Battleship!

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ECE 2700 Final Project

OAKLAND UNIVERSITY

Introduction

Summary

- Main project goal: implementing the classic board game *Battleship* onto an FGPA

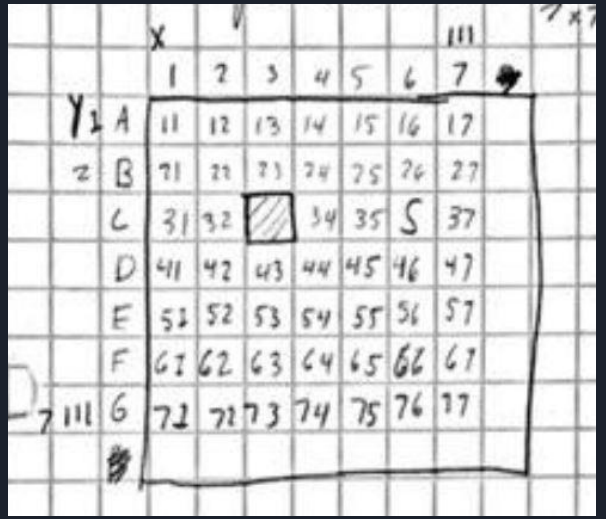
- Battleship is a two-player game where players trade turns trying to sink the other's fleet of ships

Content List

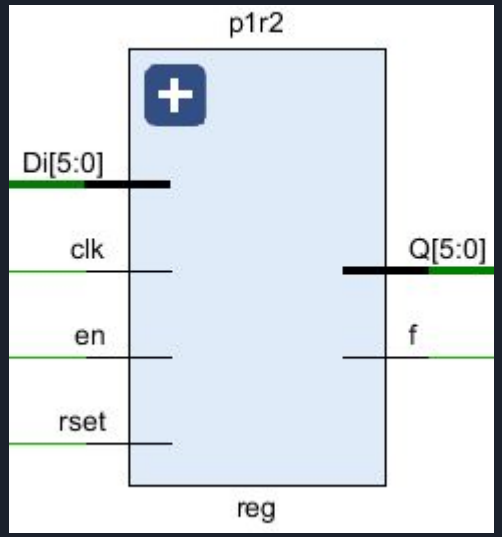
- Base Design / Conceptual Planning
- Components
  - Registers
  - Comparator
  - Serializer
  - Multiplexers
  - Demultiplexers
  - Finite State Machine
- Project challenges/ revisions
- Final Digital System Design
- Sources

Base Design / Conceptual Planning

- Gameboard was chosen to be a 7x7 grid compared to typical 10x10 grid
  - Rows are designated by letters, columns by number (ex: A7, B5, etc.)
  - 7x7 grid as chosen for simplifying the bits needed to store values
- Ships only take up one square vs multiple squares in the normal game
- Code will revolve around grid coordinates and comparing coordinates vs ships and misses



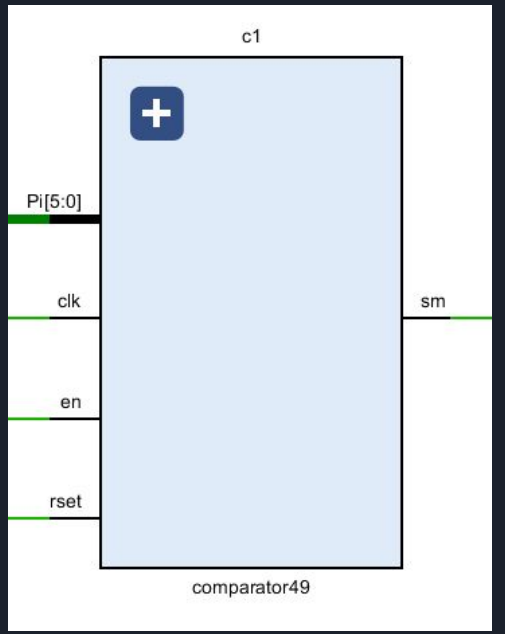
Components (Registers)



