

FPGAtors

History & Applications of FPGA

An overview of the history of the FPGA and how it’s used today

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Today’s roadmap

An overview of the history of the FPGA and how it’s used today

01 History	What inventions led to the FPGA, and how did the FPGA come about?
02 Definition & Uses	What is an FPGA, and why do we use them?
03 Applications & Workflow	How are FPGAs used in modern applications? How are they used by students at UF?
04 Conclusion	Summary, Q&A, FPGAtors future events

FPGA History

1960s - Early 1970s

1960s

- Engineers wired circuits from individual logic chips by hand
- Any changes to the circuit meant rewiring everything

Early 1970s

- **PROM** (Programmable Read-Only Memory) and basic **PLAs** (Programmable Logic Arrays) let engineers “burn in” a circuit
- These devices were programmable, but only once
- PROMs were so cheap that if engineers needed to burn in another circuit, they would just buy more
- This was not true reconfigurability, but engineers treated it as such because at the time, no other devices were available

FPGA History

Late 1970s - 1980s

Late 1970s

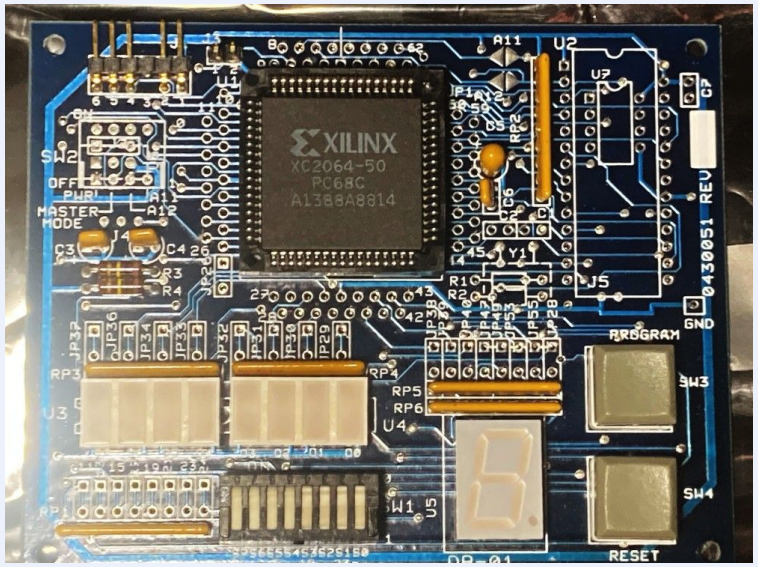
• Engineers wanted a device that made “hardware as flexible as software”

• Developments in **PLAs** allowed for reconfigurability, but these devices were simple and could only implement **combinational logic** using AND and OR gate arrays

1980s

• In 1985, the first **FPGA** was invented by Ross Freeman, co-founder of Xilinx Inc. (now part of AMD)

Xilinx XC2064



FPGA History

1990s - Today

1990s
- FPGA capacity scaled from hundreds to millions of gates
- FPGAs began to dominate prototyping

2000s
- Built-in memory, DSP blocks, faster I/O
- FPGAs implemented in networking, video, and defense applications

2010s
- FPGAs gain CPU cores on-chip (**SoC FPGA**)
- ML, 5G, data center acceleration

Today
- FPGAs are used **everywhere**, in applications ranging from cloud computing to cars



What is an FPGA?

FPGA: Field-Programmable Gate Array



- Integrated circuit with programmable gate matrix
- Can be programmed to realize **any** logic function
- **Does not** require expensive equipment to implement design



Some features of FPGAs:

- Programmable Logic Gates
- Programmable Interconnects
- Digital Signal Processing (DSP) Blocks
- Embedded Memories

- FPGAs are manufactured by several companies, with the most popular being **AMD (Xilinx)** and **Intel (Altera)**

What is an ASIC?

ASIC: Application-Specific Integrated Circuit

- Integrated circuit customized to perform **one** particular function
- Better performance, lower power consumption, smaller size
- **Does** require expensive equipment to implement design



Some features of ASICs:

- Non-Programmable Logic Gates
- Non-Programmable Interconnects
- Digital Signal Processing (DSP) Blocks
- Embedded Memories



- ASICs are manufactured by many companies, some examples include **ASIX** and **Texas Instruments**

FPGA vs. ASIC

How do FPGAs and ASICs compare?

- Notice how FPGAs and ASICs can contain nearly identical features
- **Main difference**: one is reconfigurable, the other is not
- Often times, companies will test circuits on an FPGA, then make it an ASIC once it is tested and working

FPGA

- **Reconfigurable**
- **Does not** require expensive equipment to implement a design
- Can realize **any** logic function
- Reprogrammable gate matrix

ASIC

- **Non-Reconfigurable**
- **Does** require expensive equipment to implement a design
- Can realize **one** logic function
- Better performance, lower power consumption, smaller size

Why do we use FPGAs?

FPGAs are used because of their ease of testing designs & high integration density

Designing with FPGA

- Faster, cheaper than ASIC design
- Avoids high **Non-Recurring Engineering** (NRE) costs, delays in design/fab/test
- Reprogrammable; ability to fix bugs, add features, etc.
- Many have **partial reconfiguration** support

High Integration Density

- Several millions of programmable logic elements
- Large, distributed embedded memories
- Other on-chip resources (e.g. dedicated multipliers or crypto units)

FPGA Applications

How are FPGAs used in modern applications?

- **AI & Data Centers**
  - Accelerating ML inference and cloud searches
- **5G & Networking**
  - Routing large volumes of data through cell towers
- **Aerospace, Defense, R&D**
  - Radar, secure communication, satellite
- **Finance**
  - High Frequency Trading (HFT): FPGAs execute trades in nanoseconds (faster than CPU-based trading systems)
- **Healthcare**
  - Real-time processing for MRI, CT, and ultrasound machines
- **Video**
  - Real-time video processing & broadcasting
- **Gaming**
  - Hardware emulation for retro consoles



FPGA at UF

How are FPGAs used at UF?

Courses

- **EEL 3701C** - Digital Logic
- **EEL 4712C** - Digital Design
- **EEL 4720/5721** - Reconfigurable Computing
- **EEL 6935** - Reconfigurable Computing 2
- **EEL 4930/5934** - System-on-Chip Design
- **EEL 5716** - Intro to Hardware Security
- **EEL 6744** - Hands-On Hardware Security
- **EEE 4511C -** Real-Time Digital Signal Processing Applications

Student Organizations

- **FPGAtors = ALL FPGA!!!**
- **UF Silicon Design Team** - No FPGA, but DD/DV teams write SystemVerilog

How to use an FPGA

A basic overview of how to use an FPGA

- Set up tools (e.g. Vivado, Quartus) and configure settings for your FPGA

- Create a design via an HDL or BDF

- Program your design onto the FPGA



Summary

What was covered in this workshop?

- FPGAs were created with flexibility and reconfigurability in mind
- FPGAs and ASICs are similar in many ways, but each have their own advantages and disadvantages
- FPGAs are used in a wide range of applications
- FPGAs are used by several courses at UF (and student organizations like FPGAtors!)

Conclusion

Please sign in if you haven't already!

Thank you for attending!

Next workshop, we will introduce SystemVerilog and design several simple digital components and circuits

Questions?

