



Atari 2600 Homebrew

Darrell Spice, Jr.

What is Homebrew?

- Games (or other software) made by hobbyists for platforms that are not typically end user programmable
- Over 100 have been released for the Atari 2600
- AtariAge has 80+ homebrew 2600 titles available, only Atari had a larger catalog of 2600 games

My Homebrew games

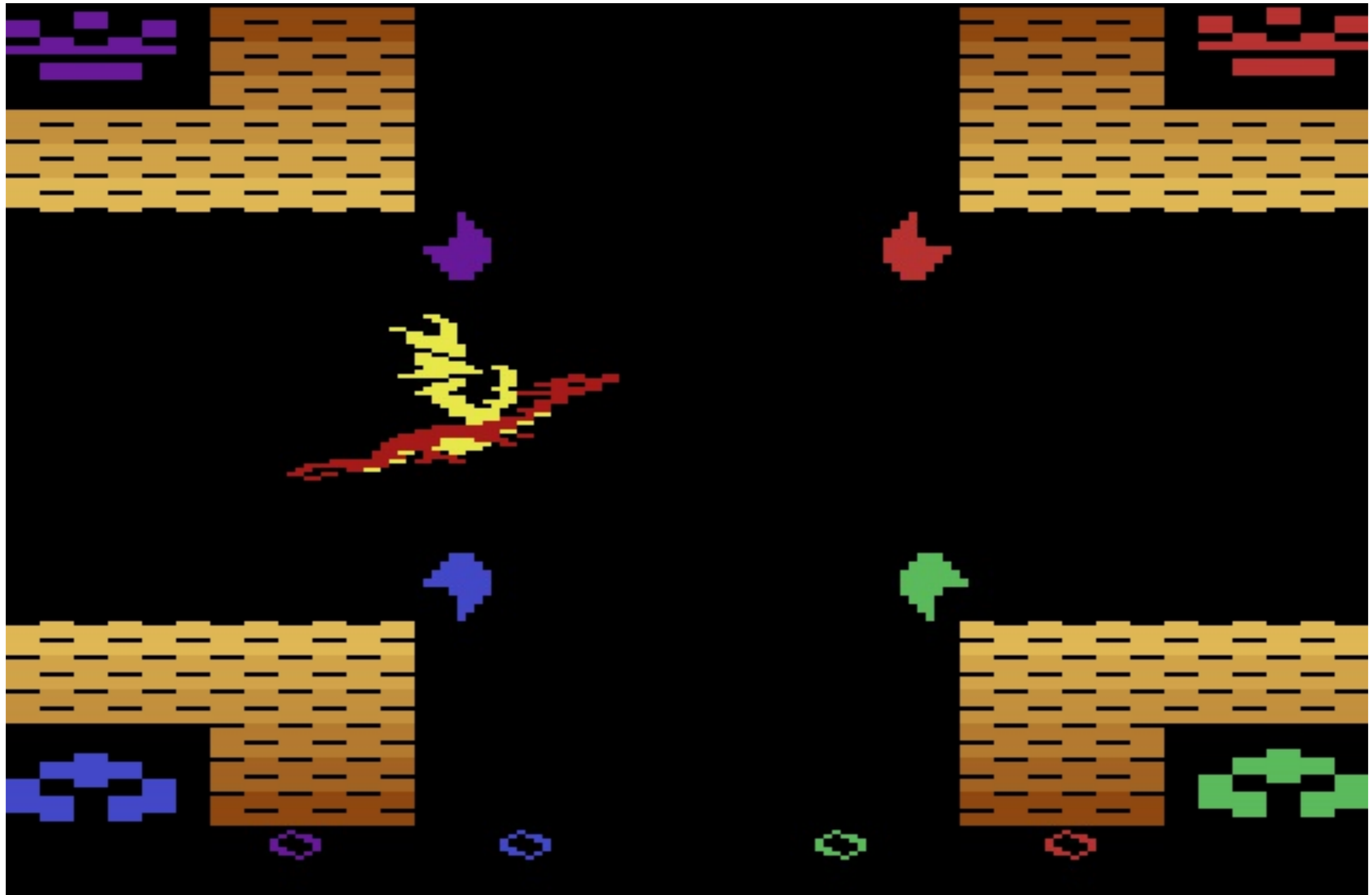
Finished

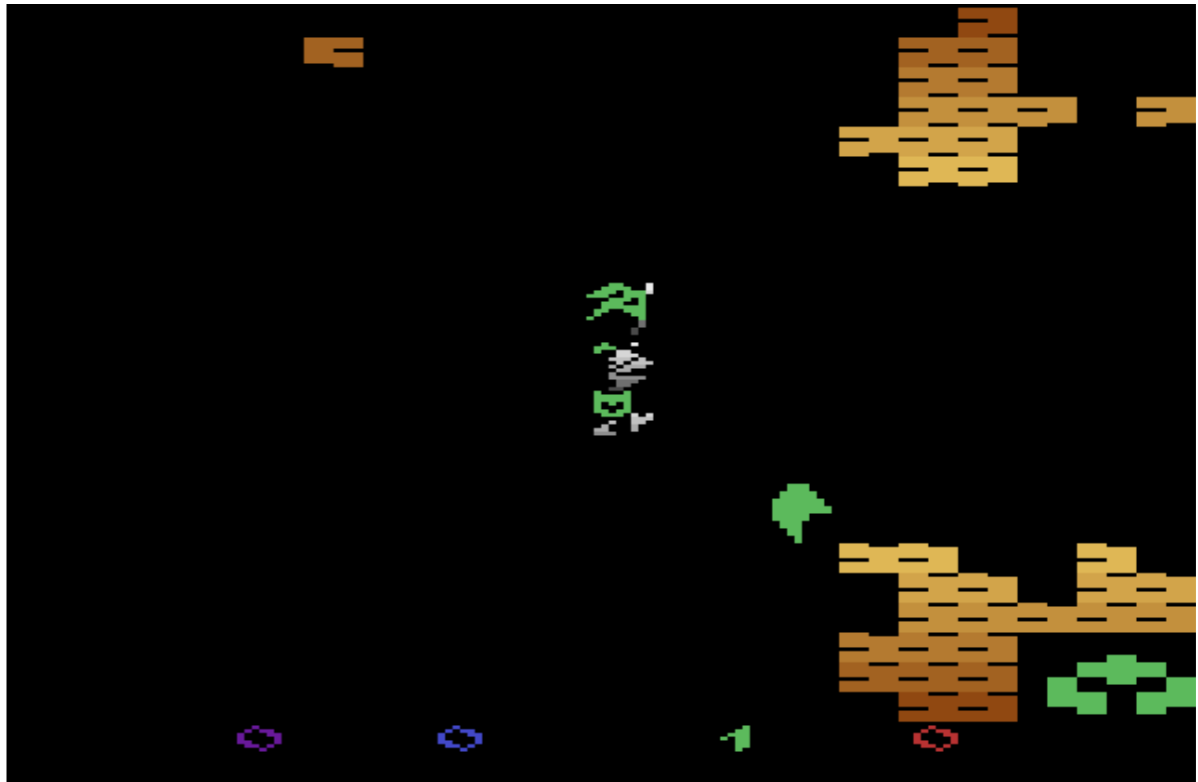
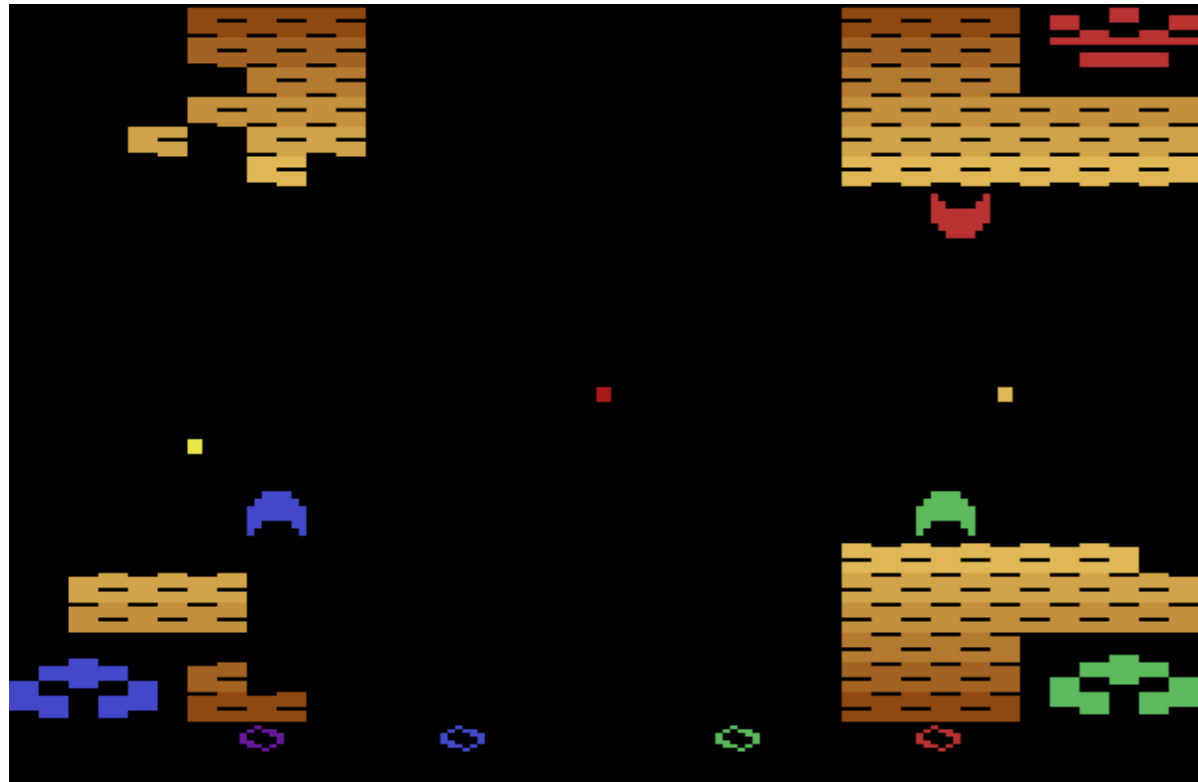
- Medieval Mayhem
- Space Rocks
- Stay Frosty
- Stay Frosty 2

WIP

- Frantic
- Timmy

Medieval Mayhem





Space Rocks

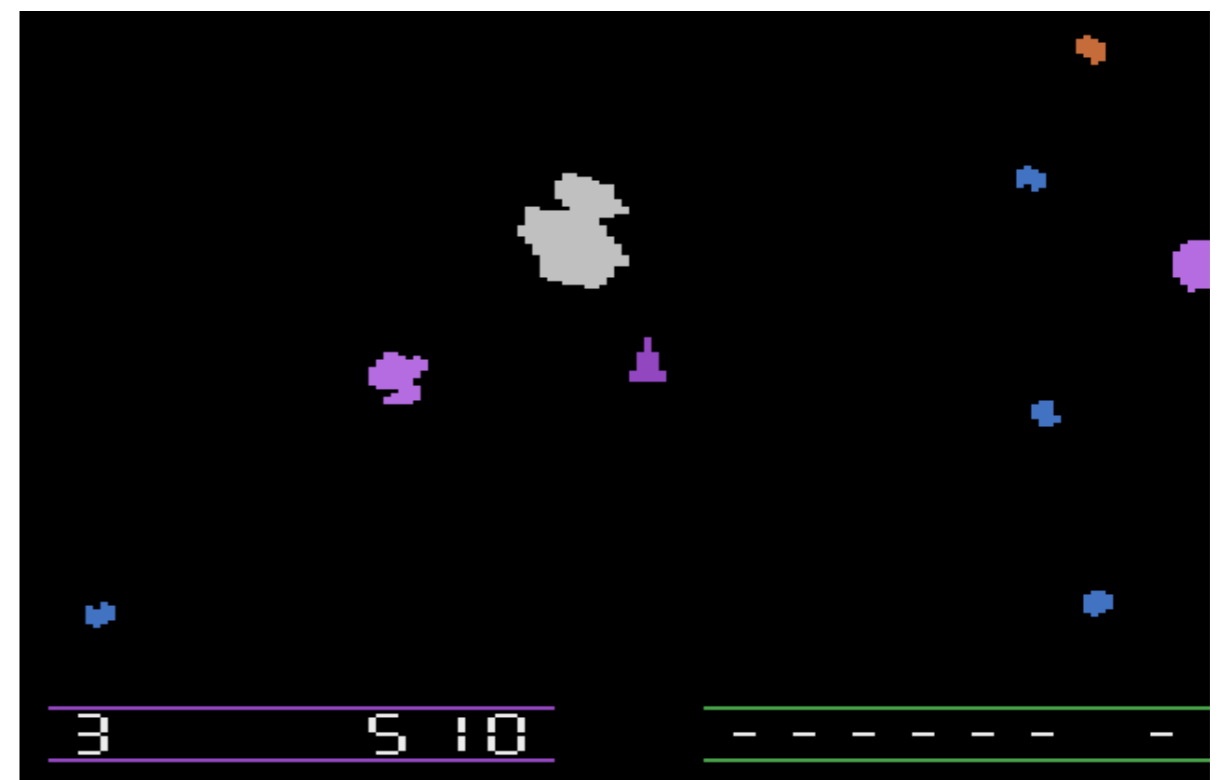
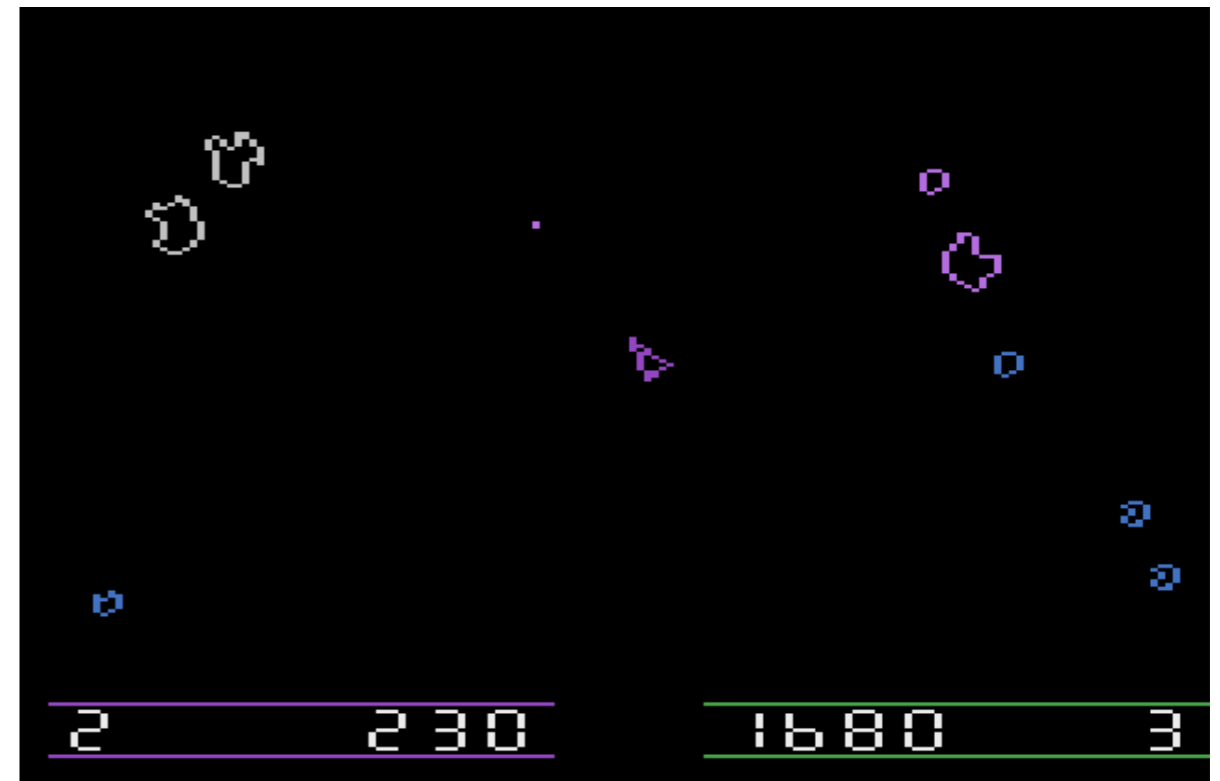


