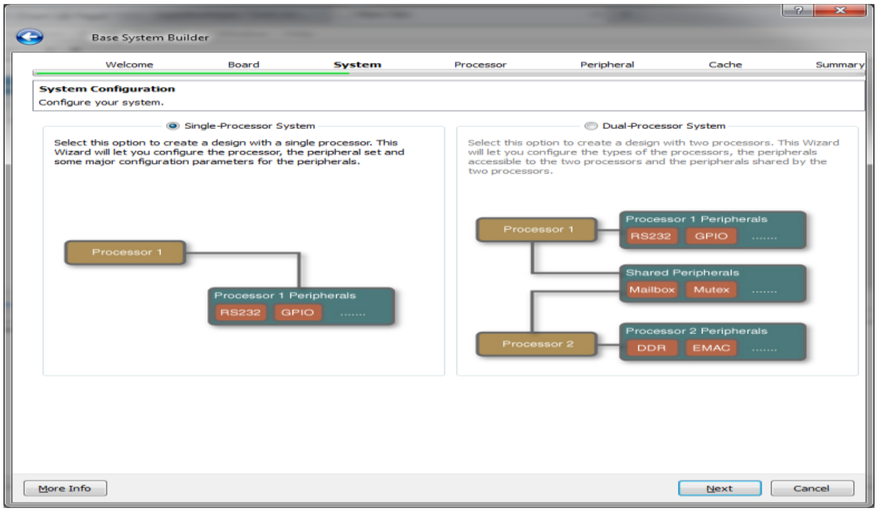

Fig 15: Configurating of system

- On the “Configure Microblaze” page, we can specify the clock frequency of our processor and the amount of memory it will use. Select the clock frequency to 125MHz. Click “Next”.

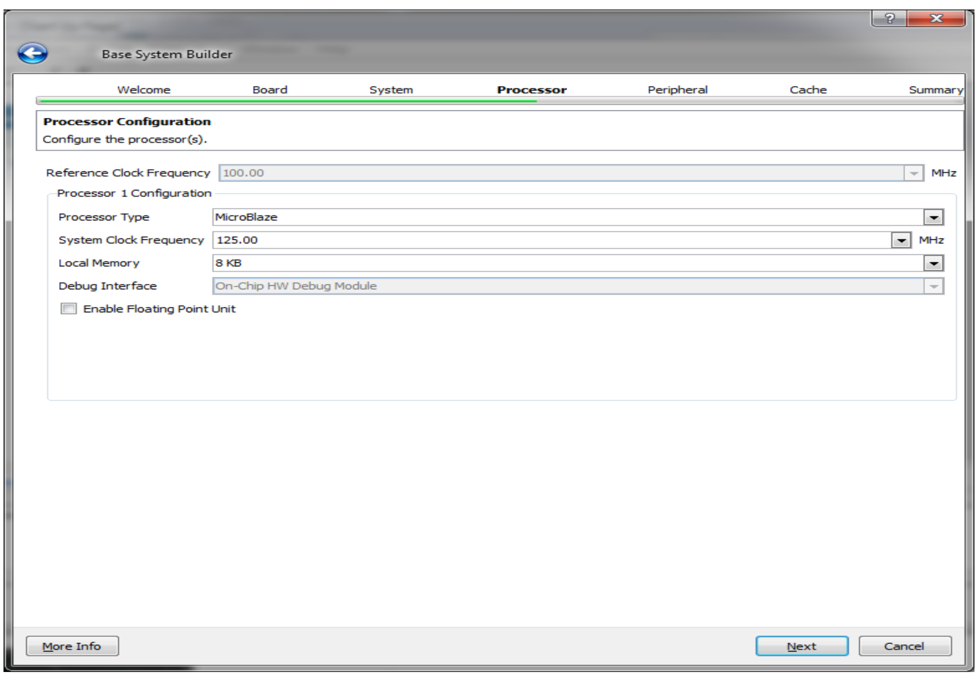

Fig 16: Configuring the processor

- Now we can select the peripherals to put in the design. The peripherals will all be connected to the Microblaze processor via the PLB and they allow us to control and access features of the FPGA and external hardware such as the DDR2 memory and the Ethernet MAC. We will leave the default setting which is to include ALL the standard peripherals. You might ask "**Why include all the peripherals?**", well most of the time you would only include the peripherals that you need so that you don't waste time building peripherals you wont use. In this case, I want you to include all the peripherals because a lot of the following EDK tutorials will be based on this "base system". This way, we wont have to go through the Base System Builder for every tutorial and we'll save time. The fact is, in a professional environment, you would never go through the Base System Builder when starting a new project, instead you would take an existing project and develop from that.