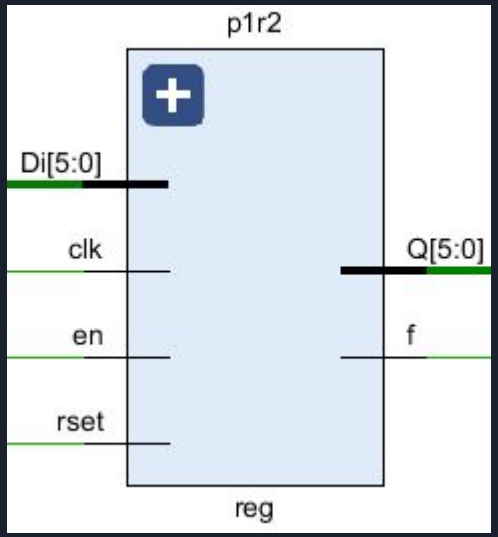
Two Types

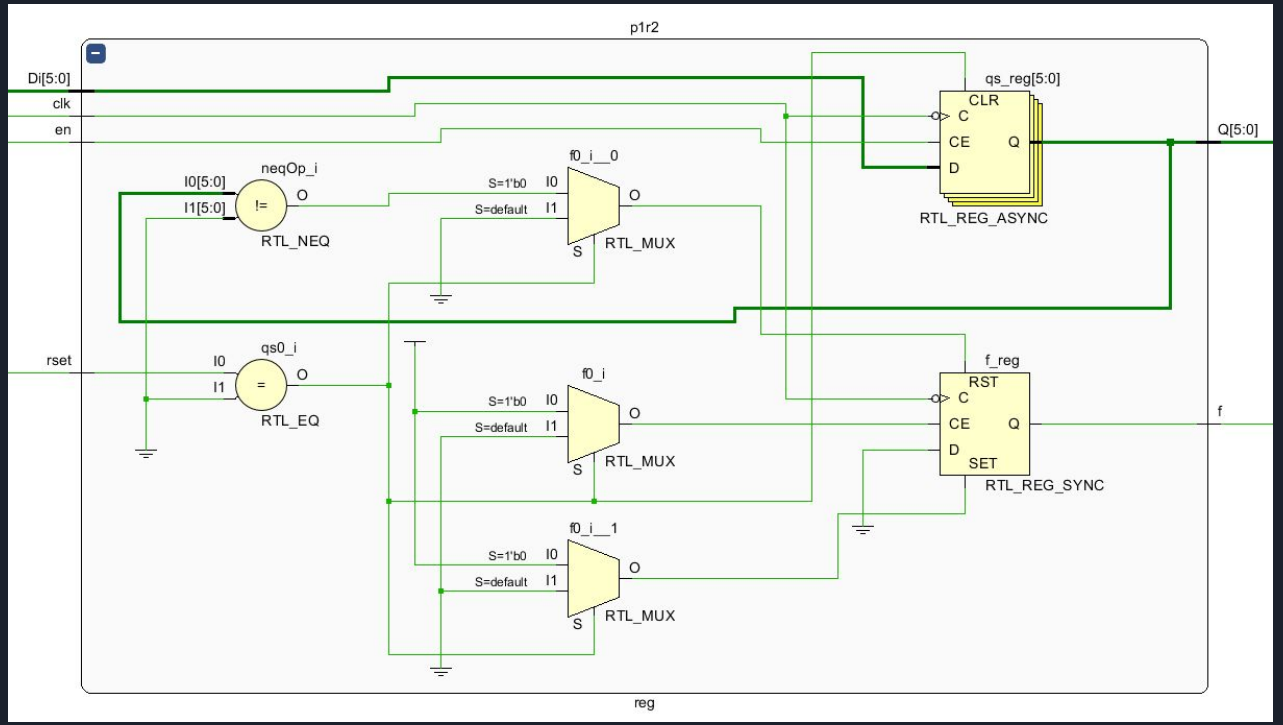
Player Ship Location

Miss Position

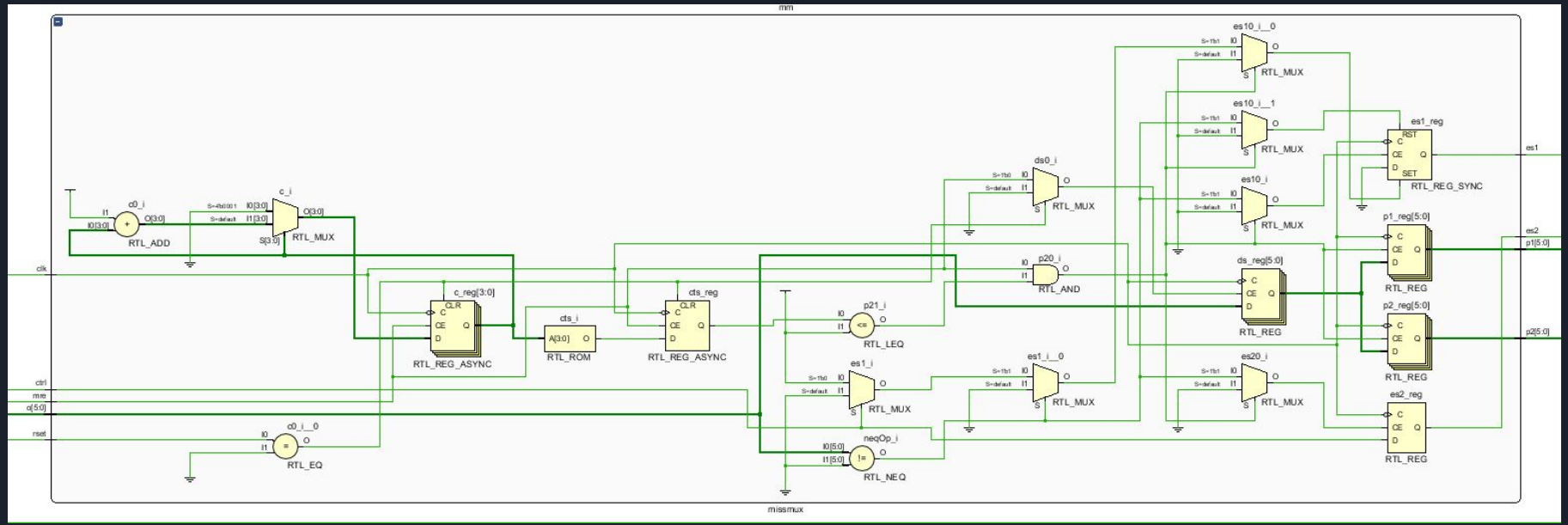


Register Close Up - Player Location



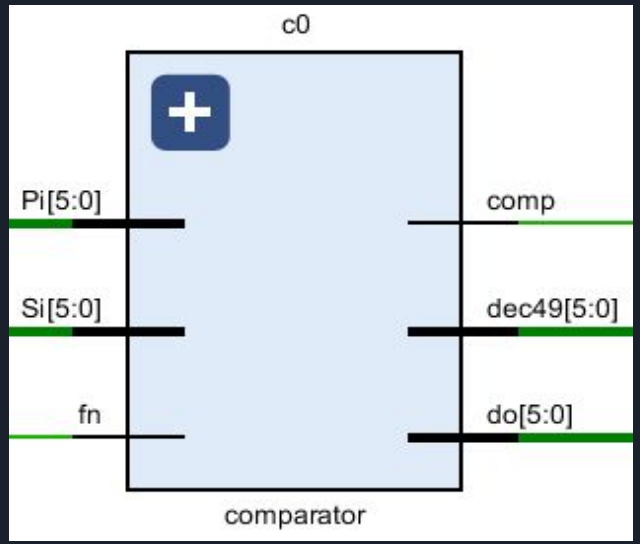


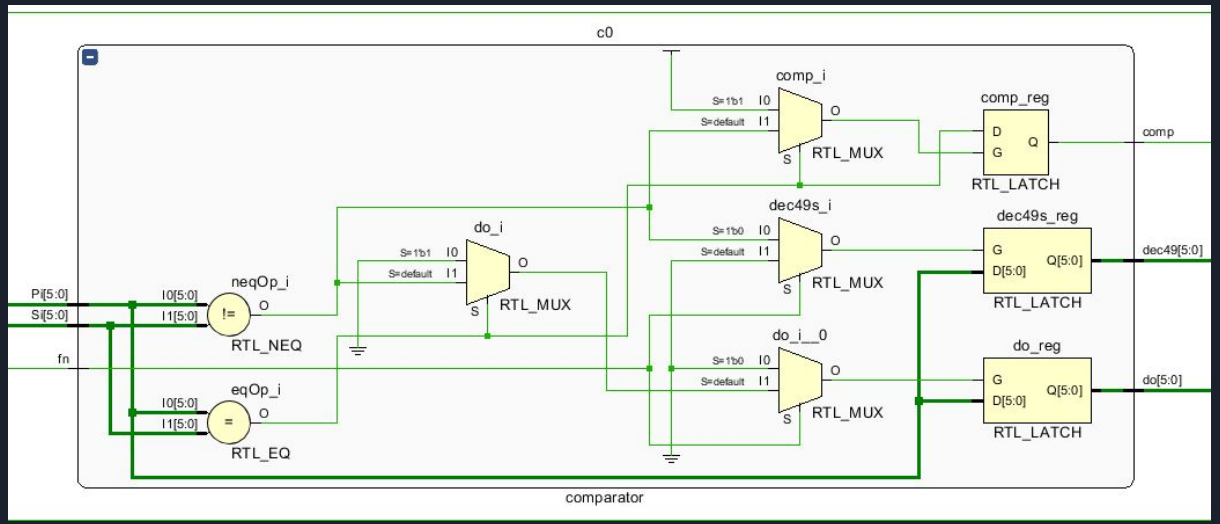
Register Close Up - Miss Position