SPACE ROCKS

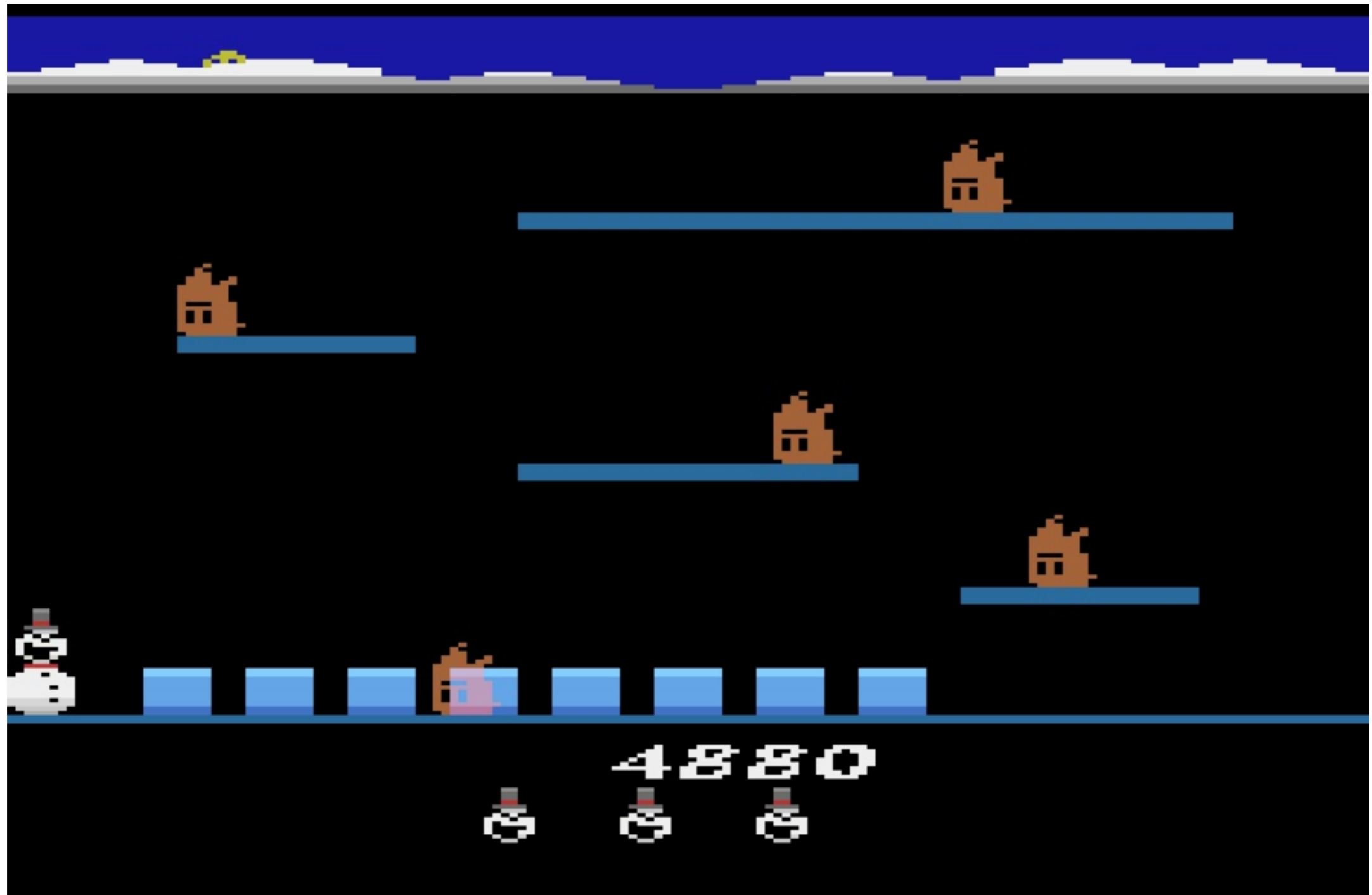
PLAYERS 1
CONTROL ↓
STYLE ←○
COLOR ●●●●
LEVEL NORMAL
OPTION HYPER
FRICTION ✓
BONUS LIFE 10k
MAGNA-NIDES ✓

