Module 1

Introduction

VHDL and FPGA development for beginners

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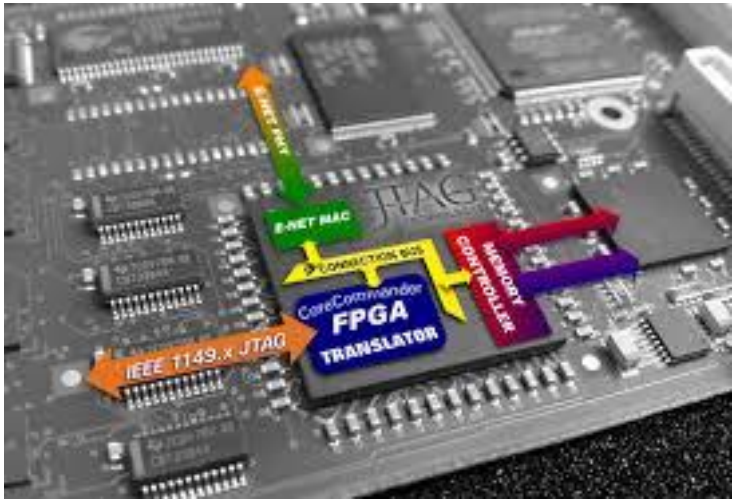
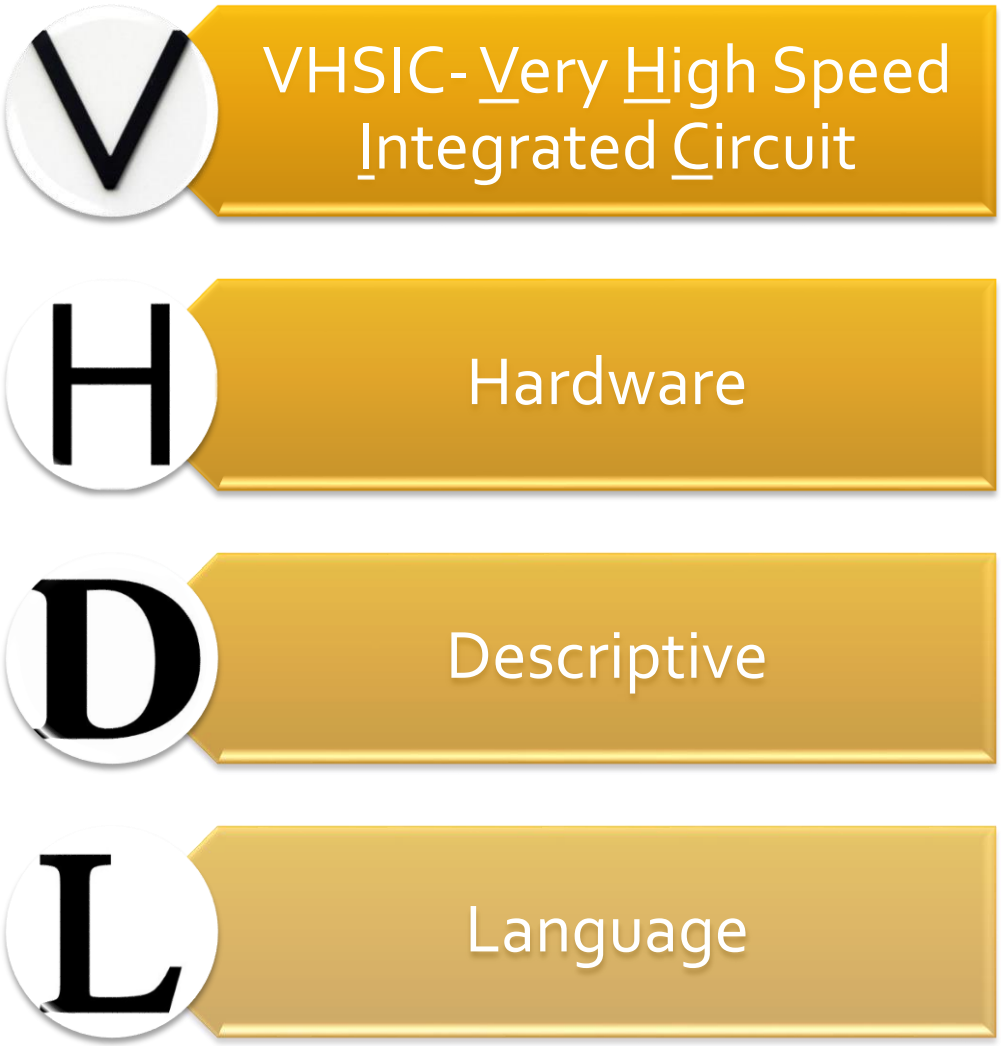
About Me

- Bachelors of Science in Electronic & Computer Engineering Technology
- Working towards my Masters in Electrical Engineering.
- Absolutely love working with electronics, especially embedded systems.

UNIVERSITY of DAYTON



VHDL



- VHDL is used to describe the actual physical circuit.

History of VHDL

- VHDL was developed in 1981 by the DoD (Department of Defense).
- VHDL was developed as a way to address the hardware life cycle crisis of electronic systems.
- The DoD gave away all rights of the language to the IEEE (Institute of Electrical and Electronics Engineers).

