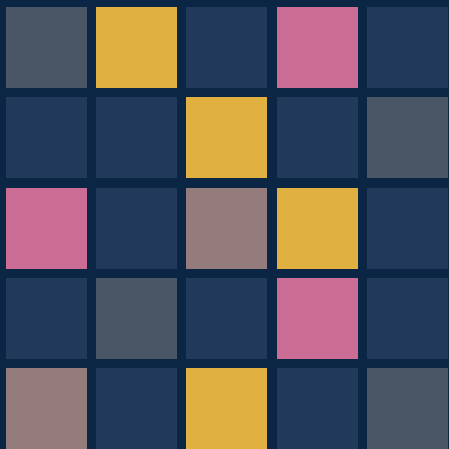


CSEE 4840 · SPRING 2026

GridBrawl

A two-player tile-control game on the DE1-SoC
FPGA



TEAM

Siyao Yu

sy3342

Sitao Zhang

sz3419

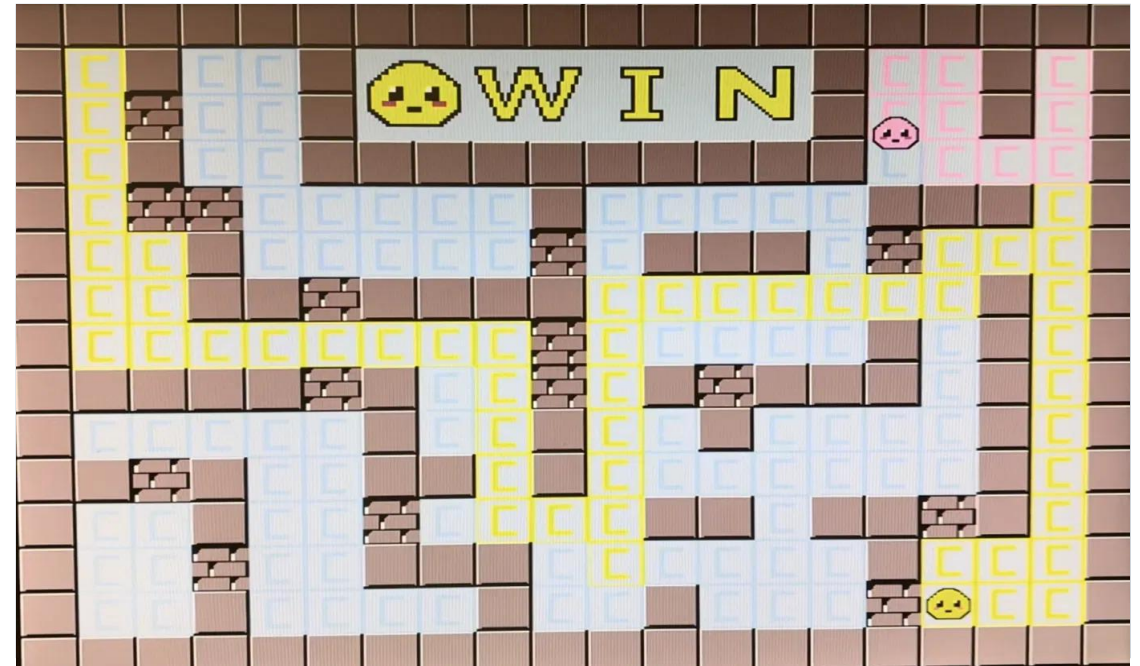
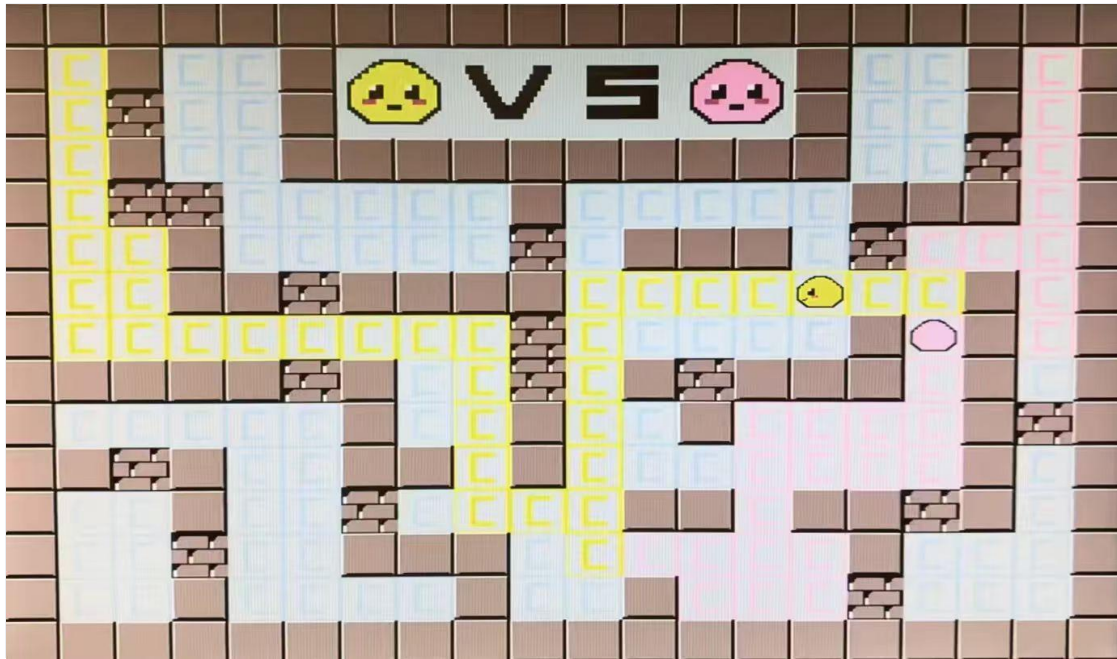
Anyongyong Zhao