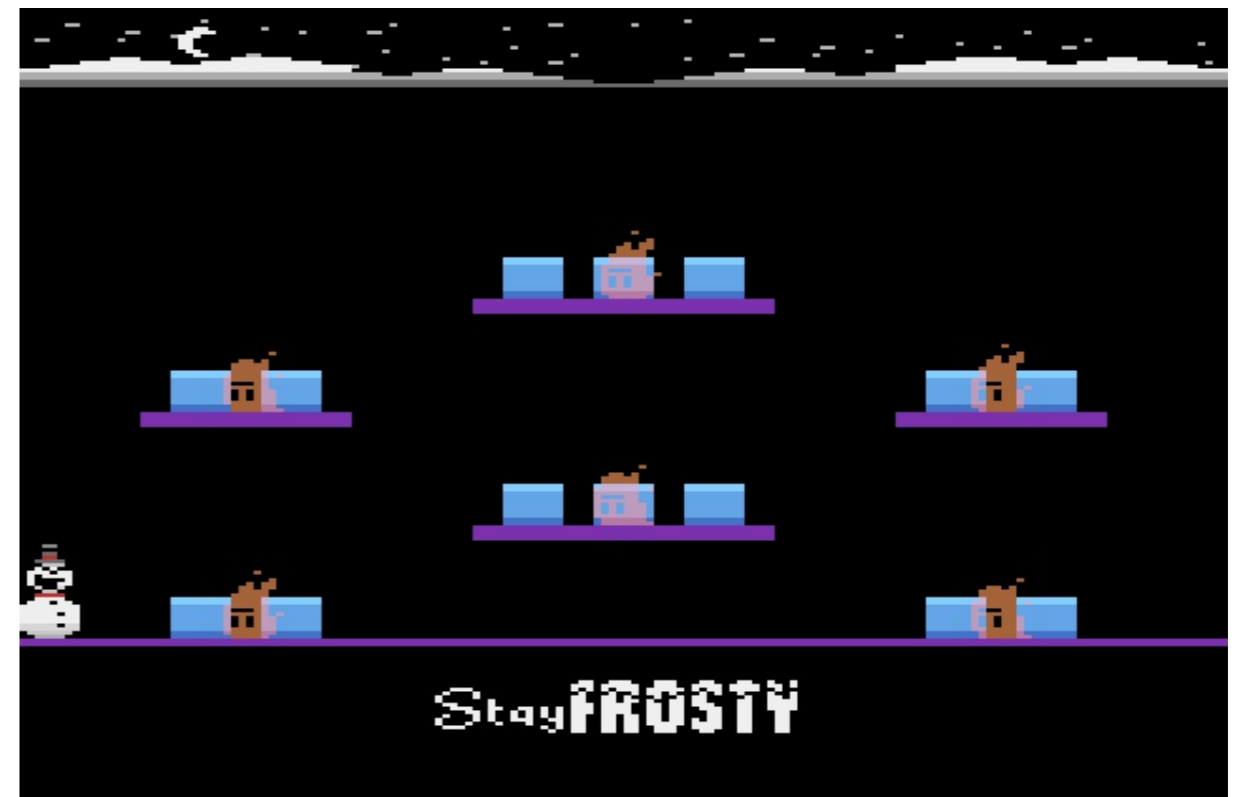
START

SPICEWARE

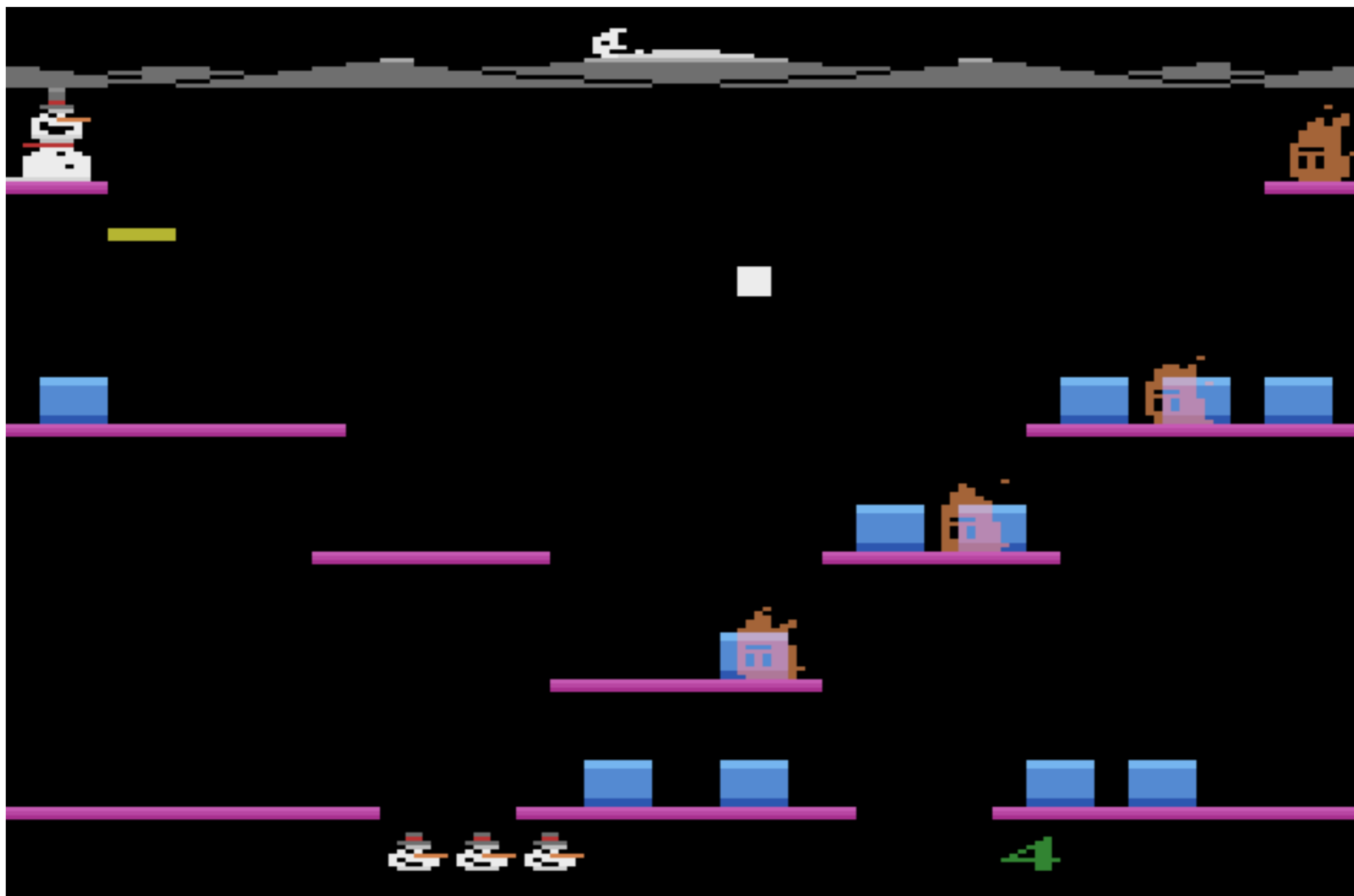


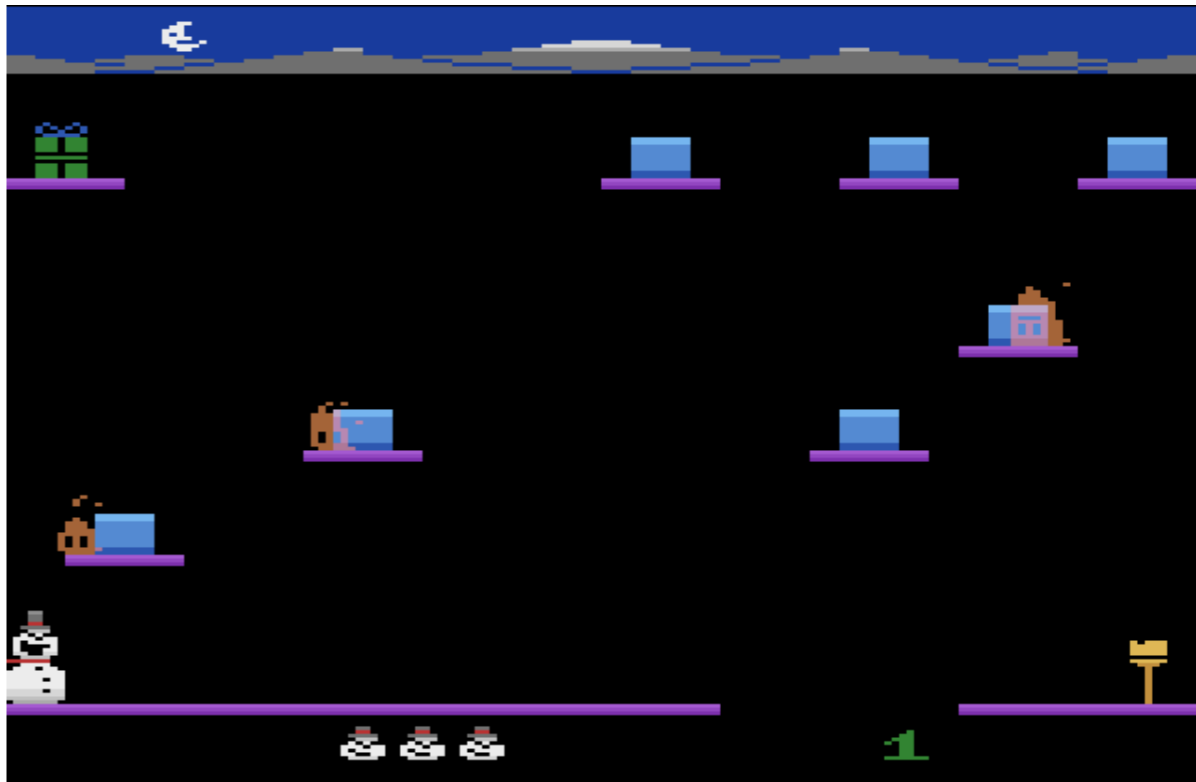
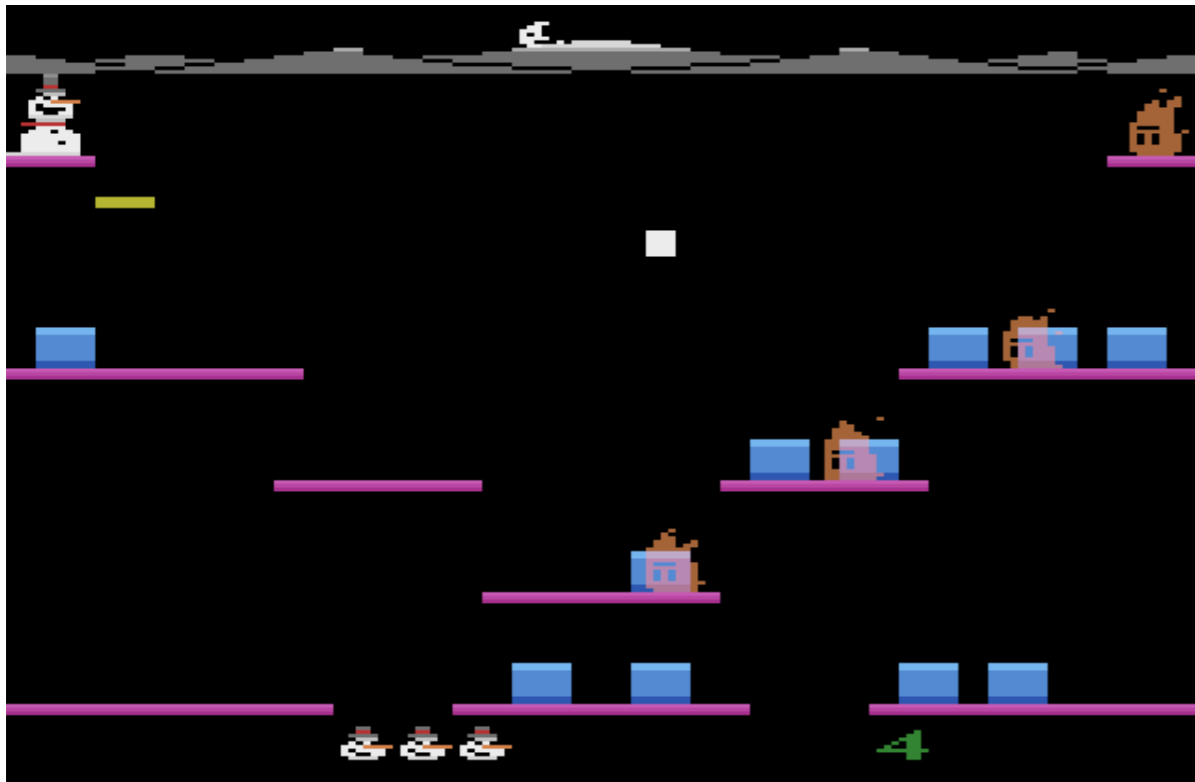
Stay Frosty



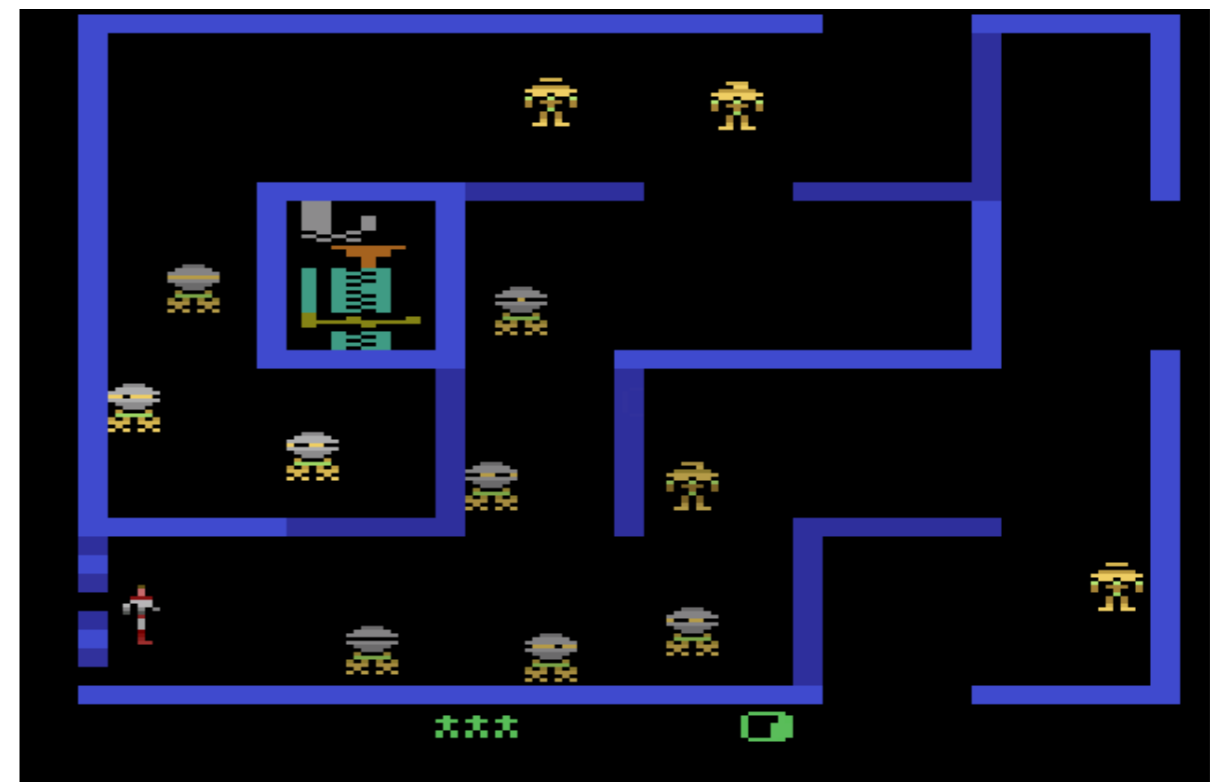
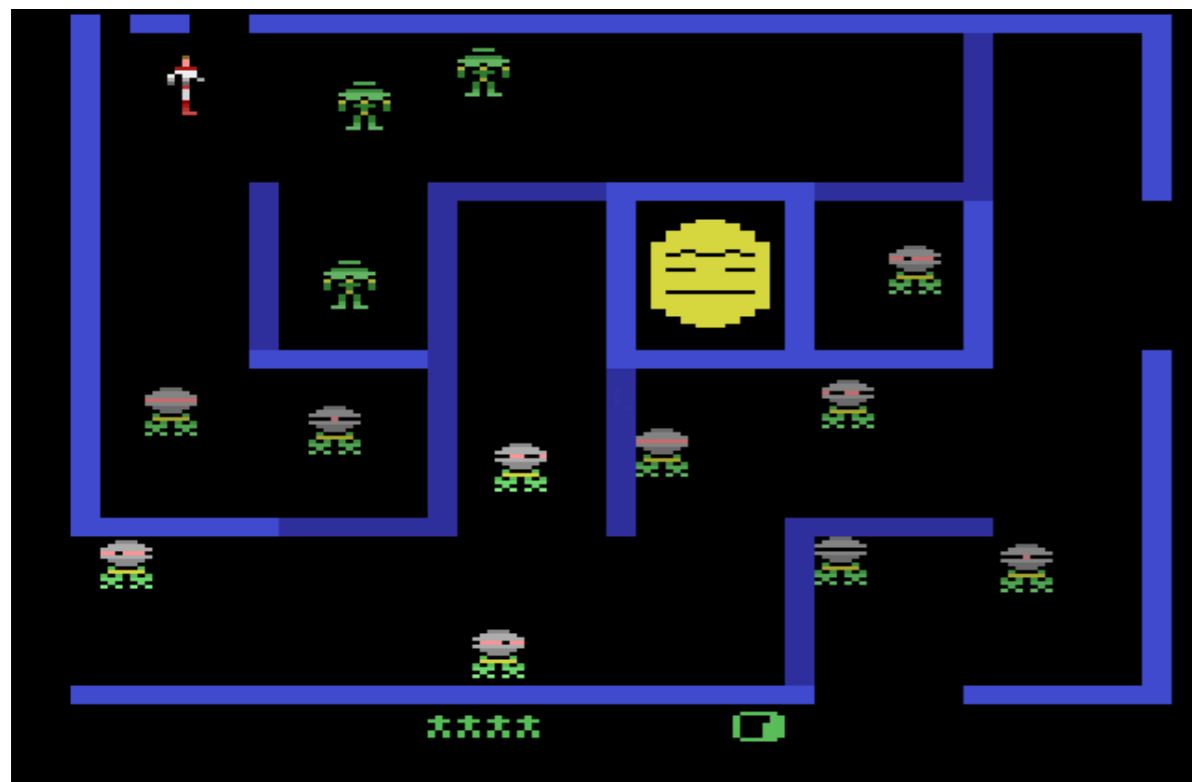


Stay Frosty 2

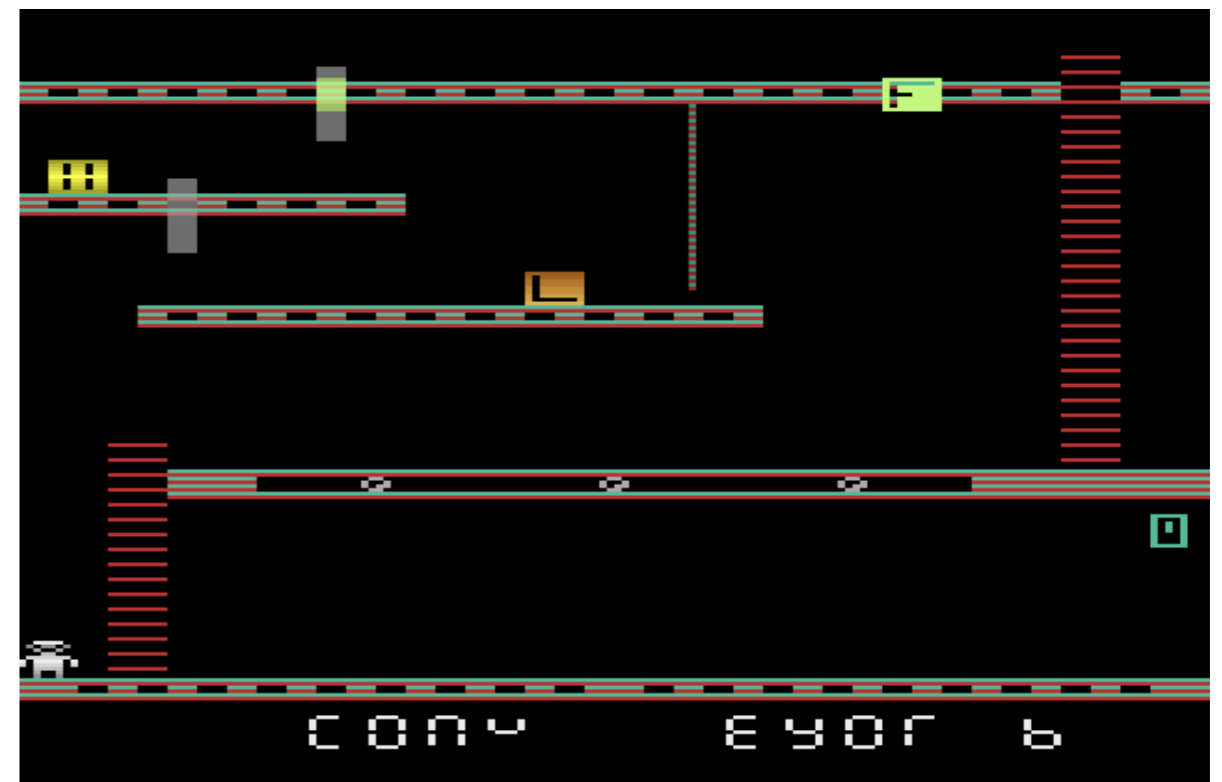
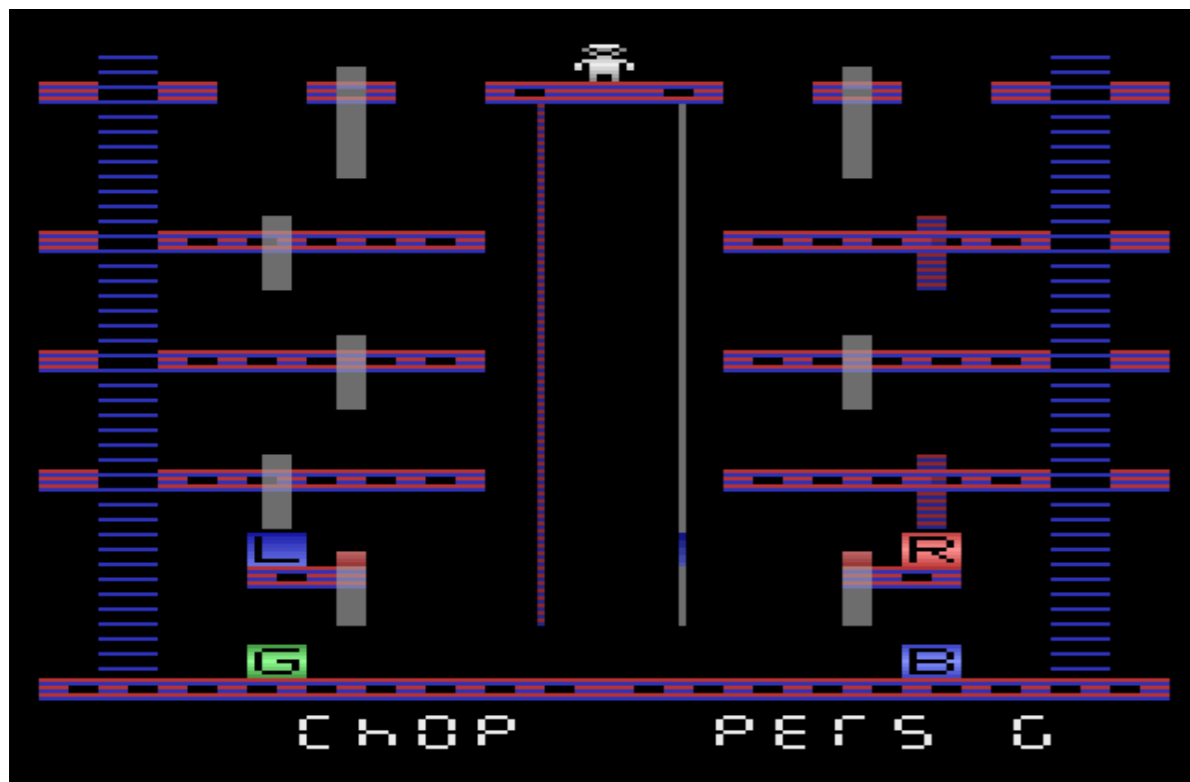
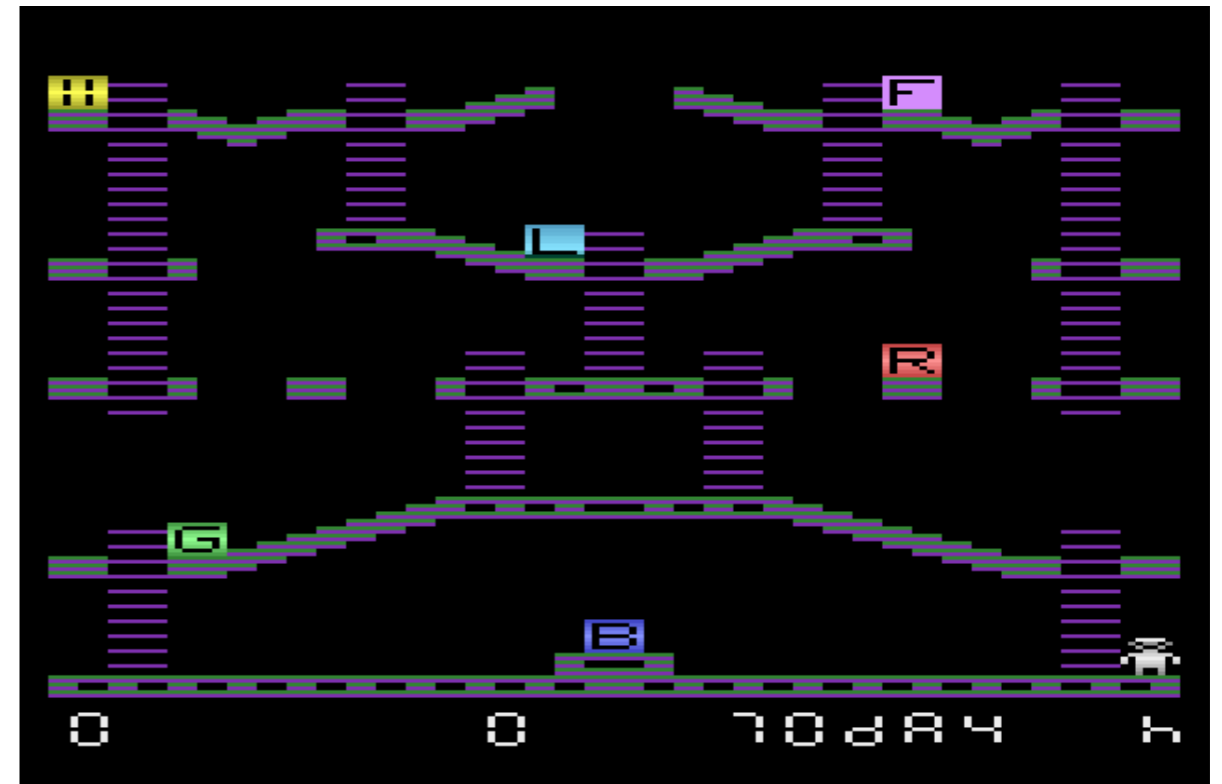




