

# Game Boy Emulation on FPGA

Game Boy - Team C0:

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# Use Case

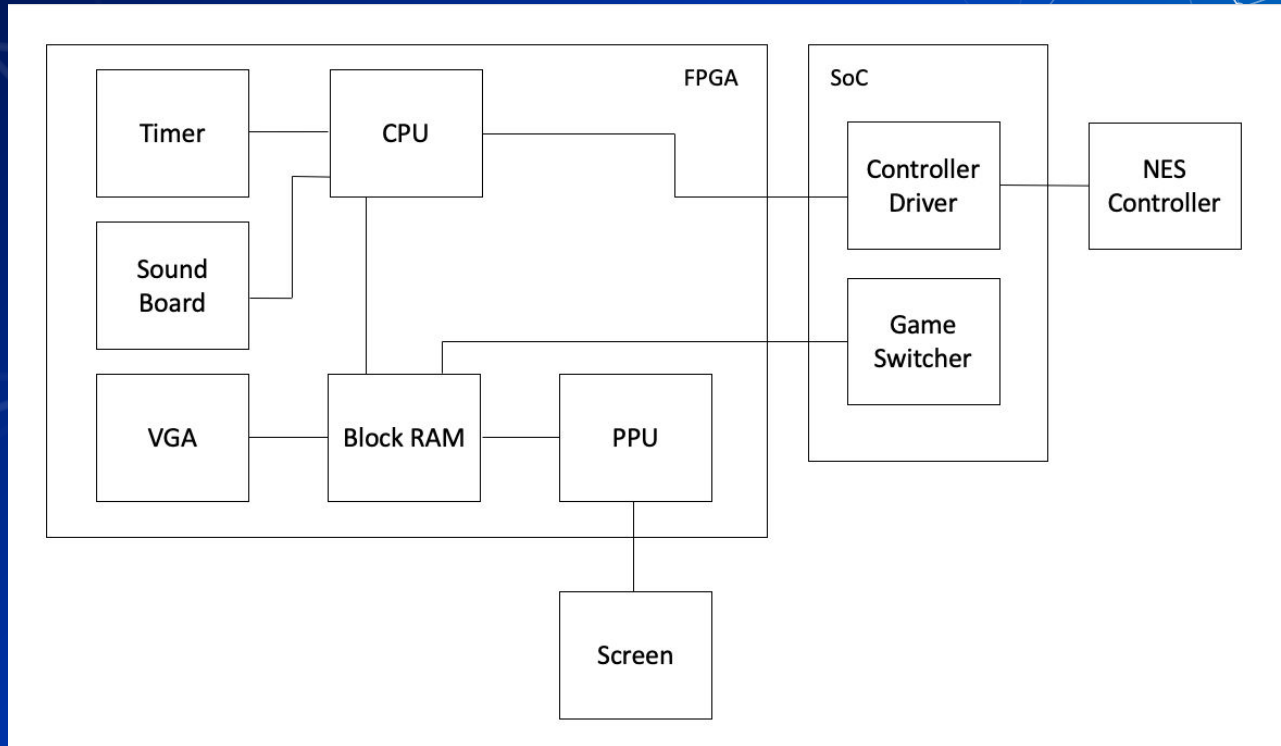
- Compare software vs hardware emulation performance
- Understand Game Boy architecture to improve knowledge of classical architectures
- Recreate classic consoles on modern hardware
- Areas: Hardware, Software



# Solution

- Components overview:
  - Altera DE10 Standard
  - NES Controllers with USB
  - VGA display
  - Speaker

# Solution - System Block Diagram



# Requirements - Performance

- Have games running at the same frame rate as they would on an actual Game Boy
- Achieve cycle accuracy on all non-illegal behavior
- Be able to load and switch between Pokémon Red and Tetris

# Requirements - Usability

- Video and audio should be in sync and should match that of the original
- React to its inputs in a timely manner with the same input delay as the original (32 - 48 ms)
- Be able to save game progress to persistent storage (i.e. user should be able to get back to the point they were in last time they played)

# Testing, Verification, and Metrics

- Cycle accurate comparison of Mooneye emulator against Game Boy
  - Trace both Game Boy and Mooneye emulator while playing Pokémon Red and Tetris
- Use video recordings to calculate the input lag
  - We may use more sophisticated methods in the future
- There are video tests that we can use to look for graphical glitches

# Testing, Verification, and Metrics

- The emulator community has a lot of emulator verification tools, we'll make use of them to lighten the load on us.
- Tests that we have to write:
  - Driver tests
  - Game switching
- Blargg's tests:
  - Cpu instruction tests
  - Instruction timing tests
  - Memory timing tests
- Mooneye GB Acceptance tests:
  - Instruction timing tests
  - Interrupt handling
  - OAM DMA
  - PPU timings
  - Serial Tests
  - Timer Tests
- Mooneye GB emulator only:
  - All the Memory Bank tests



# Tasks and Division of Labor

## ■ Tess

- CPU
- Sound
- Memory
- State saving

## ■ Adolfo

- CPU
- Graphics - PPU & VGA
- Memory
- State saving

## ■ Pratyusha

- CPU
- Drivers for controllers
- Game loader and switching
- Memory



# Stretch Goals

- Link cable
  - Make a breakout board for the link cable
  - Allow FPGA emulator to interact with Game Boy
- User profiles
  - Allow each game to have multiple user profiles, just like on the Nintendo Switch