az2932

Final Presentation · 1235 Mudd

GridBrawl: Two-Player Tile Capture

Players race to paint the 20 × 15 grid in their colour. Bombs break soft walls and kill opponents. First to 50 captured tiles wins.



640 × 480

VGA @ 50 MHz, 2 cycles/pixel

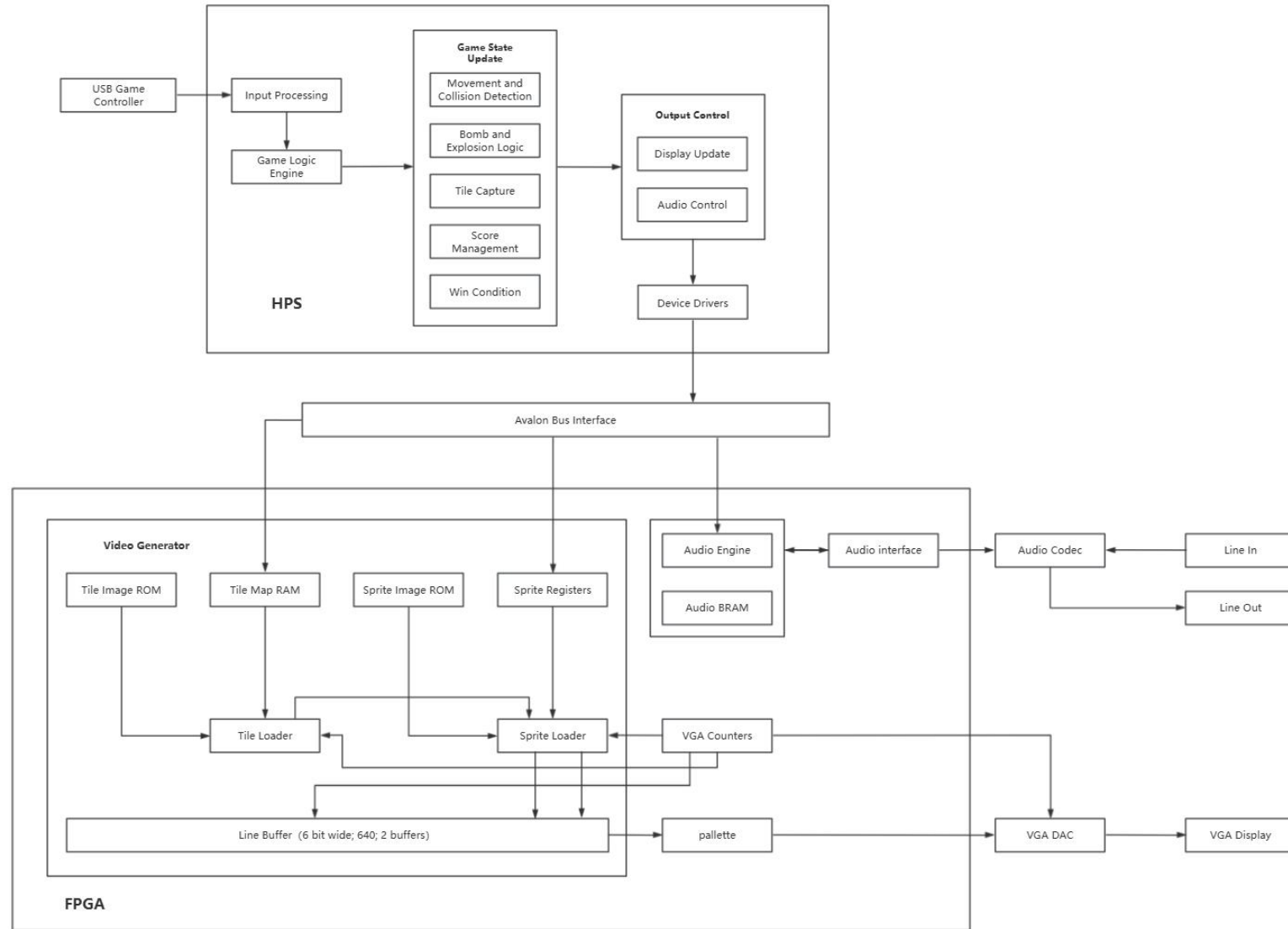
32 Hz

game tick on HPS user space

50 tiles

win condition

System Block Diagram



Address Map

Phys. Address	Offset	Meaning
0xFF200000	0x000 - 0x4AC	Tile Map RAM, 300 entries, 4-byte-spaced write offsets
0xFF201000	0x000 - 0x074	Sprite 0 – Sprite 29 (4 bytes each)
0xFF202000	0x000 - 0x003	Audio Controller

Register Bit Fields

Tile word



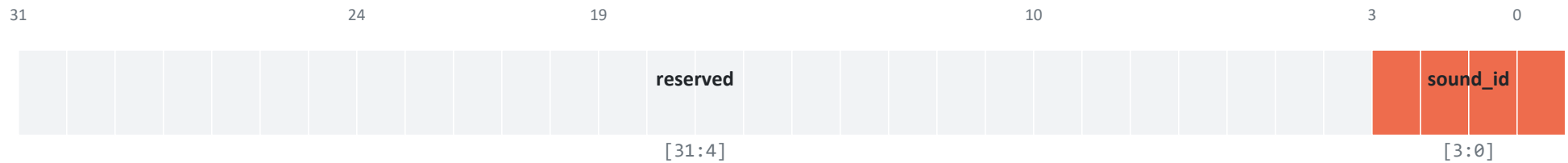
EMPTY 0 · BLUE 1 · PINK 2
YELLOW 3 · HARD 4 · SOFT 5