WIP - Frantic



WIP - TIMMY!



Challenges

- 128 bytes of system RAM (1/8 KB)
PS3 has 256 MB (262,144 KB)
- no video RAM
PS3 has 256 MB
- 4K cartridge space
- 1 MHz CPU
only 27% is available for game logic

128 bytes of RAM

- 1 KB cost \$66 in 1975 when work began on Stella (code name for the Atari)
- 128 bytes = 1/8 KB, about \$8.25

No video RAM

- TIA - Television Interface Adaptor is scan line based
- 2 players (sprites)
- 2 missiles
- 1 ball
- Low resolution playfield

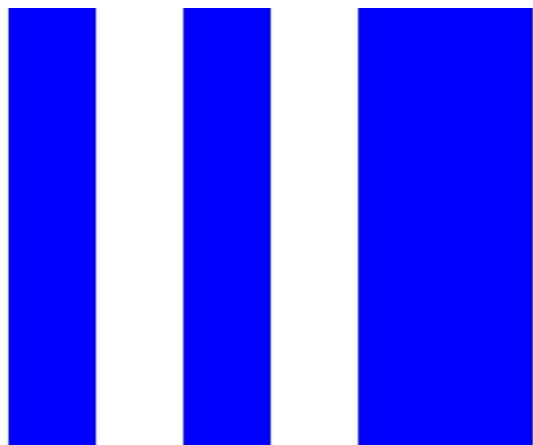
2 Players



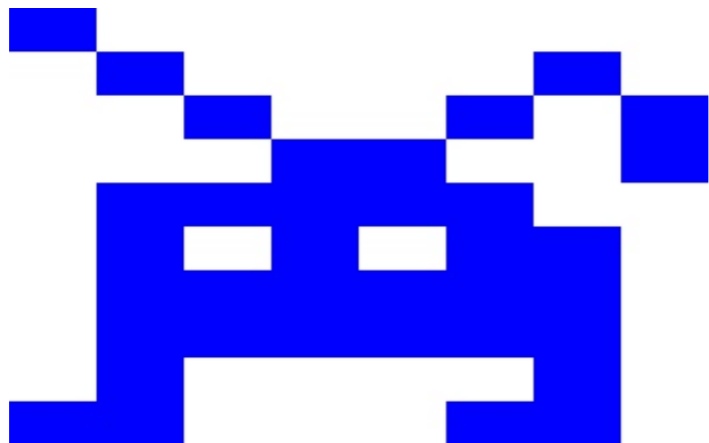
8 x 1 image



Sample pattern



If not changed, pattern repeats down the screen



Shapes are created by changing pattern on each scan line

Player Features

Three sizes:

1x



2x



4x



Three 1x duplicates



Two 1x triplicates



2 Missiles, 1 Ball



1 x 1 image

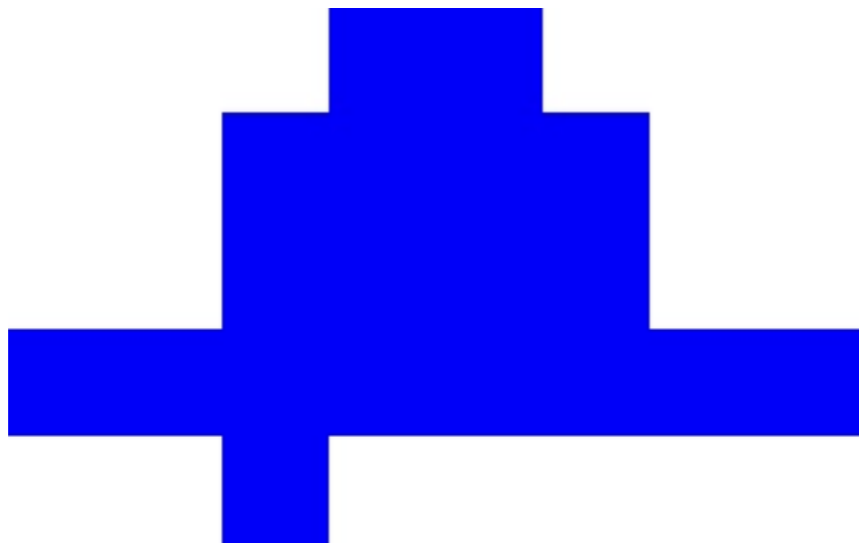
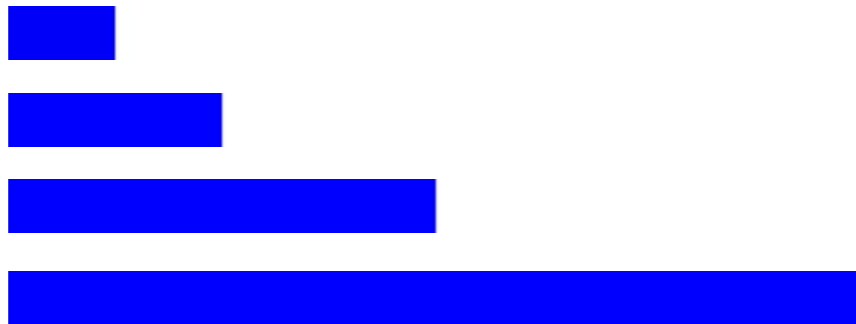
Four sizes:

1x

2x

4x

8x



Can be used to
create objects like
this bell

Playfield

20 x 1 image



Playfield is repeated



or reflected



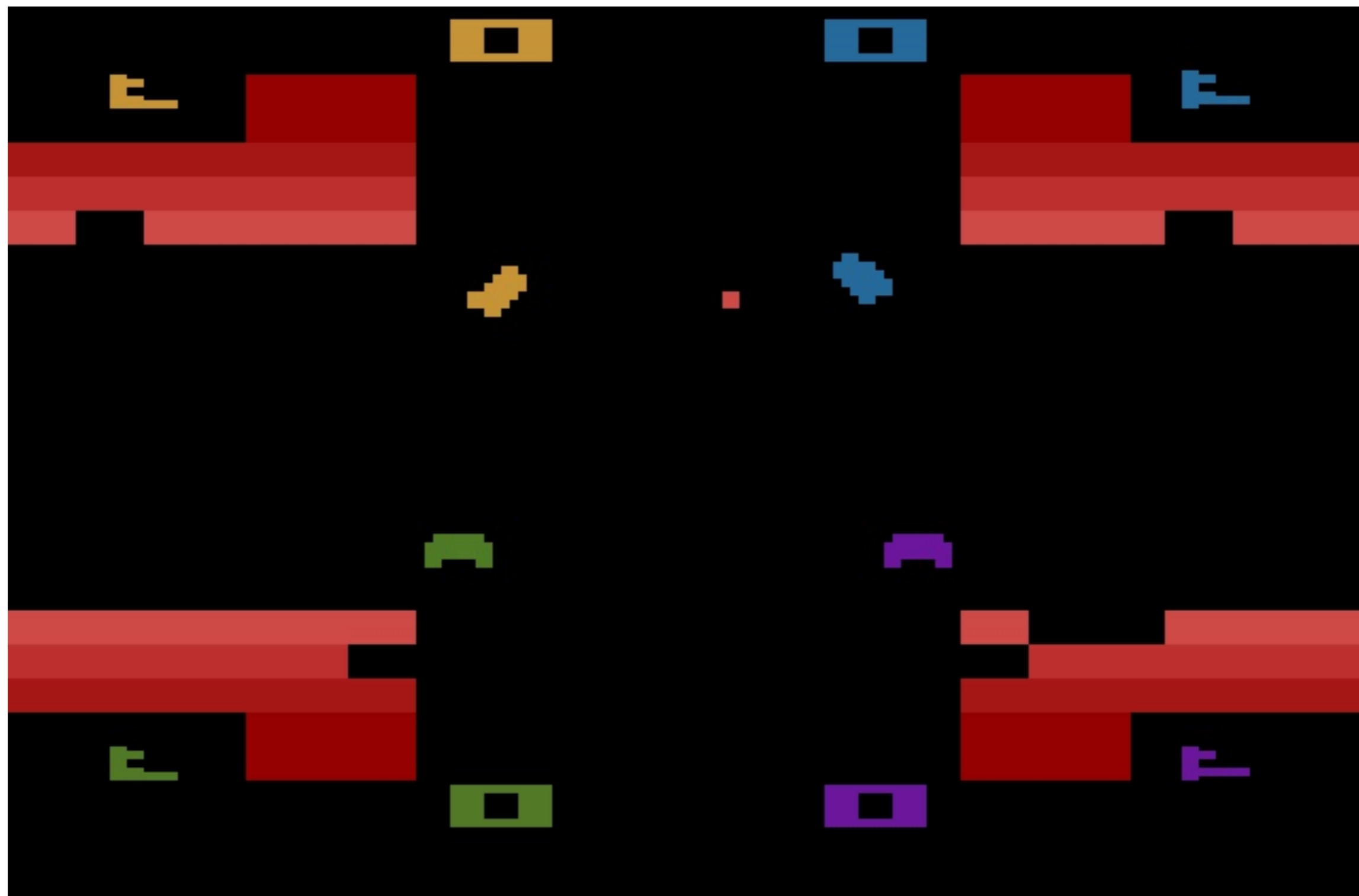
to fill width of screen

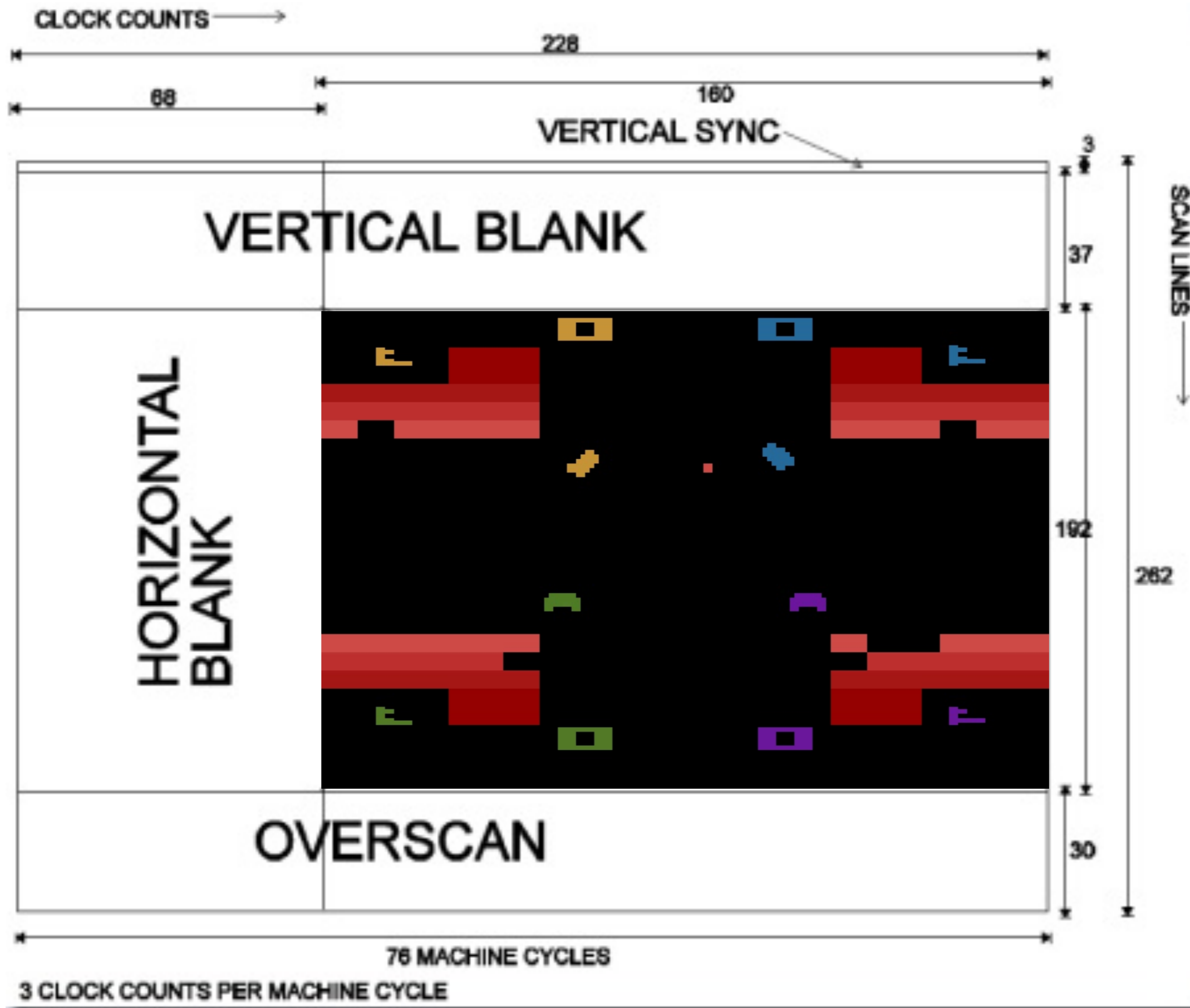
4K Cartridge

- original games were 2K
- 4K was believed to be large enough to last until the 2600's replacement hit the market
- ROM only, no Read/Write line for controlling access to RAM