Components (Main Comparator)

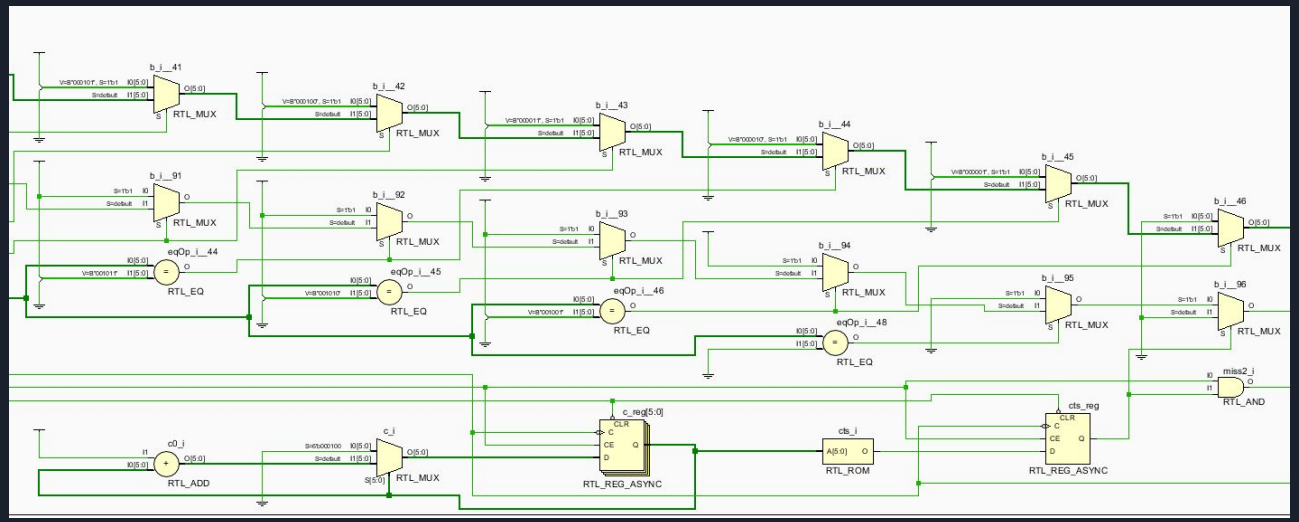
- What floats and what does not?

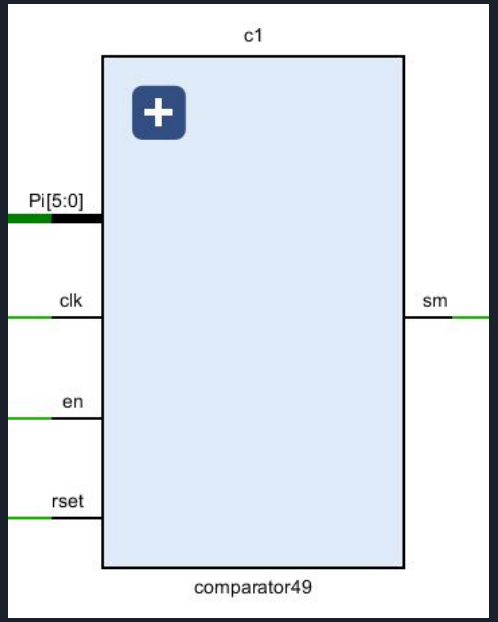




Components (Comparator, 49-bit)

- Where have you already shot?





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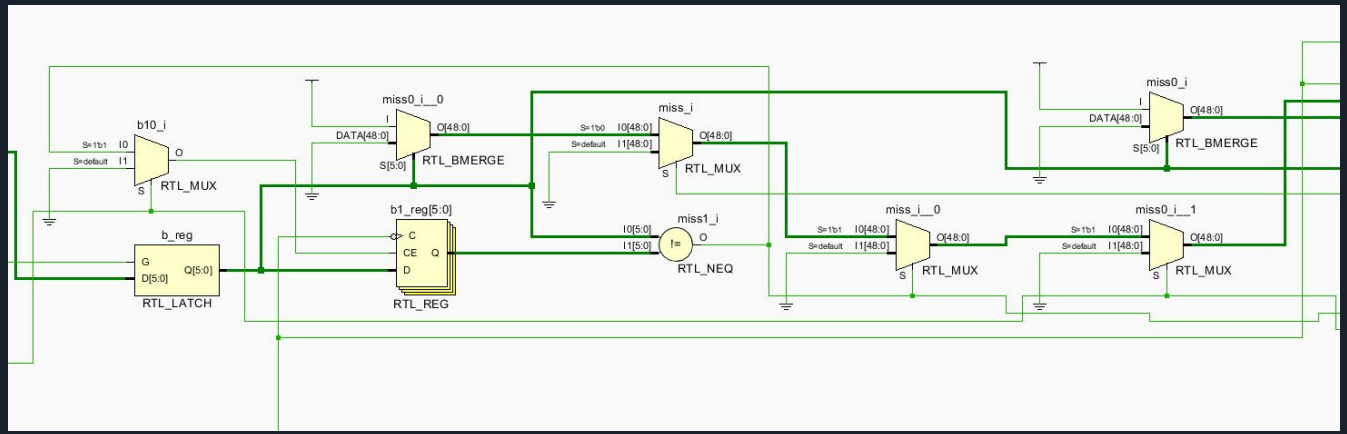