Sprite word



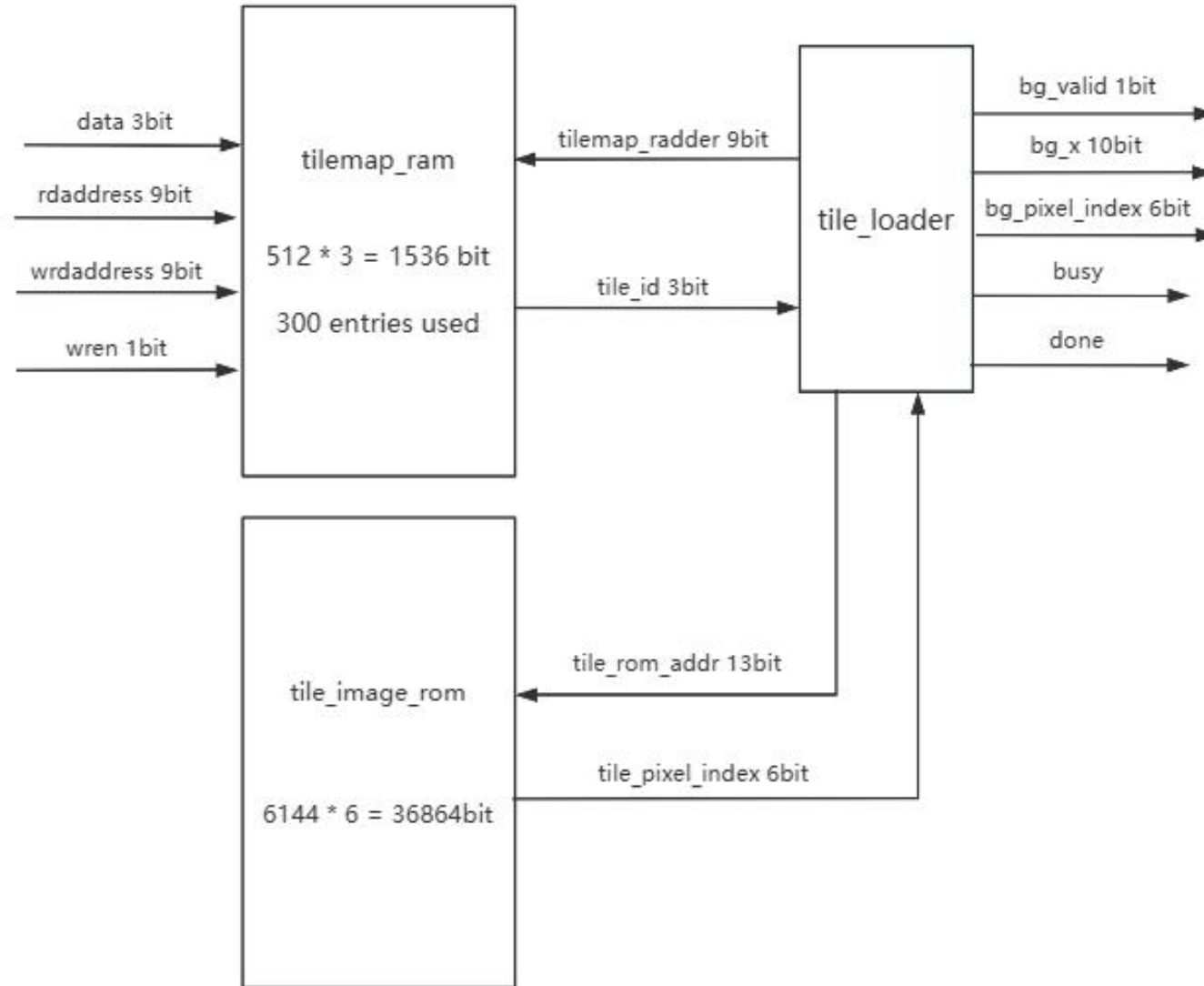
sprite_id 0-19 → 32x32 ROM
20-29 → 64x64 ROM