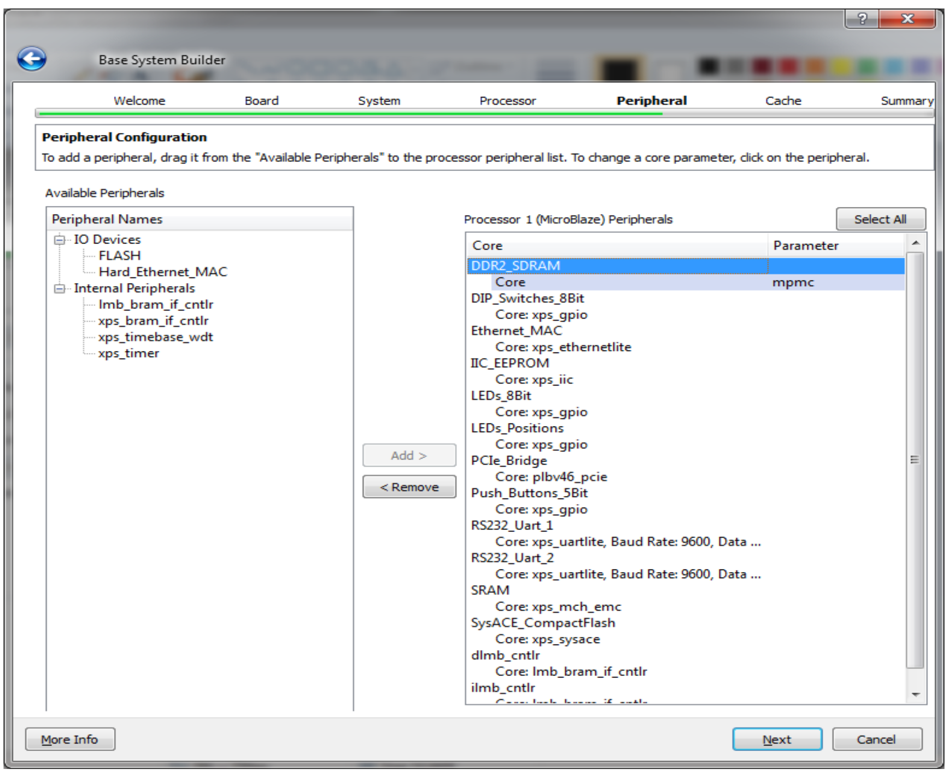

Fig 17: Configuring the peripherals

- In the next page we can configure cache memory for the Microblaze. In our case we won't use cache memory so leave the default and click "Next".

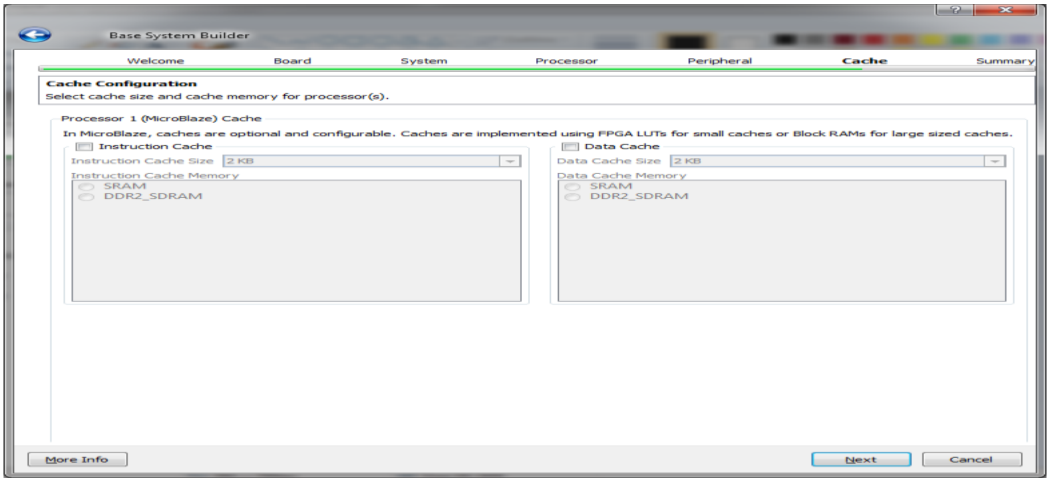

Fig 18: Configuring the Cache memory

- The Base System Builder then gives us a summary of the design that it will create for us, showing the PLB memory map, the peripherals and the files that it will create.