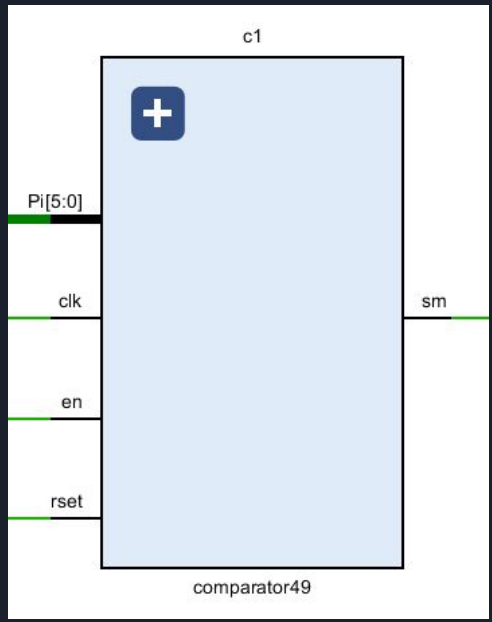

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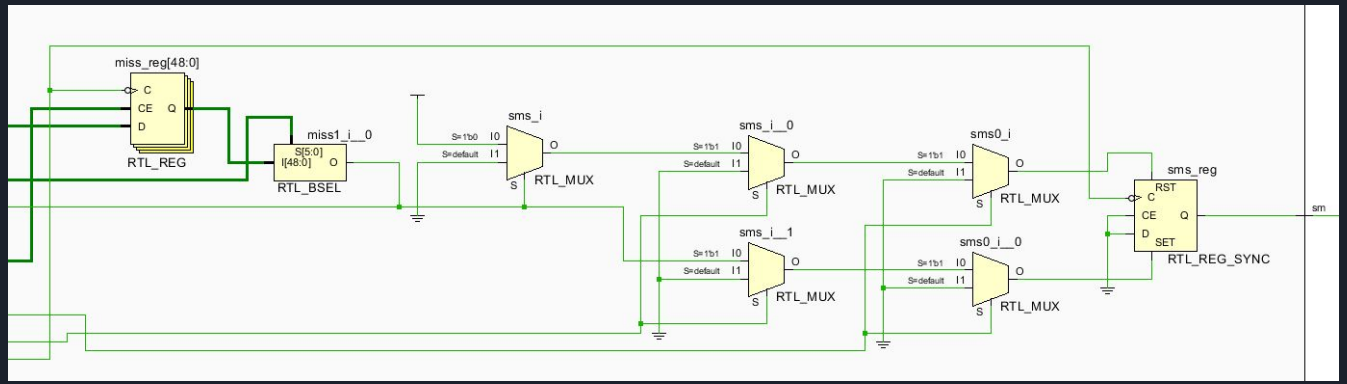
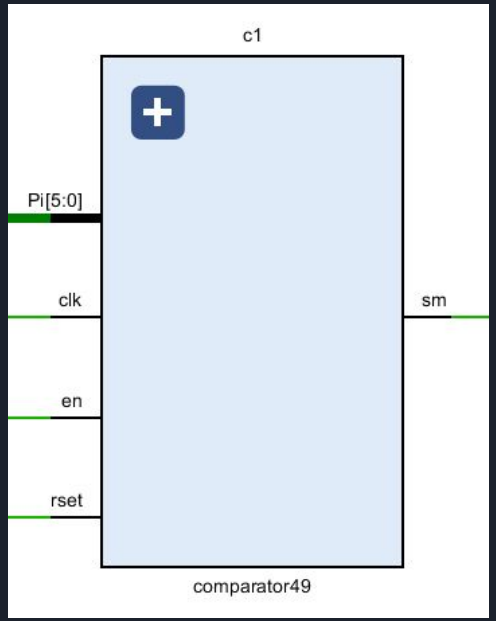
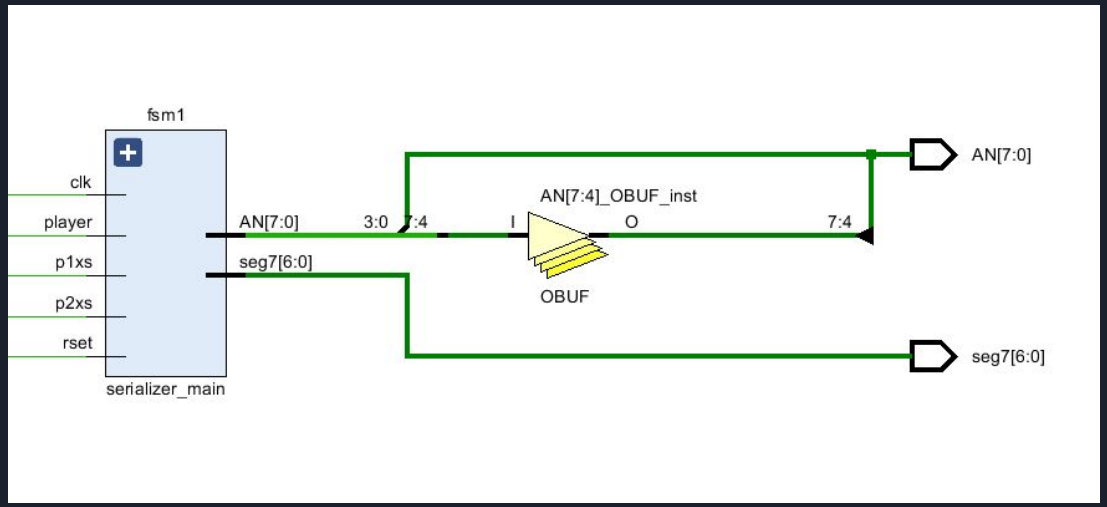