Audio word

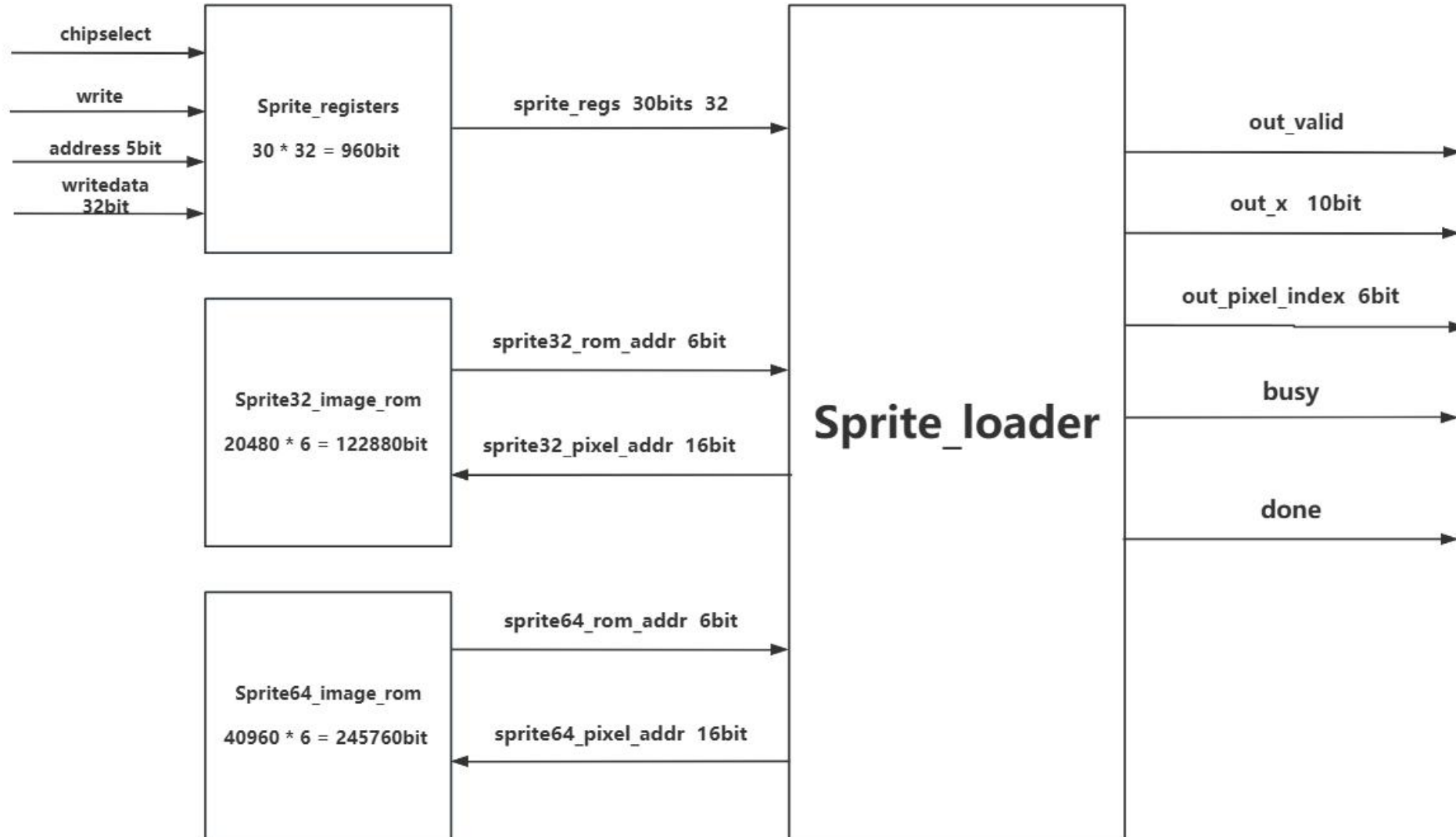


1 EXPLOSION · 2 DIE
3 VICTORY · 4 WALL_BREAK

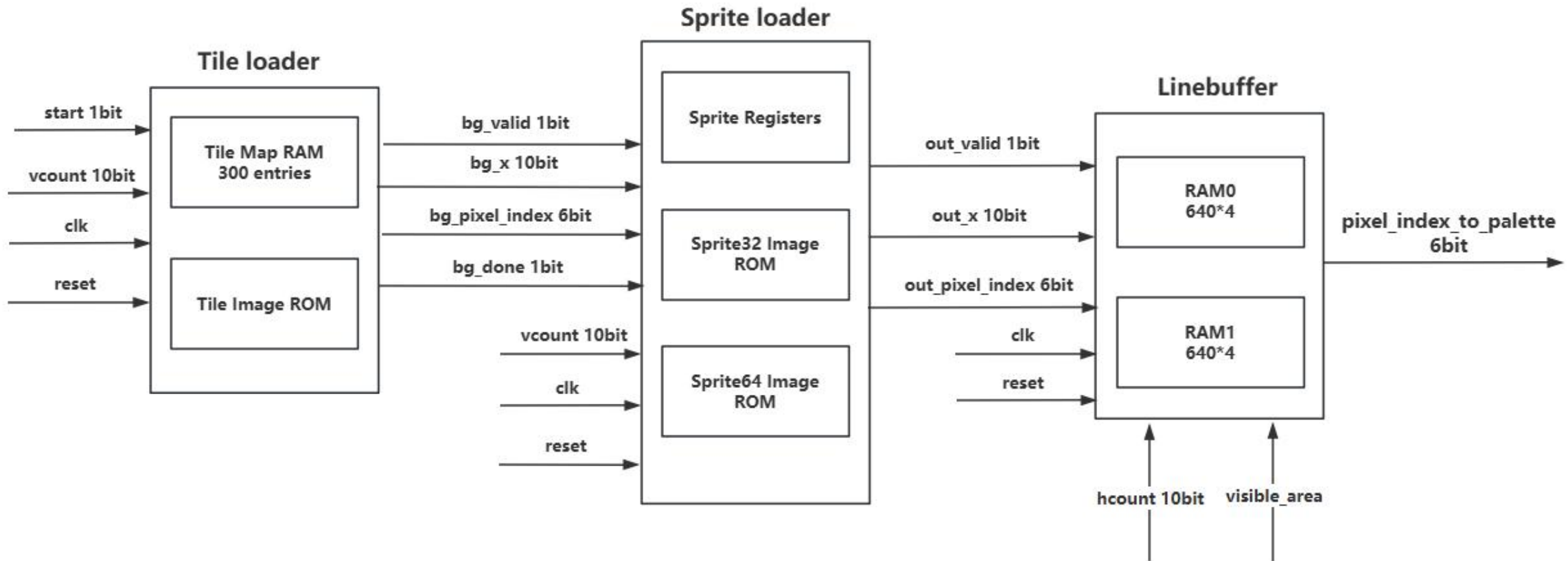
VGA control: tile drawing



VGA control: sprite drawing

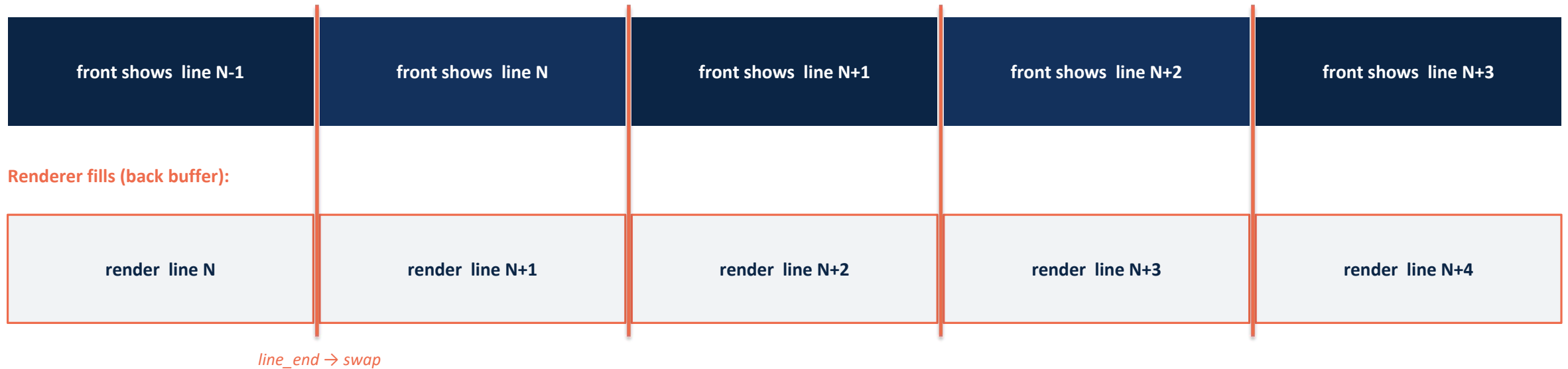


VGA control: vga top module



Double Line Buffer — Why It Works