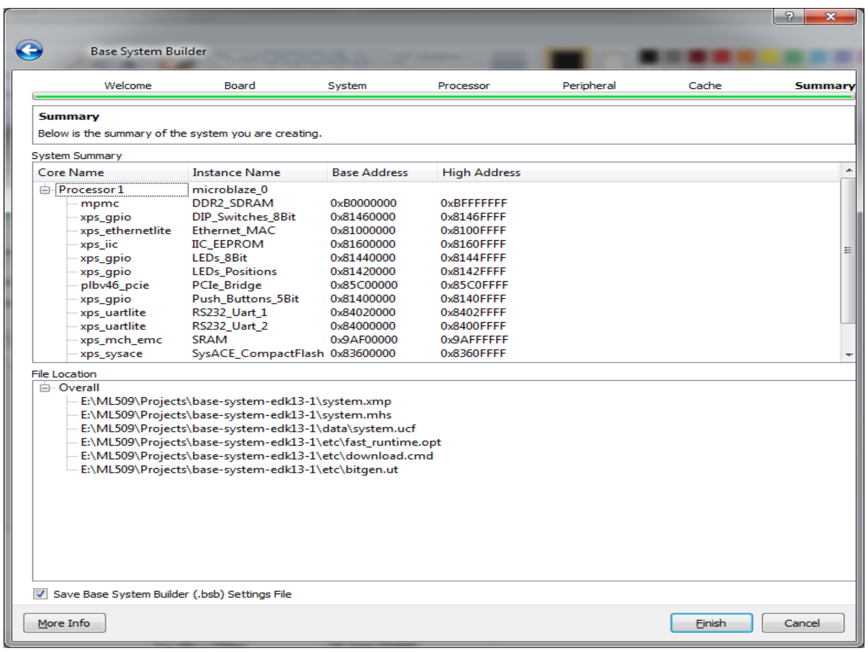

Fig 19: Summary of the system created

- Click "Finish".

CHAPTER 10: Conclusion

Firstly, we investigated microprocessors, its working and design which served as the basics for our topic. From there studied about ARM processors and FPGA (Field Programmable Gate Array). We considered FPGA because of its versatile nature and its significance as a reprogrammable device and as a suitable alternate for ASIC (Application Specific Integrated Circuit) chips.

We, with the help of Xilinx XPS software developed a communication device that performs a display operation using Vertex-5 ML505 FPGA and ARM (Xilinx software) software on a developer board of Xilinx, with that we observed the vast operations we can do with FPGA and how we can extend the use of FPGA to various applications.

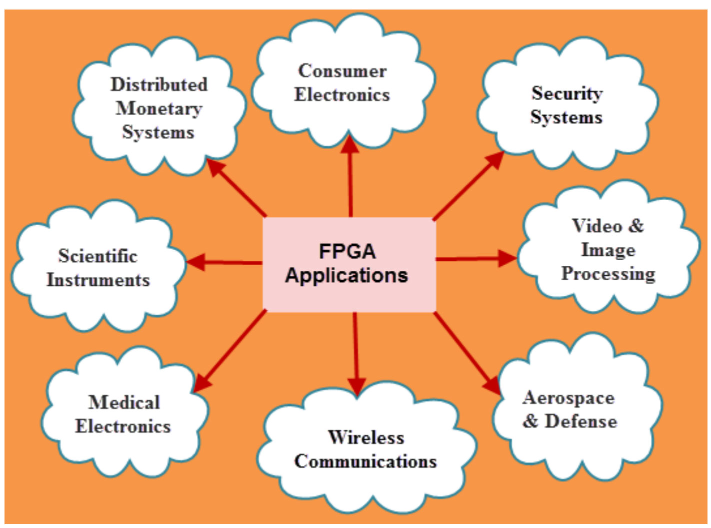

Fig 20: Applications of FPGA