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CSEE4840 Embedded Systems
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Pong Design Specification

User Interaction

Initialization

At system startup, user is prompted to select an IP address. Since no keyboard is available, mouse will be used to cycle through available addresses. A left-click selects displayed IP address. Restricting selection to 192.168.0.x is acceptable.

Once IP address is selected, rendezvous begins. See below for description of algorithm.

Gameplay

Each player sits at a DE2 station. Station requires a VGA monitor, PS/2 mouse, and Ethernet connection through hub, switch, or crossover cable to second identical station. Both players control their respective paddles onscreen with mouse.

Master starts with ball near paddle. Player may move paddle up and down and ball will follow. On mouse click, ball is released and bounces off master player's paddle. Normal Pong-style gameplay begins. Ball bounces off opponent paddle or sides. Opponent scores a goal when ball passes beyond player's paddle.

Score Display

Both local and remote score are displayed to users at the top of the screen.

Ability Scaling

If one player is significantly ahead of the other player, the winning player's paddle is reduced in size.

End

Game ends at 11 points. Similar to ping pong, winner must win by 2 points. Status messages are displayed on both stations at conclusion of game.

Display

Screen Coordinates

The visible screen area has dimensions of 640x480 pixels. All coordinates used are relative to the visible screen area. Origin is in the upper-left corner of visible screen and is represented by coordinates (0,0).

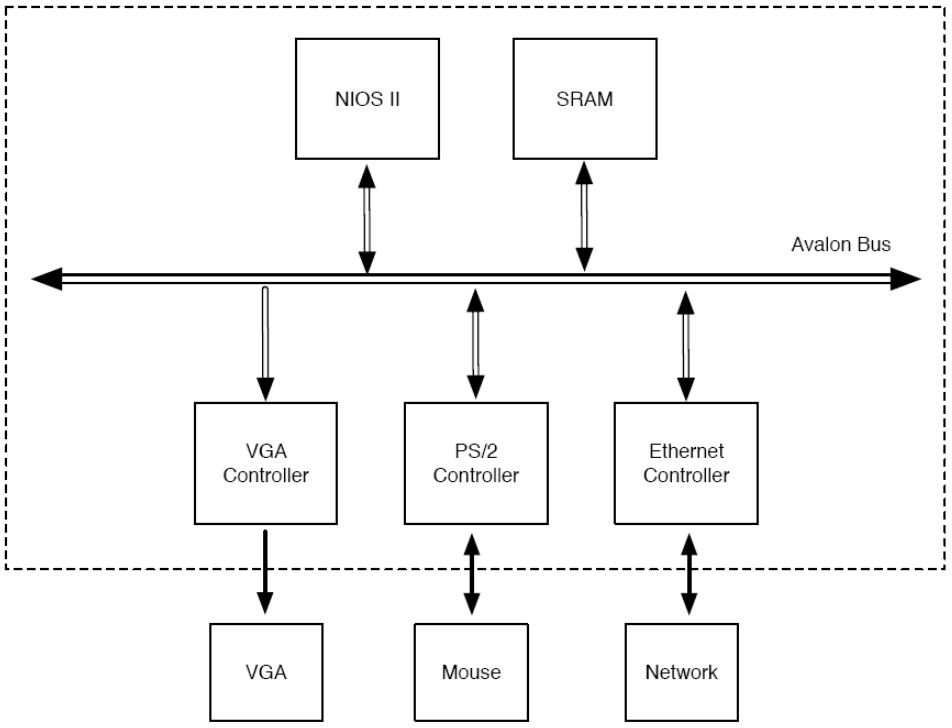
Screen Layers
The image displayed to the user is composed of three layers:

1) Game objects (paddles, ball)
2) Foreground bitmap
3) Background bitmap tile

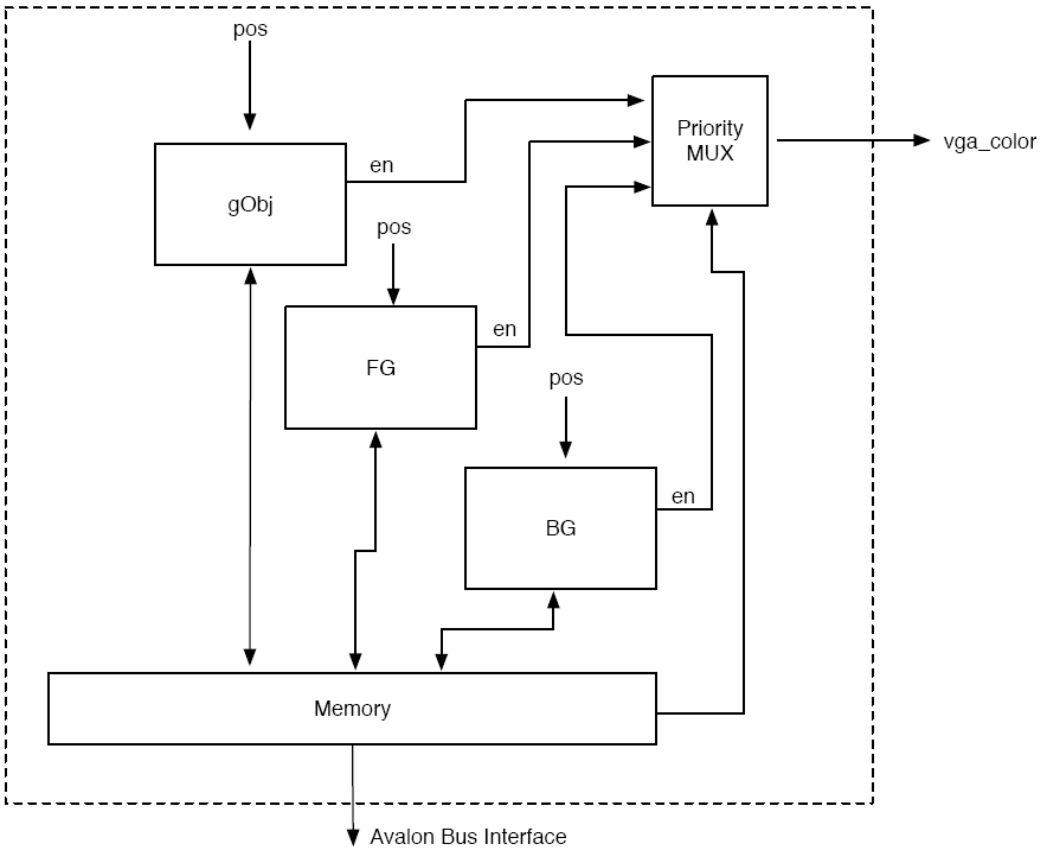
The layers are listed in order. If a game object passes into the same location as an active region of foreground bitmap, the game object will take precedence. The foreground bitmap is one color, and where it is not enabled it is transparent. The background tile is an 8x8 repeated bitmap. Where not enabled the background color is black.

Block Diagrams
Block diagrams are included for modules which will be implanted using a multi-level hierarchy. Single-level flat modules are not included.

Top-Level



VGA Controller



Memory Maps

VGA

Base Offset	Width	Name	Description
0x00	2	BALL1X	Ball x position
0x02	2	BALL1Y	Ball y position
0x08	2	PADL1A	Paddle 1 (left) start
0x0a	2	PADL1B	Paddle 1 (left) end
0x0c	2	PADL2A	Paddle 2 (right) start
0x0e	2	PADL2B	Paddle 2 (right) end
0x10	2	BACOLOR	Ball color (low 15 bits, 5 bits/color, R first)
0x12	2	PACOLOR	Paddle color
0x13	2	BGCOLOR	Background tile color
0x16	2	FGCOLOR	Foreground color
0x18	8	BGDATA	Background tile data (8x8 bitmap, 1 row/byte, MSB of each byte is leftmost column)
0x20	38400	FGDATA	640x480 foreground bitmap (row addressed)

Mouse

Address	Width (Bits)	Name	Description
0x00	1	MCTL	Mouser control register (same as first PS/2 byte)
0x01	1	MX	X movement
0x02	1	MY	Y movement

Ethernet Controller

Address	Width (Bits)	Name	Description

See DM9000A datasheet

Communication

Rendezvous

Master sends out a broadcast packet periodically. Slave, when ready to start a game, replies with its own status packet. Master receives reply, stops sending broadcast packets and game begins.

OSI Protocol Layering

Layer	Protocol
2	Ethernet
3	IP
4	UDP
5	Custom

Data Format

UDP packet payload is a fixed size and is used to convey game state information from master to slave and mouse information from slave to master.

```
struct ball_t
{
      u16   x
      u16   y
}
struct padl_t
{
      u16   a
      u16   b
}
enum msgtype_t
{
      GAME_SYN
      GAME_ACK
```

```
     STATUS_MASTER
     STATUS_SLAVE
     RESET
}
struct message_t
{
     msgtype_t t

     ball_t     ball1

     padl_t     padl1
     padl_t     padl2

     u8         score1
     u8         score2
}
```

Milestone Deliverables

Task	**M1**	**M2**	**M3**	**Final**
NIOS System				
Skeleton SOPC project	x			
SRAM peripheral	x			
VGA Peripheral				
Memory map header file	x			
Static ball logic/display	x			
Static paddle logic/display	x			
Background tile logic/display		x		
Foreground tile logic/display		x		
Mouse Peripheral				
Memory map header file	x			
Skeleton module		x		
Mouse position printf()		x		
Paddle movement with mouse			x	
Network				
Full C packet structure	x			
Master/slave rendezvous		x		
Master/slave status sharing			x	
Gameplay				
Ball bounce off paddle		x		
Paddle resizing			x	
Scorekeeping			x	
User Interface				

IP address selection			x	
Win/lose banners			x	
Score display			x	
Background selection			x	
Miscellaneous				
Subversion server	x			
Report				x