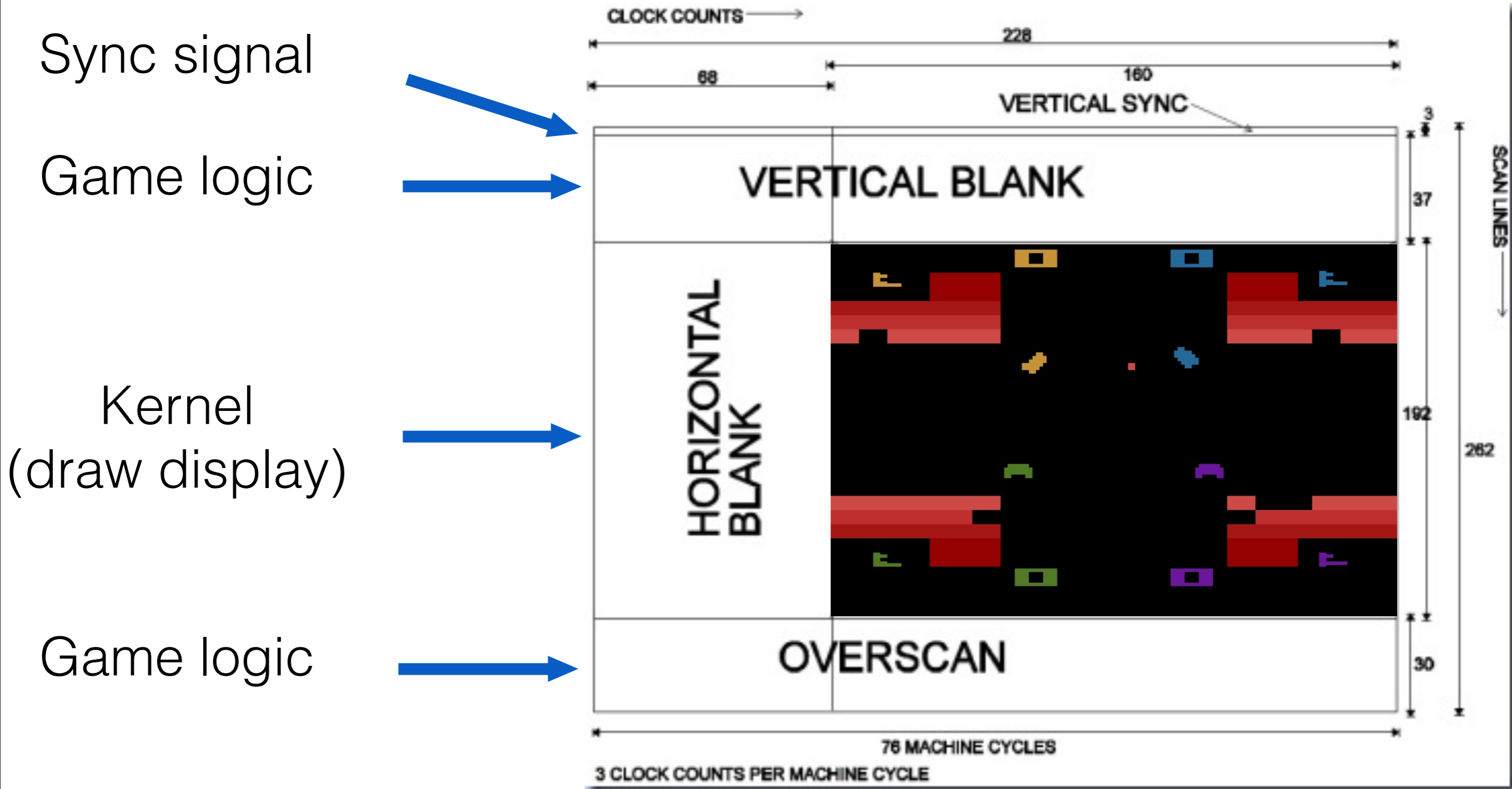
27% of 1 MHz

- CPU must update TIA (scan line video chip) in real time
- Portion of program that drives TIA is known as the Kernel
- CPU must also trigger sync signal for TV





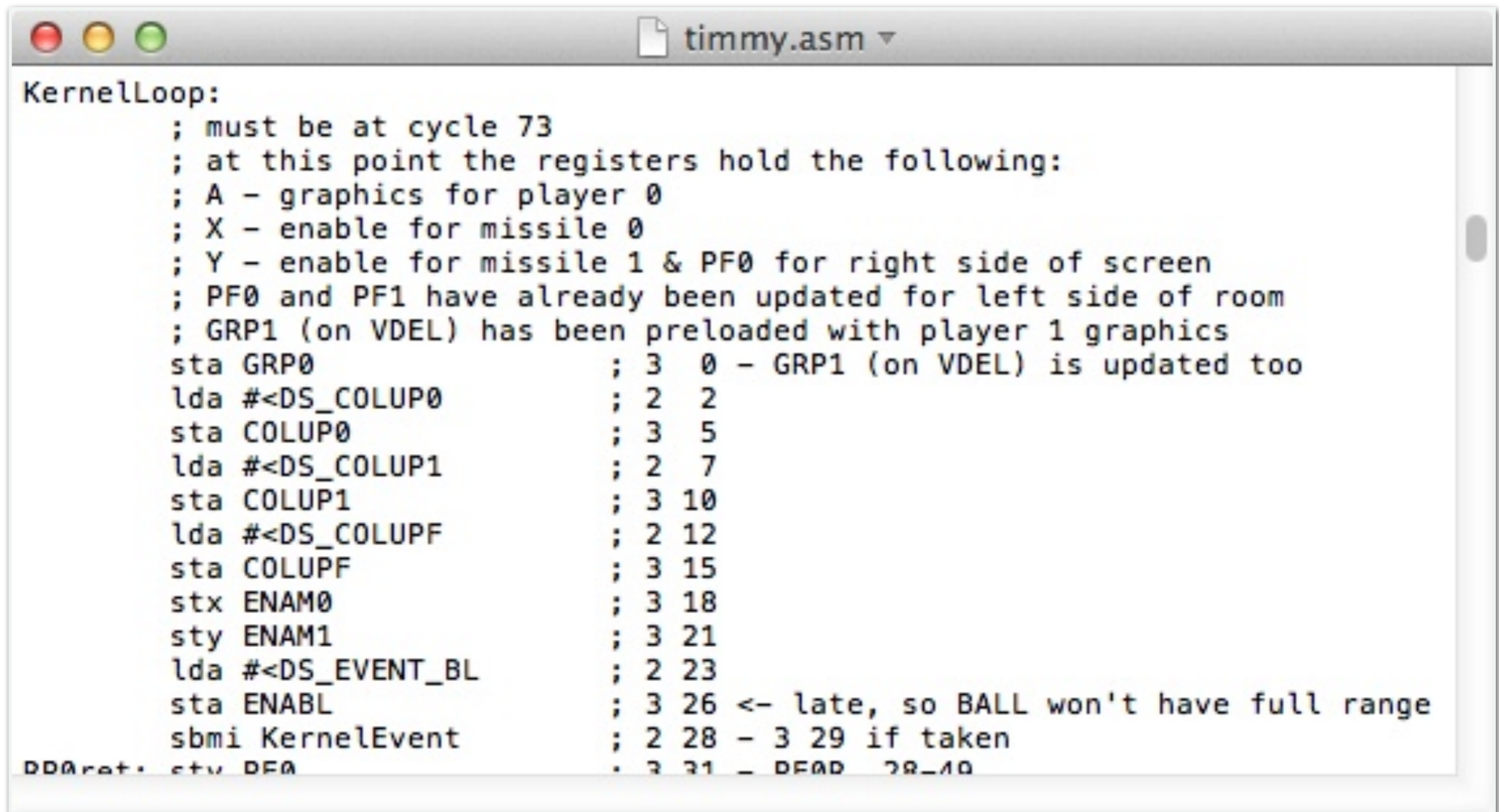
Program flow



What do you need?

- Editor
- Dasm
- Stella
- Hardware

Editor



```
KernelLoop:
    ; must be at cycle 73
    ; at this point the registers hold the following:
    ; A - graphics for player 0
    ; X - enable for missile 0
    ; Y - enable for missile 1 & PF0 for right side of screen
    ; PF0 and PF1 have already been updated for left side of room
    ; GRP1 (on VDEL) has been preloaded with player 1 graphics
    sta GRP0                ; 3 0 - GRP1 (on VDEL) is updated too
    lda #<DS_COLUP0        ; 2 2
    sta COLUP0             ; 3 5
    lda #<DS_COLUP1        ; 2 7
    sta COLUP1             ; 3 10
    lda #<DS_COLUPF        ; 2 12
    sta COLUPF             ; 3 15
    stx ENAM0              ; 3 18
    sty ENAM1              ; 3 21
    lda #<DS_EVENT_BL      ; 2 23
    sta ENABL              ; 3 26 <- late, so BALL won't have full range
    sbmi KernelEvent      ; 2 28 - 3 29 if taken
DDAret: stx DE0           ; 3 31 - DE0D 28-10
```

Notepad or TextEdit will do

A programmer's editor like jEdit is nicer
<http://www.jedit.org>

```
timmy.asm
File Edit Search Markers Folding View Utilities Macros Plugins Help
□ timmy.asm (~ /Projects/Atari/Timmy/)
1053 ; PF0 and PF1 have already been updated for left side of room
1054 ; GRP1 (on VDEL) has been preloaded with player 1 graphics
1055 sta GRP0 ; 3 0 - GRP1 (on VDEL) is updated too
1056 lda #<DS_COLUP0 ; 2 2
1057 sta COLUP0 ; 3 5
1058 lda #<DS_COLUP1 ; 2 7
1059 sta COLUP1 ; 3 10
1060 lda #<DS_COLUPF ; 2 12
1061 sta COLUPF ; 3 15
1062 stx ENAM0 ; 3 18
; ENAM1 ; 2 21
1059,39 (29493/140997) (assembly-6502,none,MacRoman)Nmr oUG 14/81Mb 1:05 PM
```

Dasm

Assembler that converts human readable
code into machine readable code

<http://dasm-dillon.sourceforge.net>

Stella

- Turns your computer into an Atari
- Integrated debugger makes coding easier

A screenshot of the Stella 3.5 emulator in debugger mode. The window title is "Stella 3.5_svn_test2: Debugger mode". The interface is split into several panels:

- Game View:** A smaller version of the maze game.
- Registers:** Displays CPU registers: PC: F140, SP: FF, A: 00, X: 00, Y: 20. It also shows bit planes: PS: n v - B d I Z C.
- Memory:** A memory dump table with columns for address (00xx) and hex values. The current address is 86 25.
- Disassembly:** A list of instructions being executed, such as LDA, STA, and STX, with their addresses and operands.
- Debugger Controls:** Buttons for Step, Trace, Scan +1, Frame +1, Exit, Undo, Rev, Srch, Cmp, and Rset.
- Command Prompt:** A text area showing the command history, including "autoExec()", "autoexec file", "config file", and "symbol file" messages.