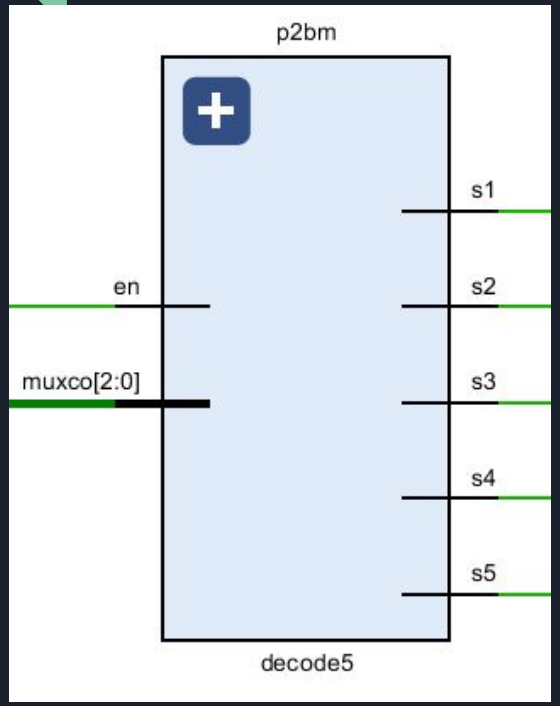


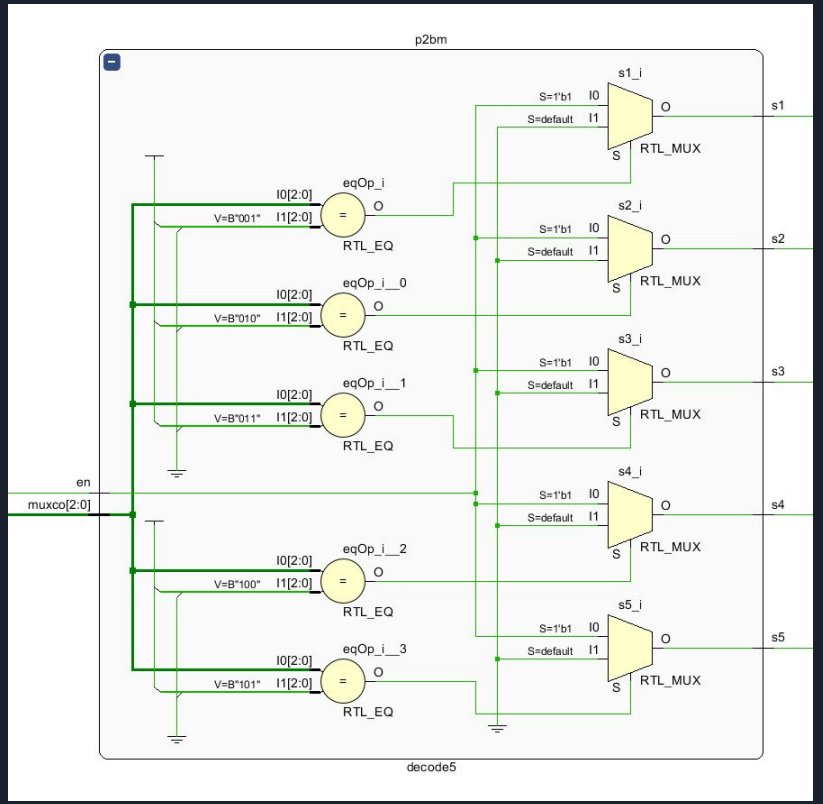
Components (Serializer)

- 4x 7-segment display serializer
  - Based off code from class website/lecture notes
- Displays player turn, current grid position, and eventual player “win screen”
- Serializer is paired with a pulse counter, two decoders, and a simple FSM
  - The hex - to - 7-seg decoder has been slightly modified in terms of how certain inputs trigger specific displays

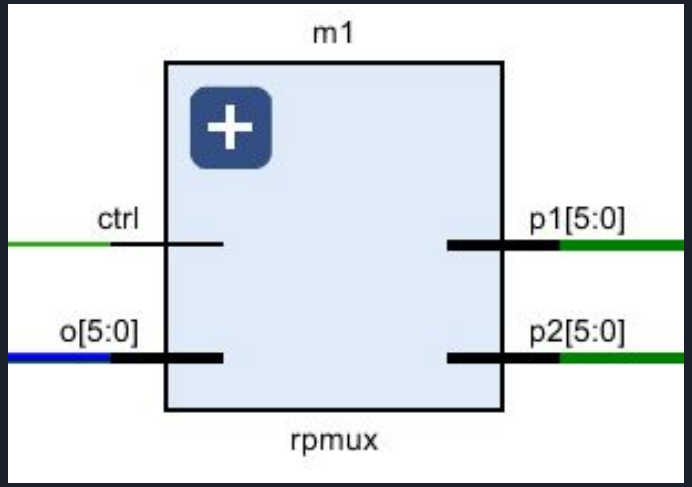


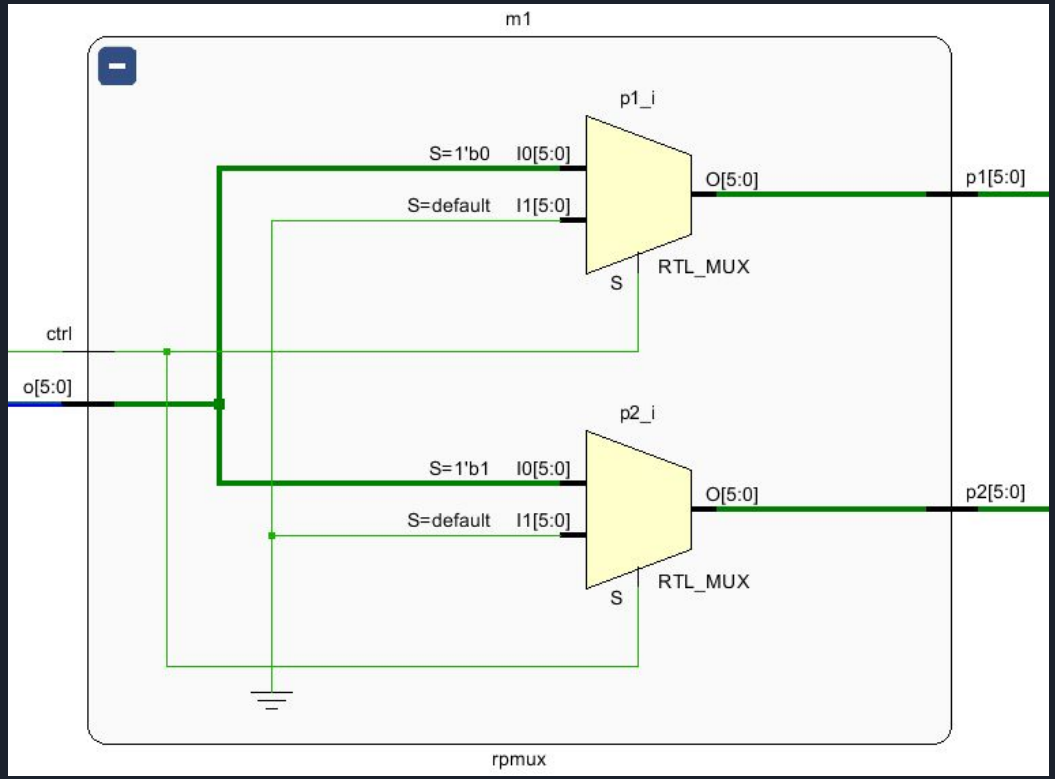
Components (Demultiplexers)