VGA scan reads:



Rule (encoded in `video_generator_top.sv`):

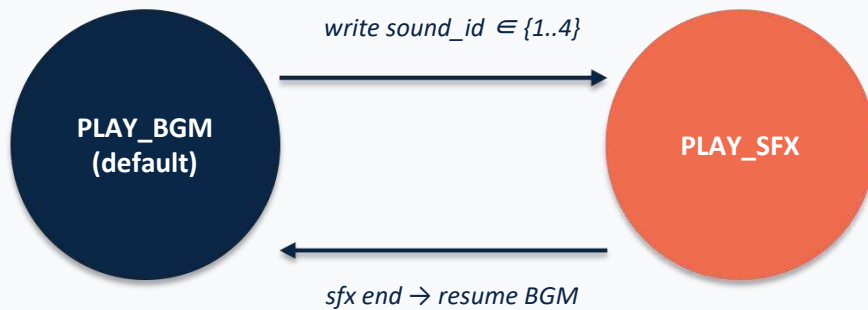
1. At each `line_begin`, start rendering `vcount + 1` into the back buffer.
2. Swap front \leftrightarrow back only at `line_end`, never mid-scanline. Tearing eliminated.

Audio Subsystem

audio_rom layout (8-bit unsigned samples, address space 0x00000–0x2AF7F)



Playback FSM



Implementation details that actually work

6× sample-hold (sample rate divider)

Each ROM sample is held for 6 codec-ready cycles, giving 8 kHz playback from the WM8731 codec running at ~48 kHz.