Devices that use VHDL

FPGA

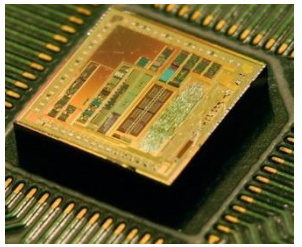
Field
Programmable
Gate
Array

CPLD

Complex
Programmable
Logic
Device

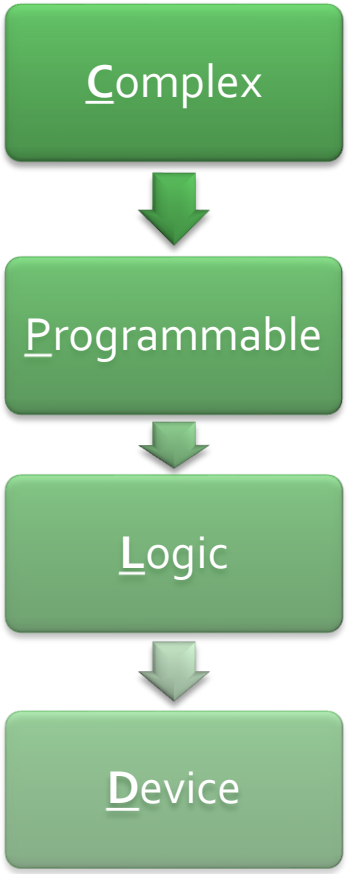
ASIC

Application
Specific
Integrated
Circuit



Uses for VHDL

- VHDL is used as a way to simulate the behavior of a circuit.
- VHDL is typically used as a way of describing the circuit inside a FPGA (Field Programmable Gate Array)
- The logic inside a CPLD (Complex Programmable Logic Device) can be described using VHDL.
- VHDL is used as a way of creating an ASIC (Application Specific Integrated Circuit).



FPGA vs CPLD

FPGA

- Designed using logic blocks.
- Much higher logic capacity.
- Typically are used for much more complex designs.
- Volatile memory.
- Typically more expensive than CPLD.

CPLD

- Designed based on EEPROM.
- Less logic capacity than FPGA.
- Typically used for a simpler less complex design.
- Non-volatile memory.
- Typically more cost effective than FPGA.

FPGA / CPLD Manufactures

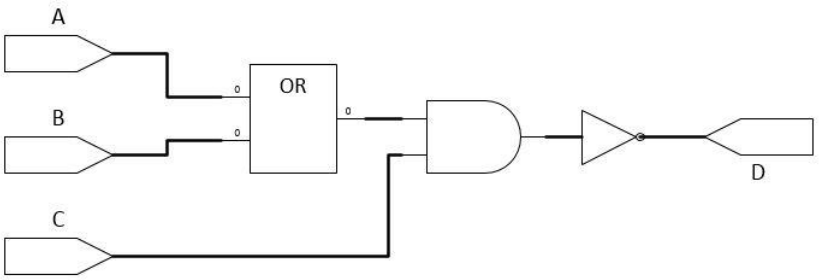
- Xilinx and Altera combined make up approximately 88% of the FPGA / CPLD market.

We are NOT Programming

- VHDL is **not** a programming language.
- We are describing the behavior of a specified circuit.
- VHDL is not software, it is used to describe the hardware that software runs on.
- When VHDL is synthesized the compiler runs through the code and constructs the gates specified in the VHDL code and implements them onto the targeted logic device.

Example

DIGITAL LOGIC CIRCUIT



VHDL EQUIVALENT

```
----------------------------------------------
-- Digital Logic Circuit
-- Udemy Example
----------------------------------------------
library IEEE;
use IEEE.STD_LOGIC_1164.ALL;
use IEEE.numeric_std.all;

entity example is
port (
    D       : out std_logic;
    A       : in std_logic;
    B       : in std_logic;
    C       : in std_logic);
end example;

architecture behavior of example is
begin

    D <= not((A or B) and C);

end behavior;
```

Example

C++ FOR LOOP

```cpp
#include <iostream>
using namespace std;

int main ()
{
   // for loop execution
   for( int a = 10; a < 20; a = a + 1 )
   {
       cout << "value of a: " << a << endl;
   }

   return 0;
}
```

Results from C++ for loop

```
value of a: 10
value of a: 11
value of a: 12
value of a: 13
value of a: 14
value of a: 15
value of a: 16
value of a: 17
value of a: 18
value of a: 19
```

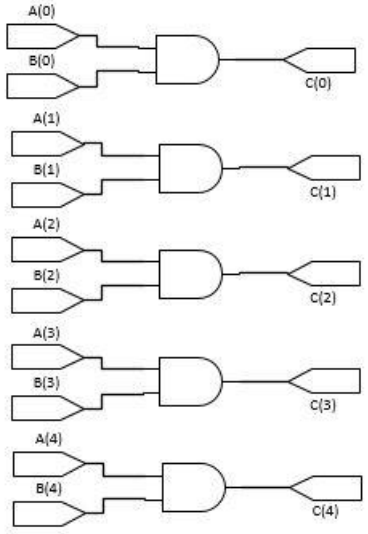
VHDL FOR LOOP

```vhdl
-- VHDL for loop example
for a in 0 to 4 loop

    C(i) <= A(i) and B(i);

end loop;
```

Results from VHDL for loop



They are not Equal!

- Right now the important thing to understand is that even though the syntax of VHDL is very similar to several programming languages it does not run the same.
- When VHDL is implemented everything happens in parallel. For example when the for loop is executed all the C outputs C(0) thru C(4) are running concurrently.
- The C++ for loop like other software programming languages do not have concurrent outputs. As seen in the previous slide the value of variable "a" changed every loop.

Summary

- VHDL is used to describe the behavior of a digital circuit.
- Top 2 manufactures of FPGA's and CPLD's are Xilinx and Altera.
- VHDL is **not** a software programming language.
- Though VHDL has a lot of the same conditional logic as other languages, it does not produce the same results.

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