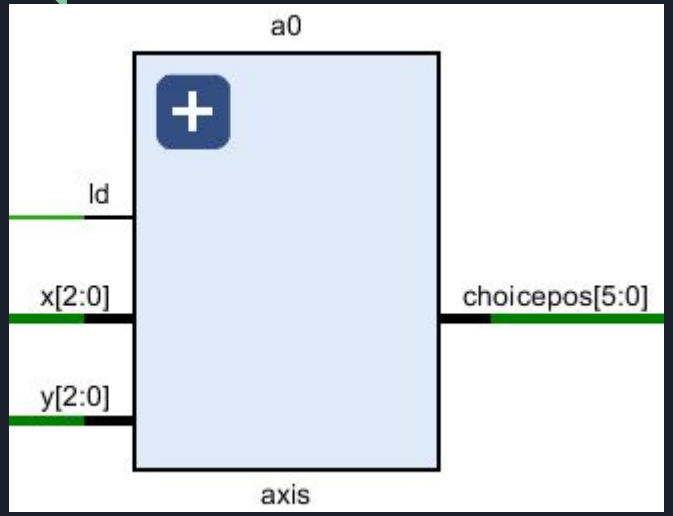


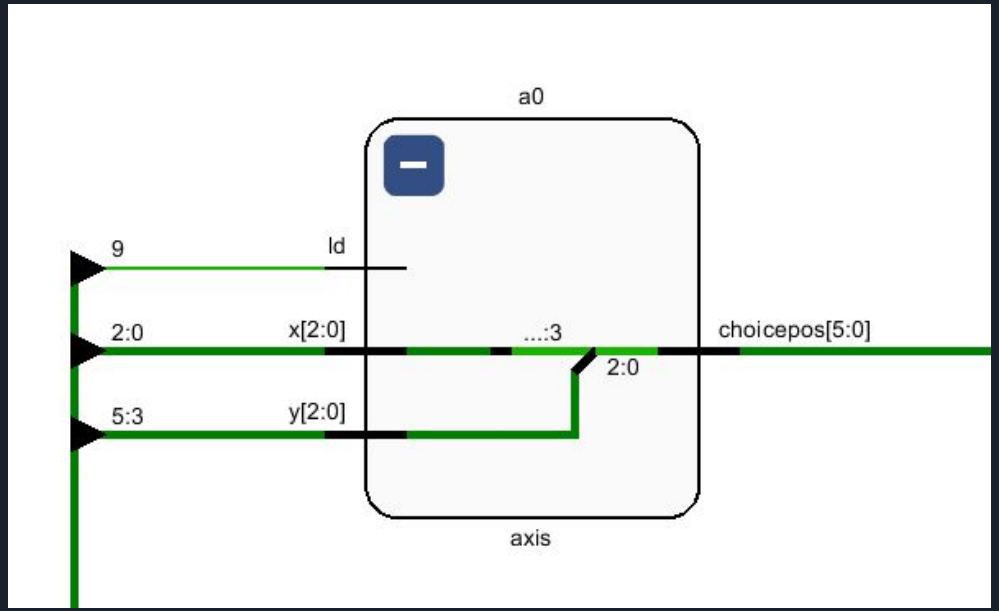
Components (Multiplexers)



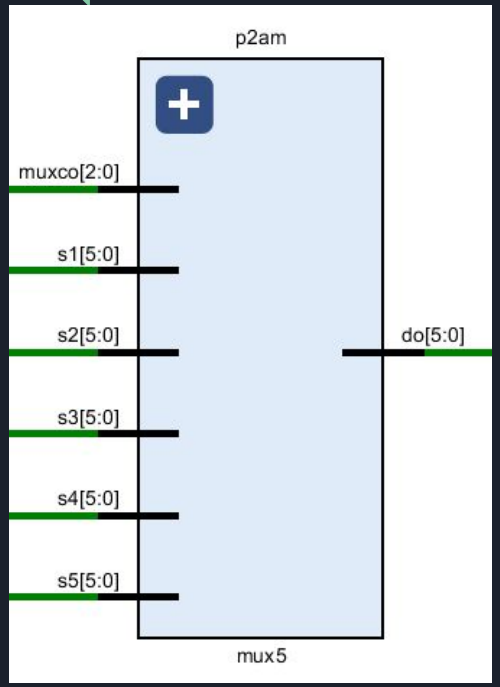


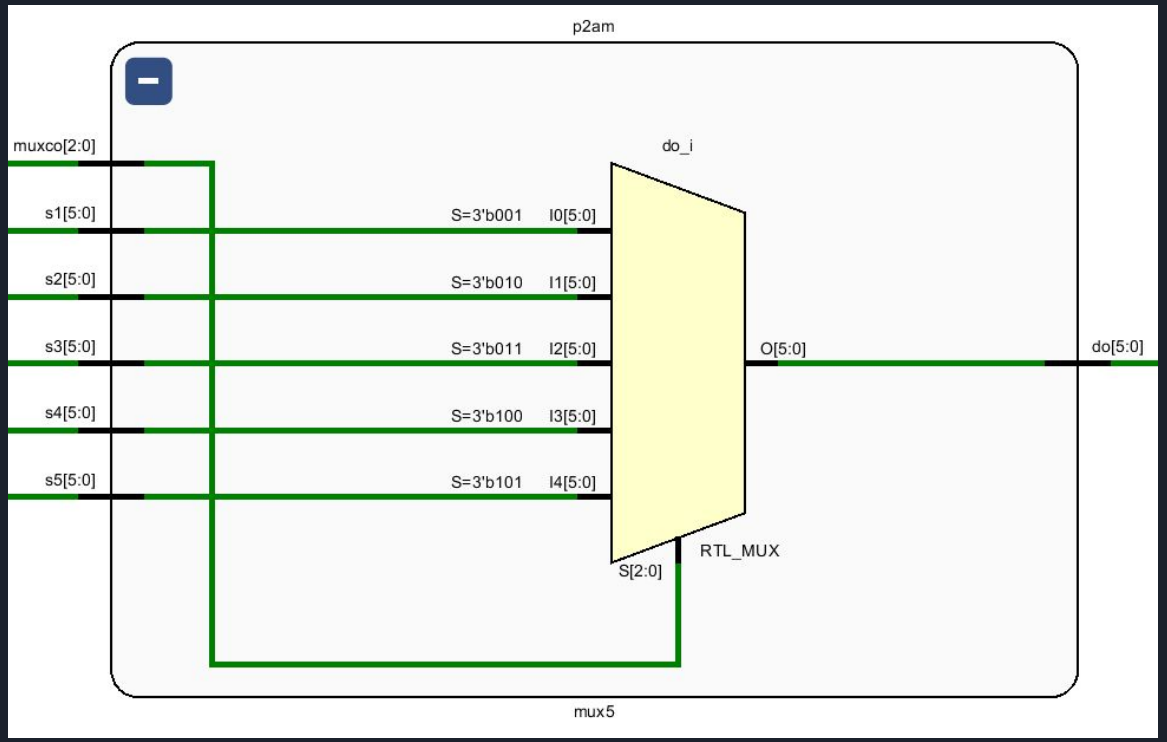
Components (Integrator)