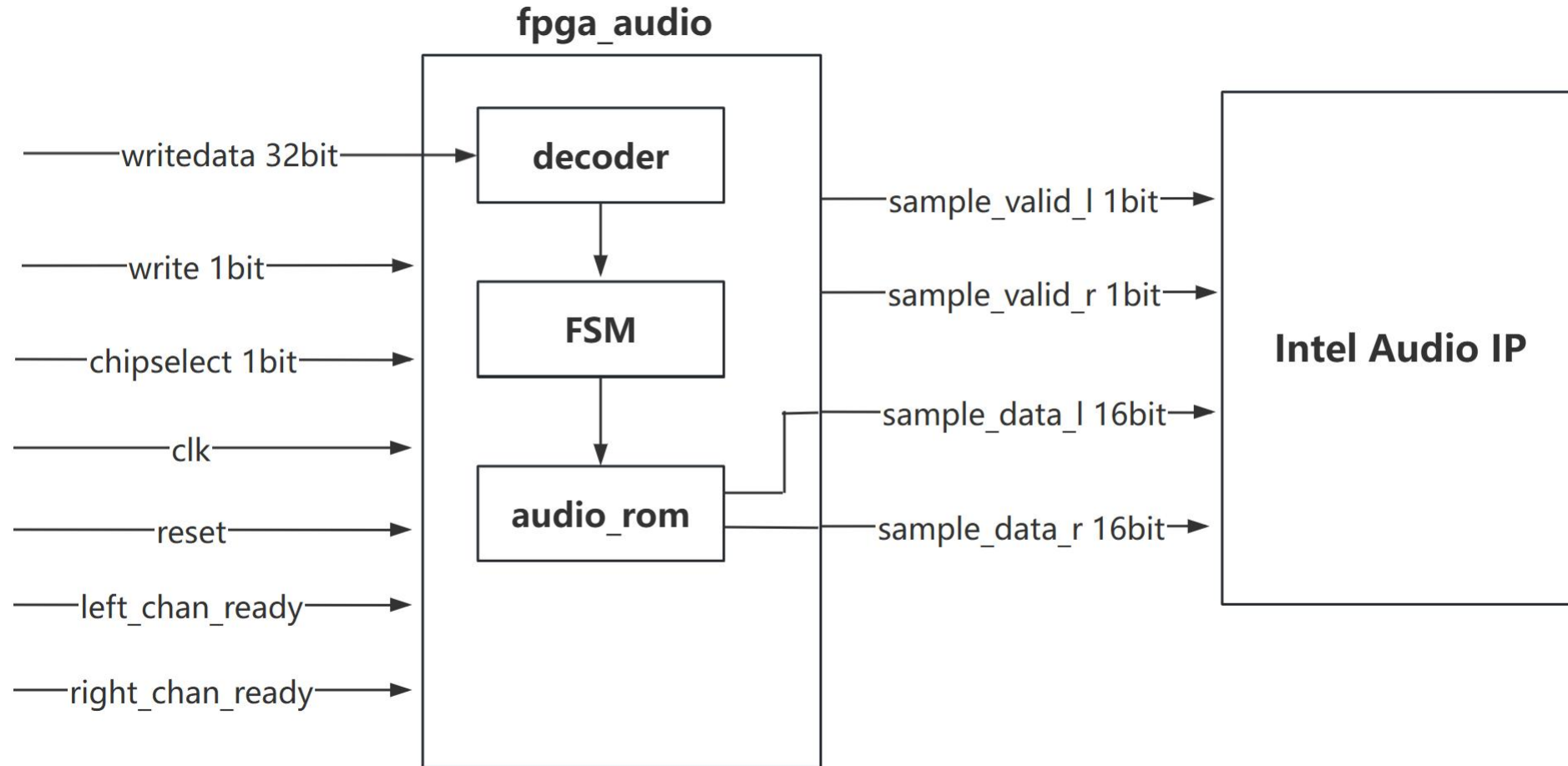
BGM resume bookmark

bgm_address saved during SFX; restored automatically when SFX hits sound_end_address.

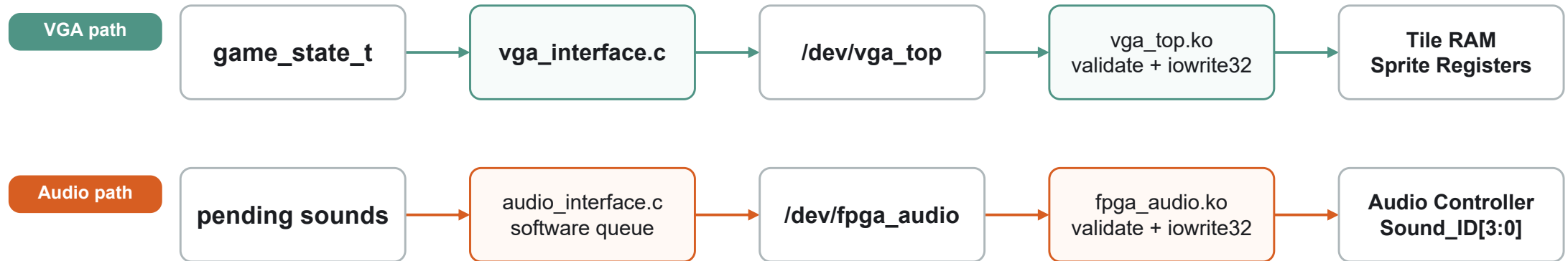
DC-offset shift

8-bit unsigned ROM data is XOR-ed with 0x80, then placed in the upper 8 bits of the 16-bit signed sample sent to the codec.