Hardware

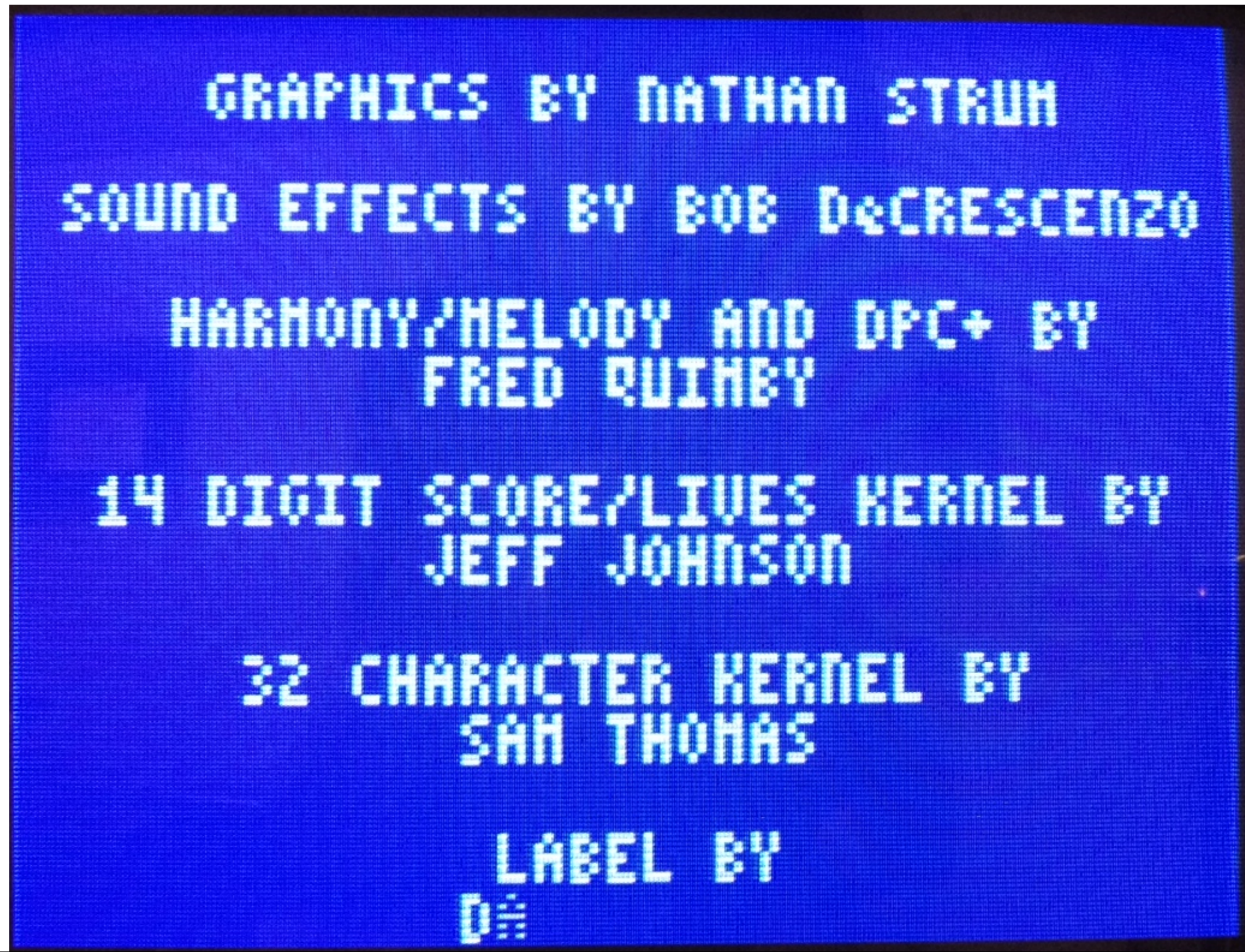
- Atari 2600
- Supercharger
- Krokodile cart
- Harmony

Atari 2600

While Stella is great, it's not 100% accurate so you need to test your code on the real thing.



32 character text on Atari



32 character text on Stella

GRAPHICS BY NATHAN STRUH

~~50~~ SOUND EFFECTS BY BOB DECRESCENZO

≡ HARMONY/MELODY AND DPC+ BY
FRED QUINBY

~~1~~ 14 DIGIT SCORE/LIVES KERNEL BY
JEFF JOHNSON

32 CHARACTER KERNEL BY
SAM THOMAS

LABEL BY
DAVE

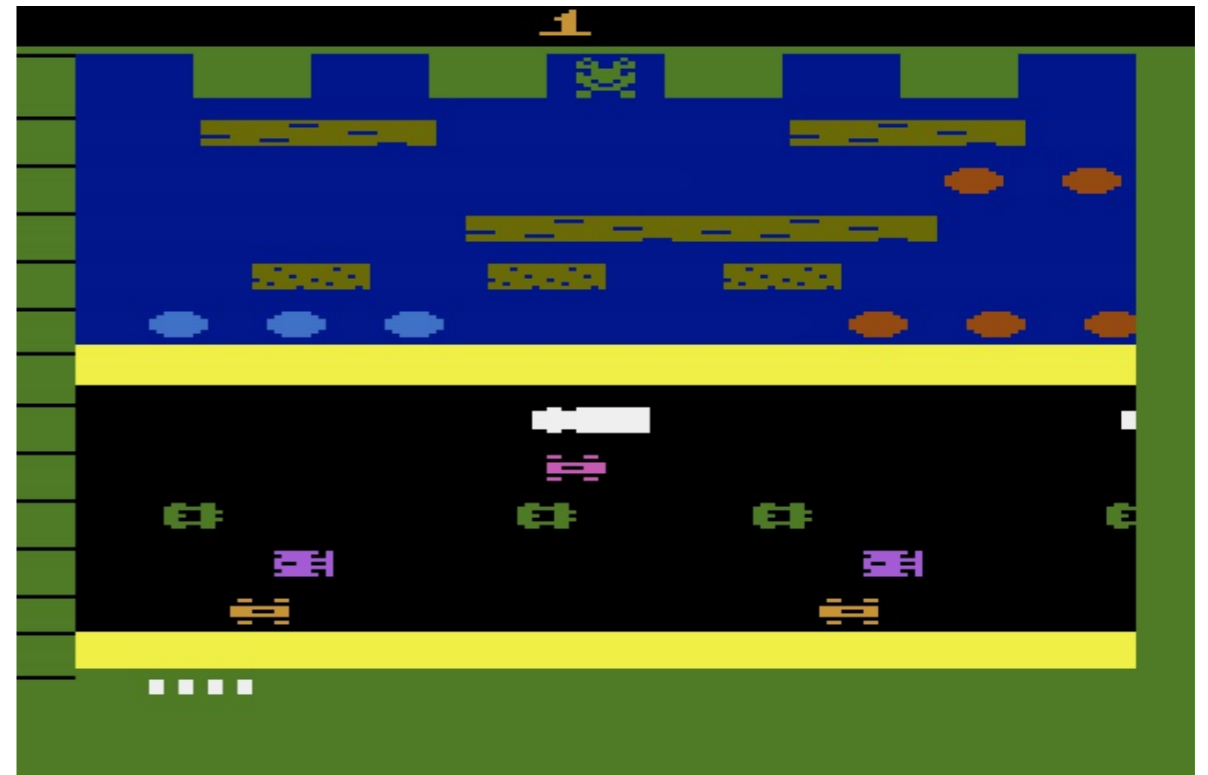
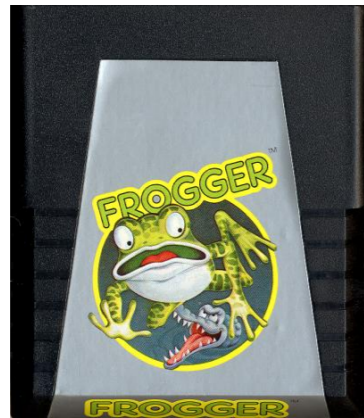
Starpath Supercharger



Starpath Supercharger

- Released in 1982 for \$45
- Uses audio to load programs (games were sold on cassettes)
- 6 K RAM, 2 K BIOS
- Program MAKEWAV converts ROM image to sound file

Starpath Supercharger



Krokodile Cartridge



Krokodile Cartridge

- Released in 2005 for \$99
- Uses serial port to load programs
- 512 K Flash ROM, 32 K RAM

Harmony Cartridge



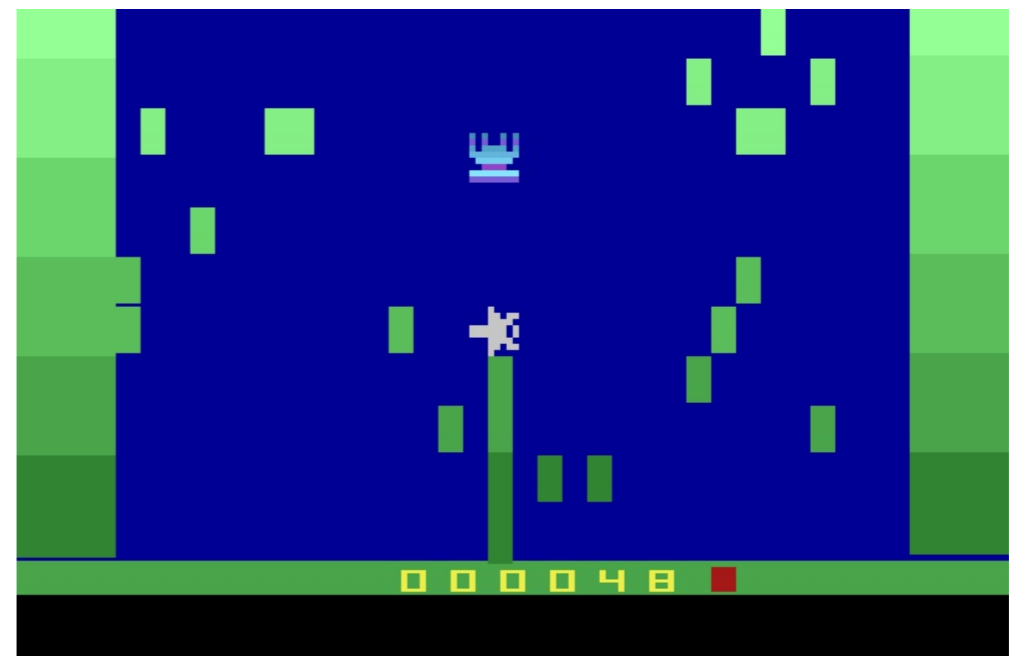
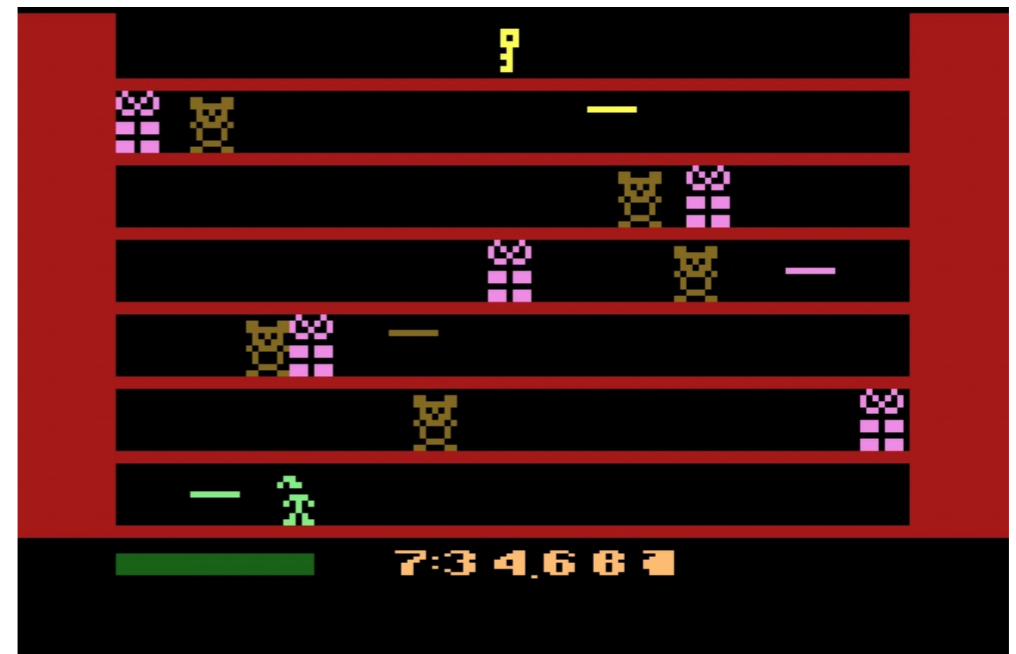
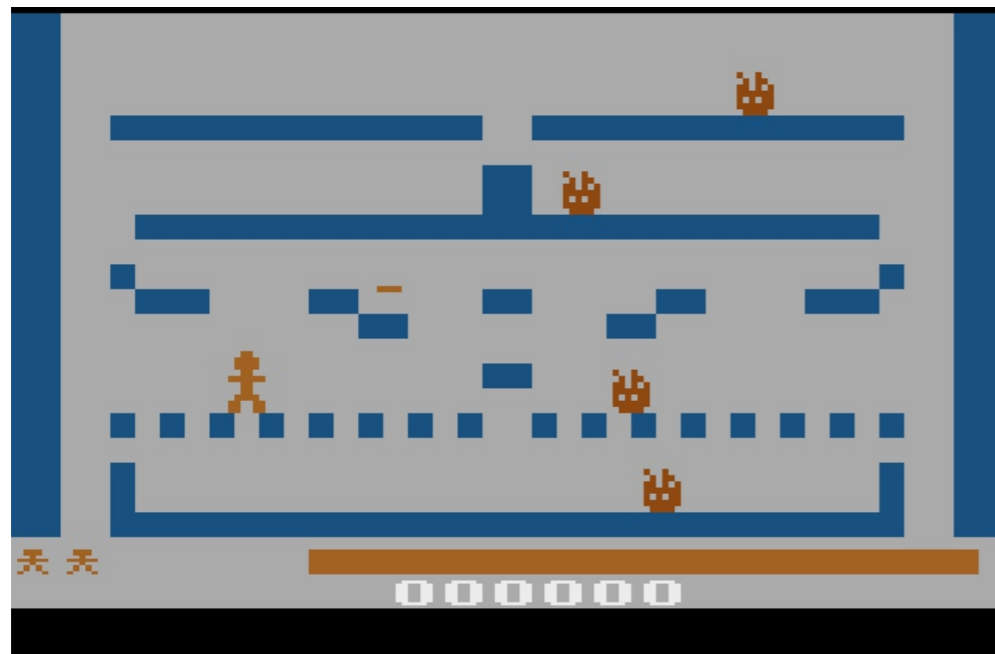
Harmony Cartridge

- Released in 2009
- Still produced, sells for \$59.99 and \$79.99
<http://harmony.atariage.com>
- Uses SD card or USB to load programs
- 32 K Flash ROM, 8 K RAM
- 70 MHz ARM processor
- Melody variation used by Atari Age to produce stand alone games

batari Basic

- Provides a simpler way to create Atari games
- Uses a BASIC like language for game logic
- Provides a number of prebuilt Kernels

batari Basic games



How are the limited
objects used to create
complex games?