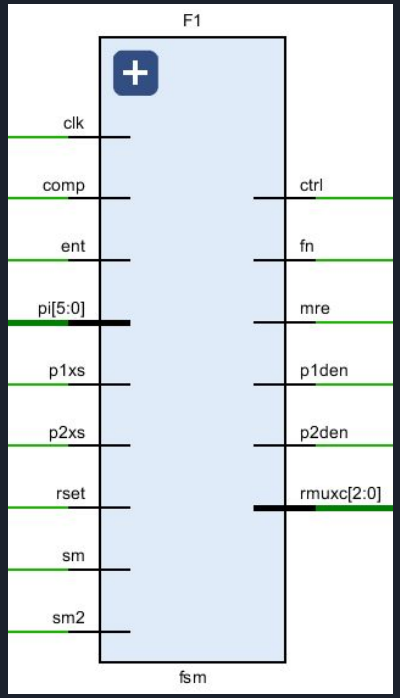
Components (Multiple Input Or)





Components (Finite State Machine)

- FSM design is set to rotate between player turns
- Has built in functions to check for:
  - Ship count
  - When a player wins
  - When a hit is scored
  - Handling coordinate input
  - Handling duplicate coordinate input



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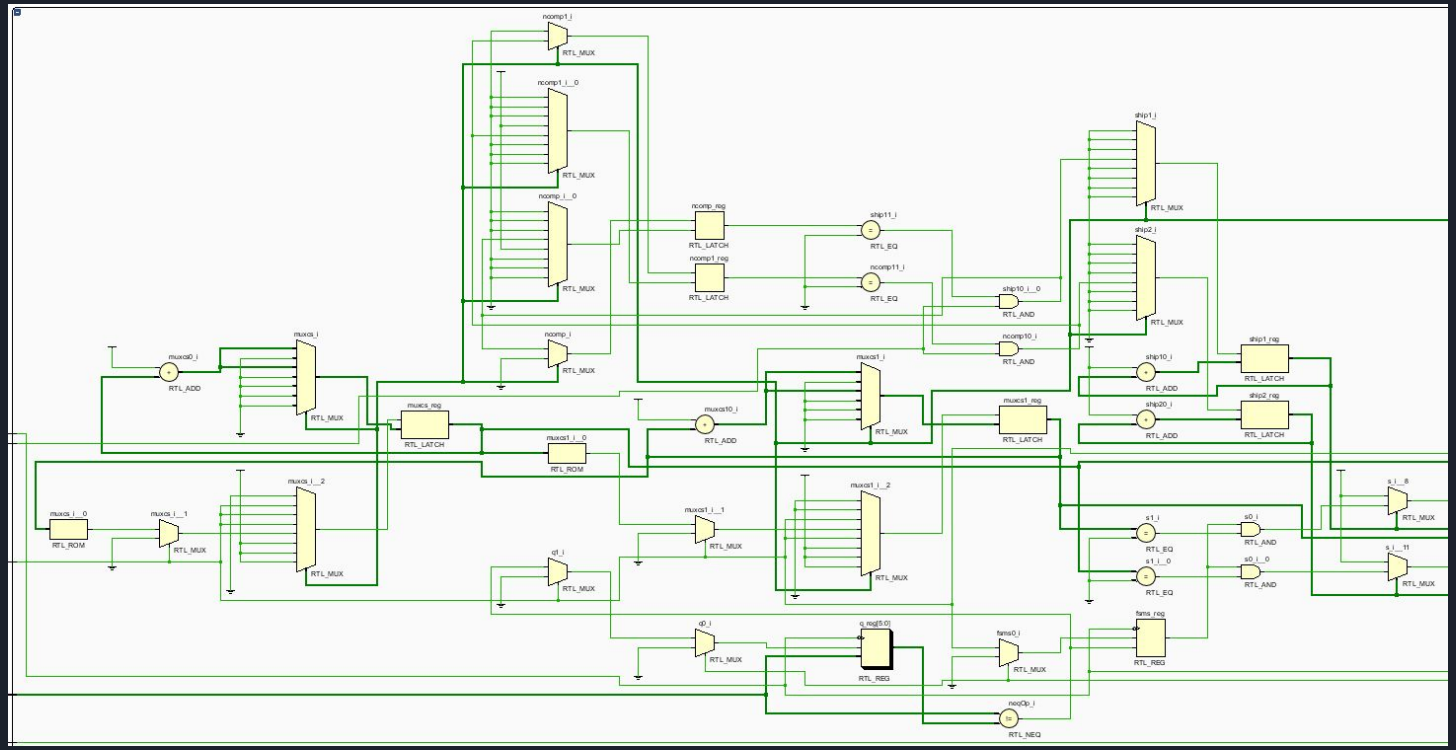