Audio Subsystem



Software / Hardware Interface

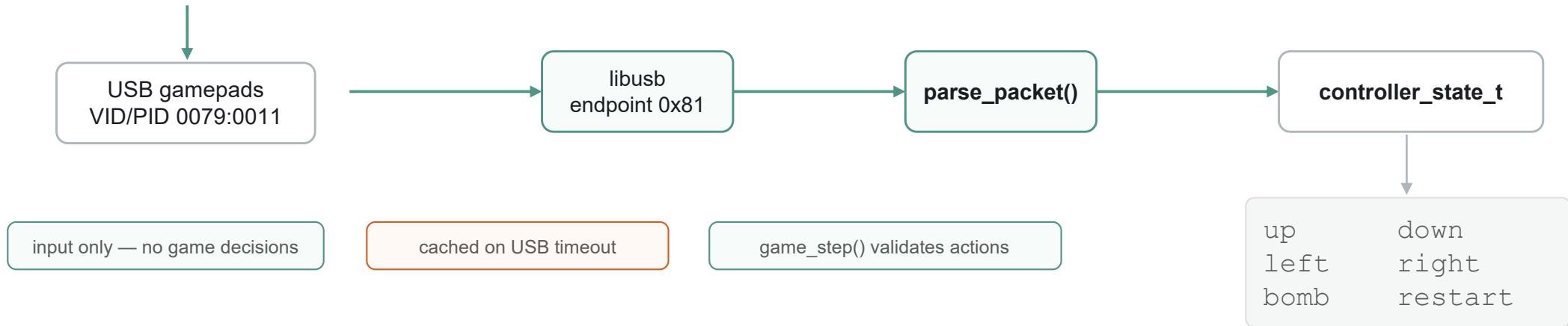


Avalon-MM register map

Address	Device file	Target hardware	Software operation
0xFF200000	/dev/vga_top	Tile Map RAM: 20 × 15 entries	VGA_WRITE_TILE ioctl
0xFF201000	/dev/vga_top	Sprite Registers: 30 × 32-bit	VGA_WRITE_SPRITE ioctl
0xFF202000	/dev/fpga_audio	Audio Controller: Sound_ID	write 32-bit sound id

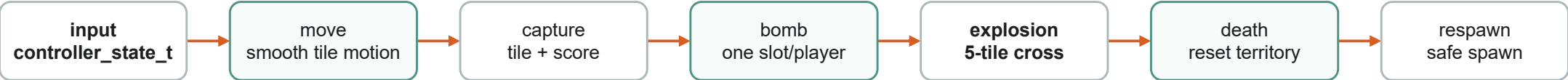
Controller Input

The controller communicates with an 8-byte USB HID packet; usbcontroller.c converts it into game actions.

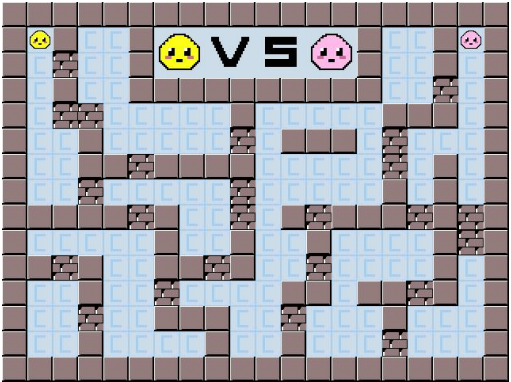


Game Logic

game_logic.c updates game_state_t; rendering and audio consume the state after each tick.



20 × 15 tile map

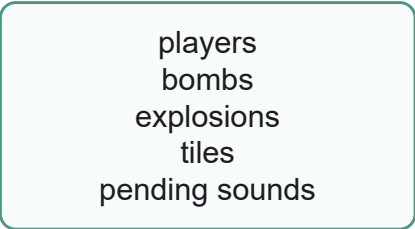


Bomb → five-cell explosion



center + up/down/left/right

game_state_t



32 Hz game tick

Live Demo

GridBrawl on DE1-SoC — VGA monitor + speakers

Questions?