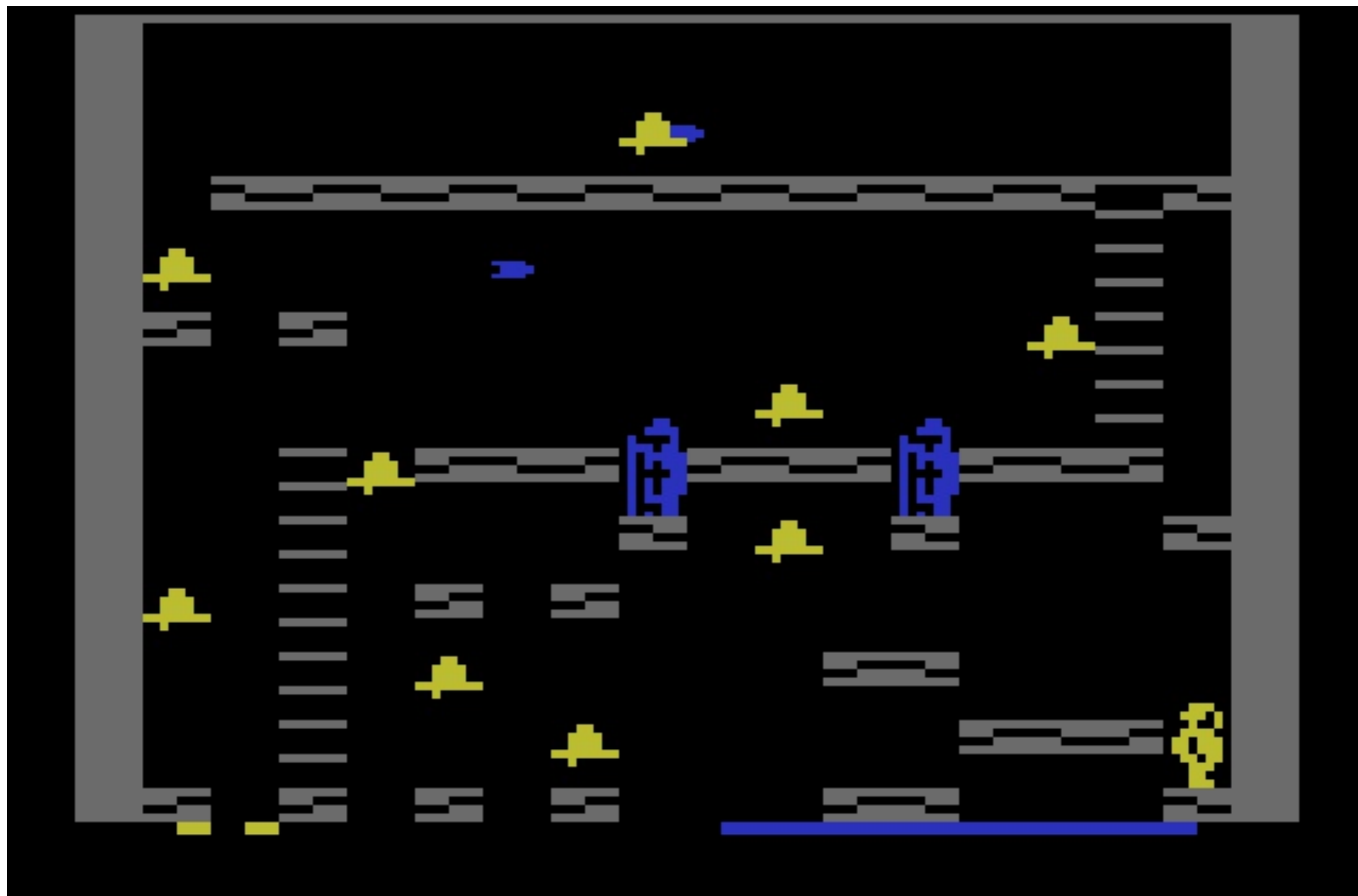
Space Invaders



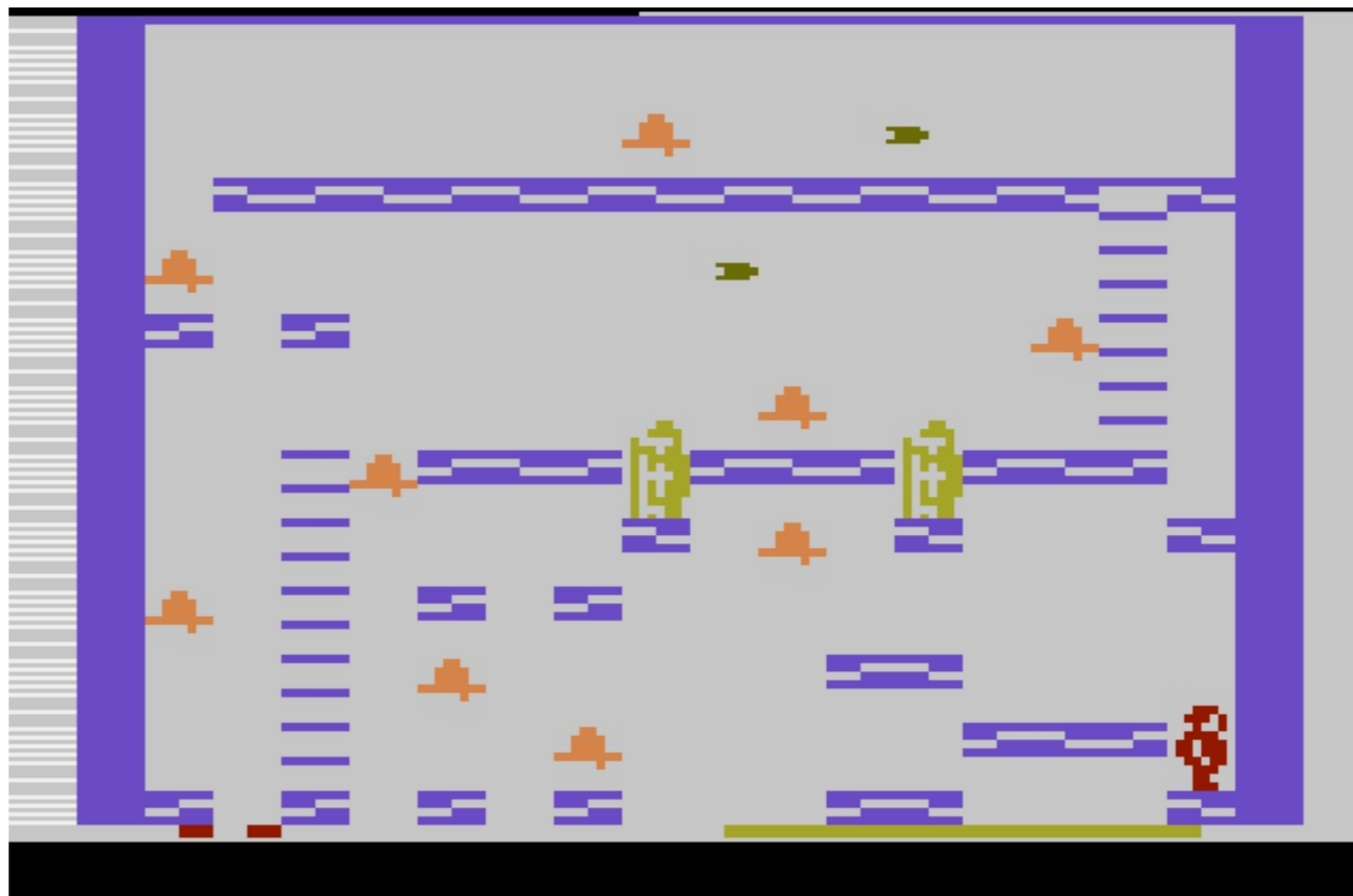
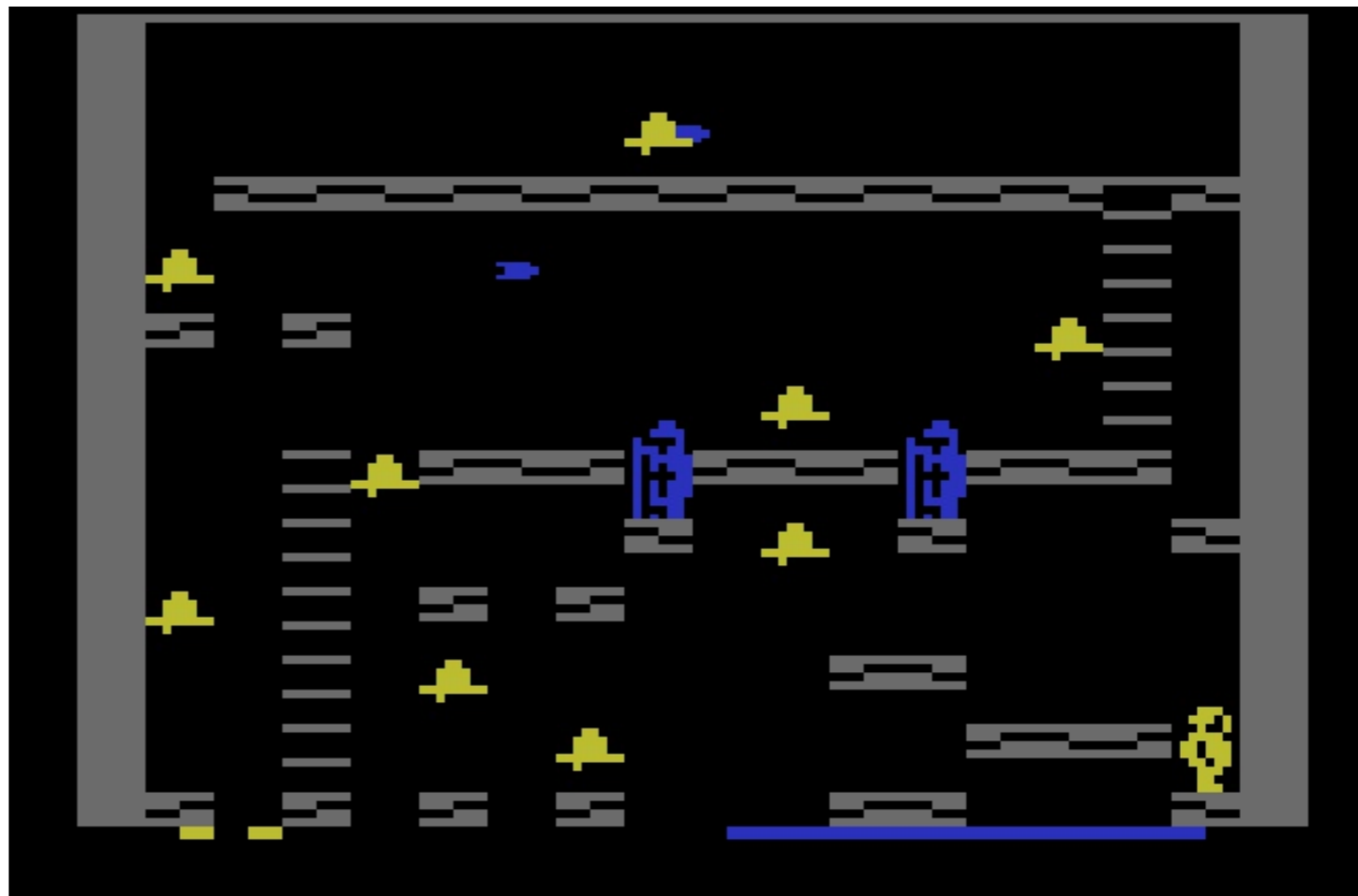
-  Background
-  HMOVE
-  Playfield
-  Ball
-  Player 0
-  Player 1
-  Missile 0
-  Missile 1



Hunchy II



-  Background
-  HMOVE
-  Playfield
-  Ball
-  Player 0
-  Player 1
-  Missile 0
-  Missile 1



Keystone Kapers



 Background

 HMOVE

 Playfield

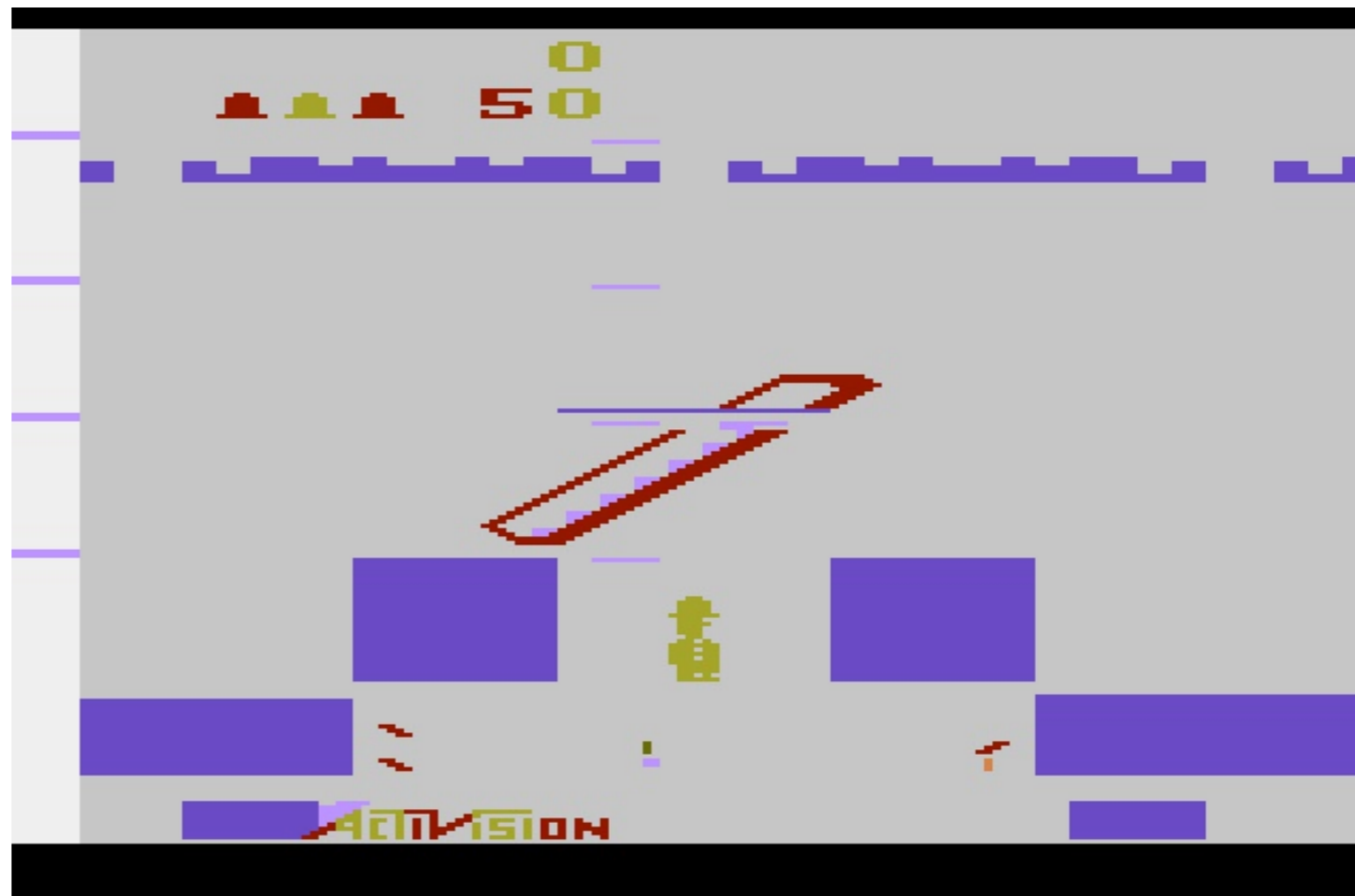
 Ball

 Player 0

 Player 1

 Missile 0

 Missile 1





Supercharging games

(graphic by Nathan Strum)

Supercharging your game

- Bankswitching
- Extra RAM
- Coprocessor
- Bus Stuffing

Bankswitching

- Game split into 4K banks
- Atari can only see 1 bank at a time
- Cartridge has hardware to present different banks upon request
- Companies came up with various "modes" of making the request
- Krokodile Cartridge supports up to 512K using mode 3F

Extra ROM with bankswitching allows for in game menus



Extra RAM

- Extra RAM allows for more complex games
- Address line used to work around the lack of a R/W line. This makes the RAM appear twice in memory, one address range for reading and the second for writing.
- Not compatible with INCrément or DECrément instructions.
- Krokodile Cartridge supports up to 32K using mode 3E