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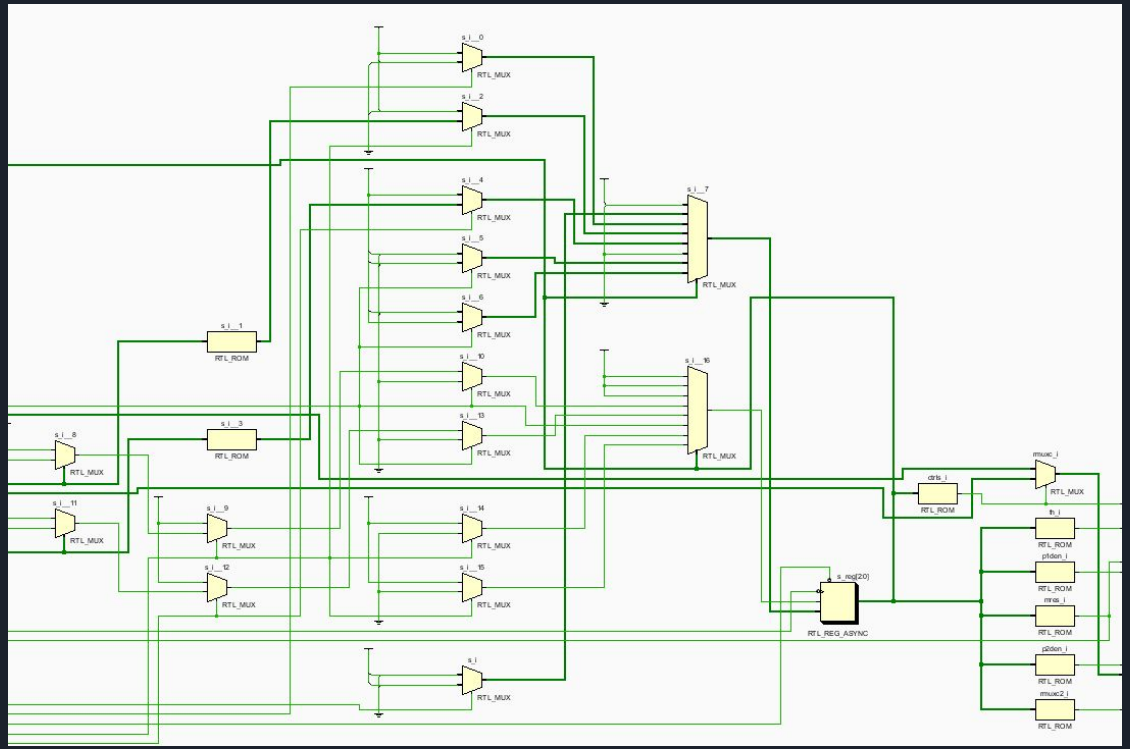
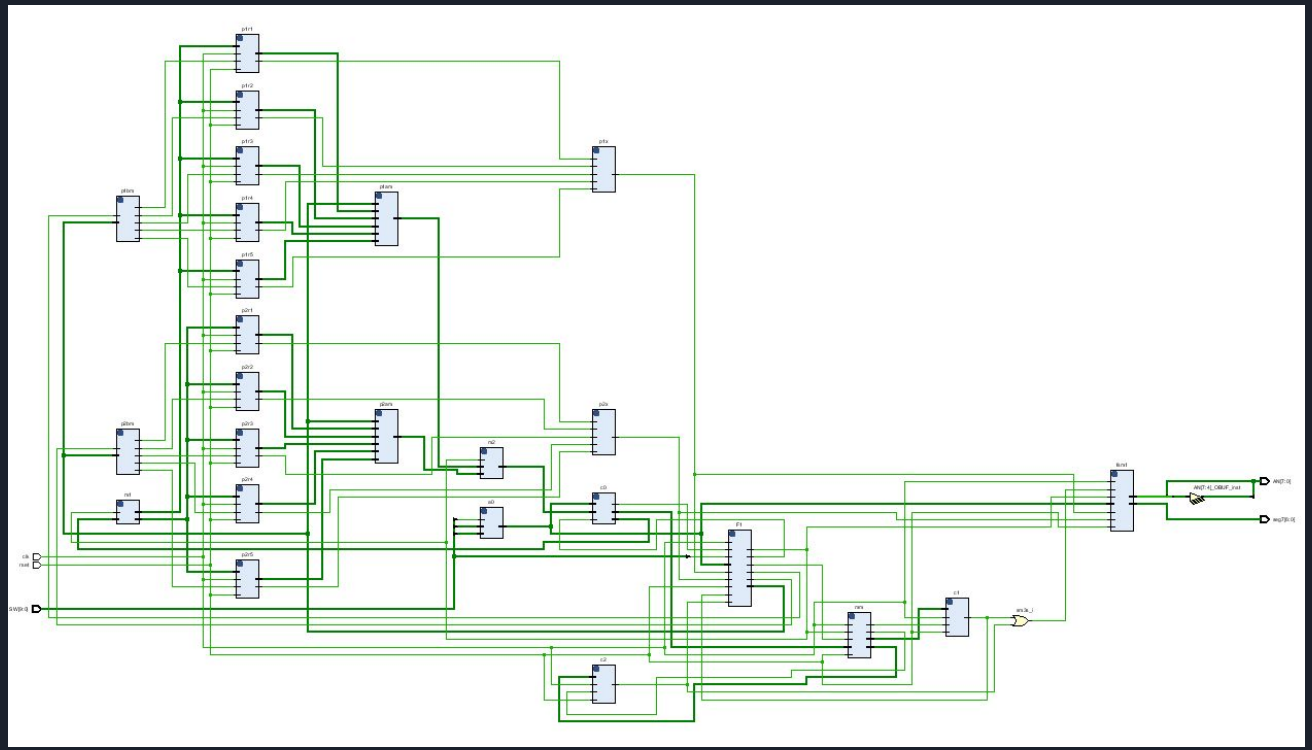


Project challenges/ revisions

- Original plans had a VGA display interface and artificial player to be added to design
  - Both were dropped due to complexity and lack of experience with combining VGA and VHDL
- 7-segment serializer was planned to be more elaborate (possibly using all 8 displays on FGPA)
  - Revised plans to incorporate four displays similar to design from lecture notes due to limitations of FGPA and handling of various inputs for displaying
- Comparator design
  - Massive amount (49-bits) to compare to keep track of ship locations as well as misses throughout entire grid
- FSM design
  - Needed to be able to cycle between player turns without overwriting opposite player components such is player input/registers/etc.
  - Synchronization issues are the main source of constant revisions to the code, aligning each signal up properly or working the code so that signals would not get crossed.
    - Circuit still contains timing bugs - crossing of synchronizing/signals miss-register signals

Final Digital System Design



Surrogate Demo

Thank You for your time. Any Questions?

Sources/ Citations

- Title Picture
  - https://www.microsoft.com/en-us/p/battleship-war-tactics/9pnnr1hvws95?activetab=pivot:overviewtab
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