Coprocessor

- DPC in Pitfall 2
- DPC+ in Harmony/Melody

DPC

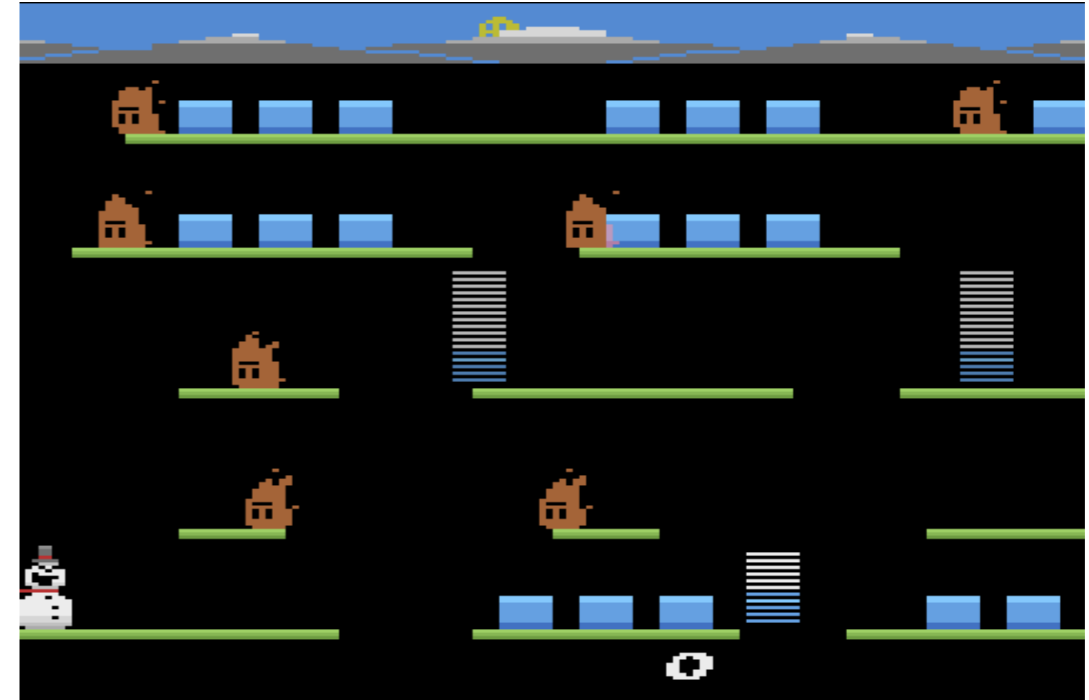
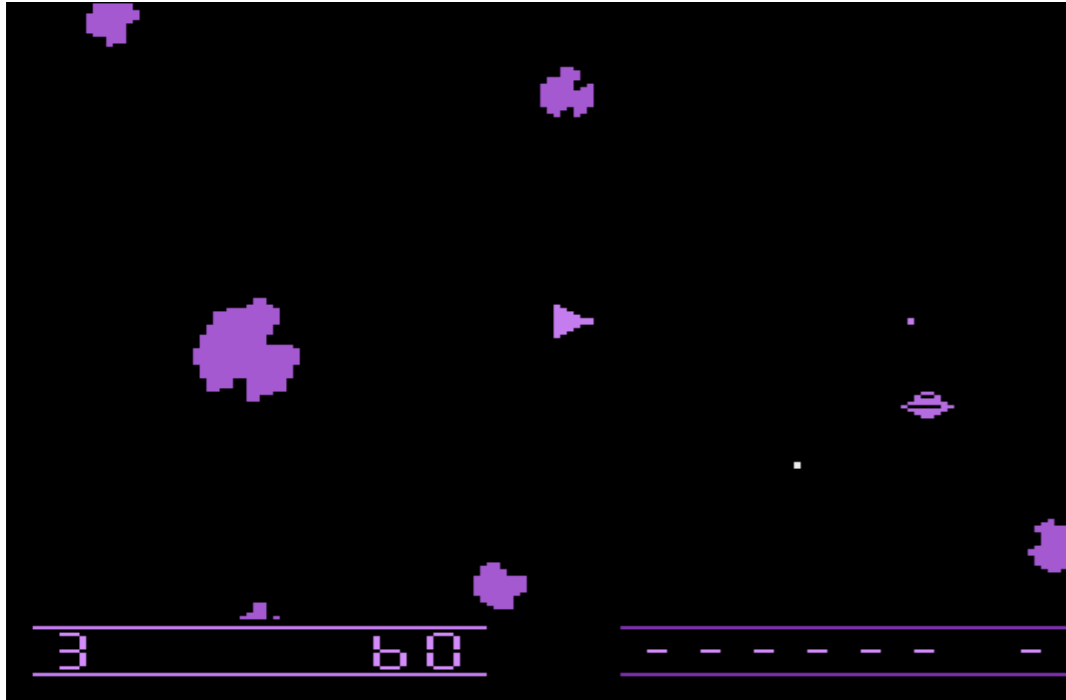
- Display Processor Chip designed by David Crane
- 8K ROM
- 2K Display Data (holds graphics and other data)
- Data Fetchers return Display Data for fast updates to TIA
- Data Fetcher Window mode greatly speeds up player processing
- 3 voice music using square waves (4 bit digital sound)



DPC+

- Enhanced version of DPC designed for Harmony/Melody by Fred Quimby, Chris Walton and Darrell Spice, Jr.
- 24K ROM
- 4K ROM/RAM based Display Data
- Fast Fetch mode for even faster Data Fetchers
- 3 voice music using custom waveforms (4 bit digital sound)
- Can offload non-Kernel processing to 70 MHz ARM

DPC+ Games



Bus Stuffing

- Commodore(!) developed The Graduate, a computer keyboard add-on for the 2600
- Processors in the keyboard overdrive the data bus (aka bus stuffing) for fastest possible TIA updates
- Harmony/Melody support bus stuffing



Display Sprite Routines

- DoDraw
- DPC
- DPC+
- Bus Stuffing

Display Sprite Routines

- **DoDraw**, 26 cycles
- DPC
- DPC+
- Bus Stuffing

```
LDA #SPRITEHEIGHT  
DCP SpriteTemp  
BCS DoDraw  
LDA #0  
.BYTE $2C
```

DoDraw

```
LDA (GfxPtr),Y  
STA GRP0  
LDA (ColorPtr),y  
STA COLUP0
```

Update Image

Update Color

Display Sprite Routines

- DoDraw, 26 cycles
- **DPC**, 14 cycles
- DPC+
- Bus Stuffing

```
LDA DF0DATAW  
STA GRP0  
LDA DF1DATA  
STA COLUP0
```

```
Update Image  
Update Color
```


Display Sprite Routines

- DoDraw, 26 cycles
- DPC, 14 cycles
- **DPC+**, 10 cycles
- Bus Stuffing

```
LDA #<DF0DATAW  
STA GRP0  
LDA #<DF1DATA  
STA COLUP0
```

```
Update Image  
Update Color
```

Display Sprite Routines

- DoDraw, 26 cycles
- DPC, 14 cycles
- DPC+, 10 cycles
- **Bus Stuffing**, 6 cycles

STX GRP0
STX COLUP0

Update Image
Update Color

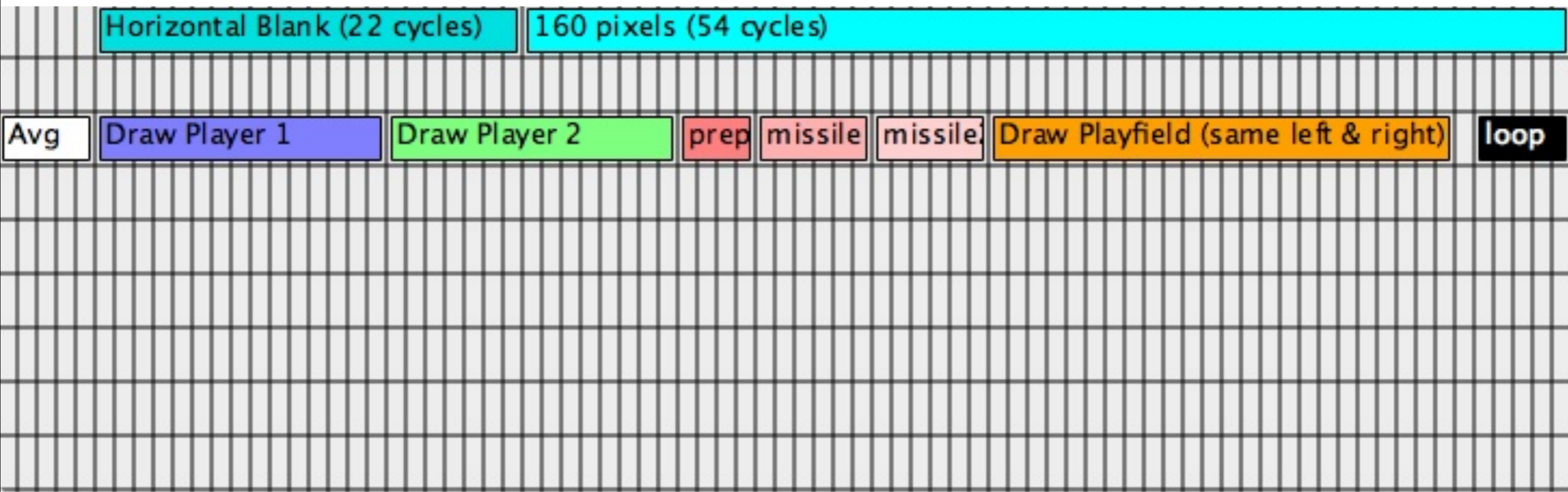
Kernel comparisons

Horizontal Blank (22 cycles)

160 pixels (54 cycles)

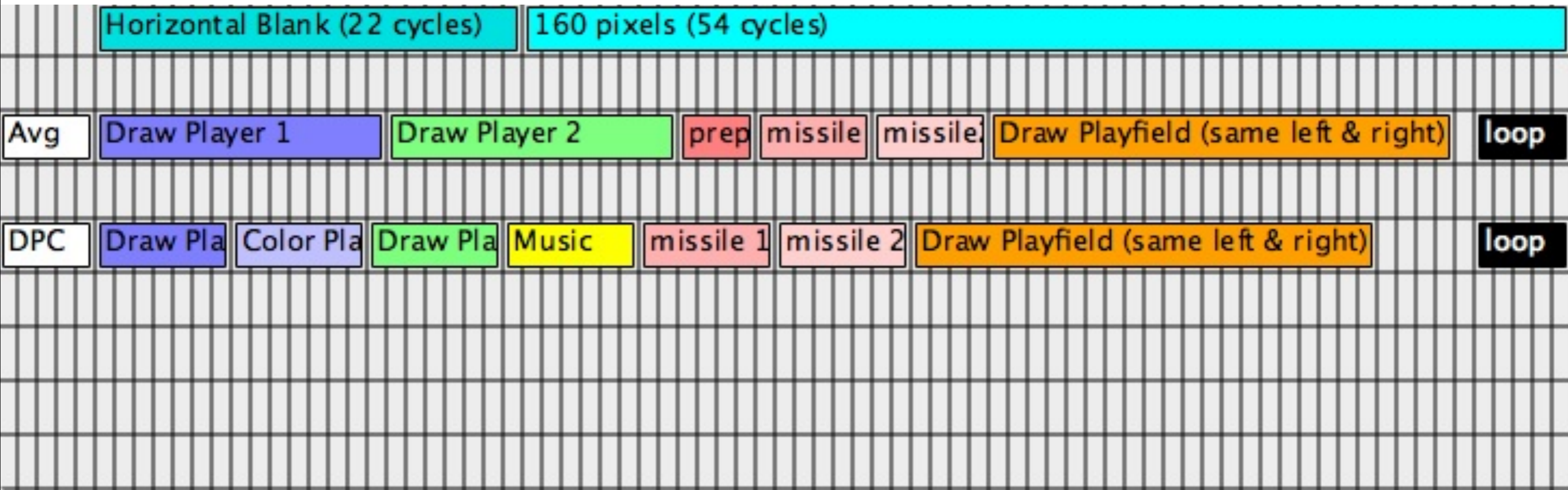
76 cycles to draw scan line.

Average Kernel



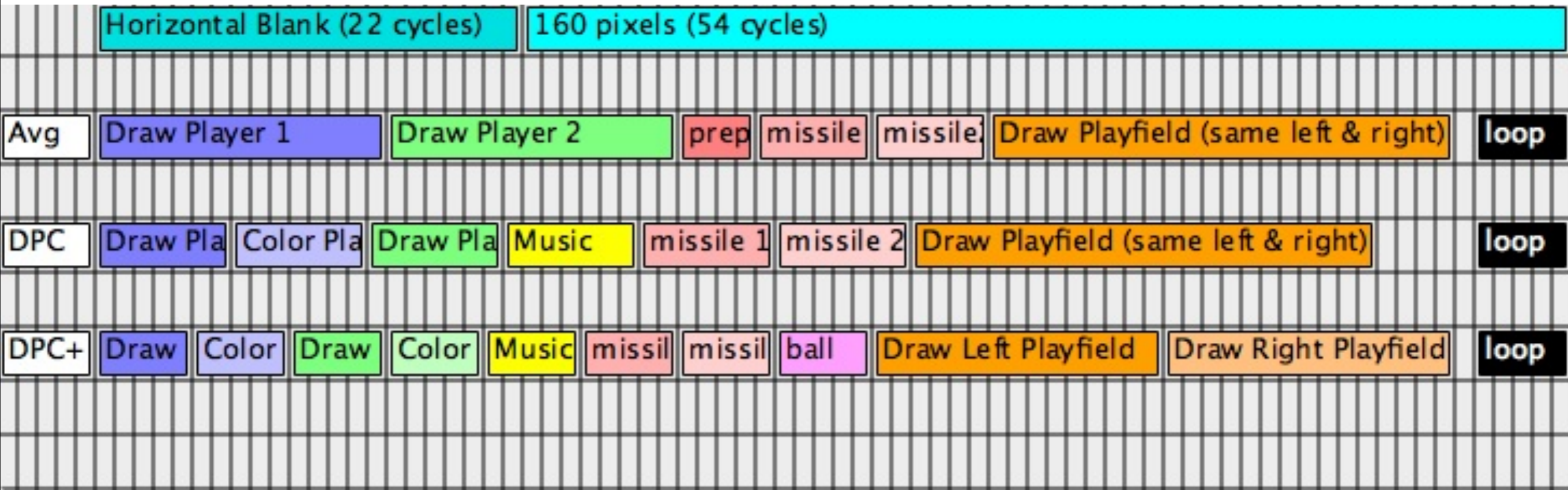
- 2 single color players (sprites)
- 2 missiles
- Simple reflected or repeated playfield

DPC Kernel



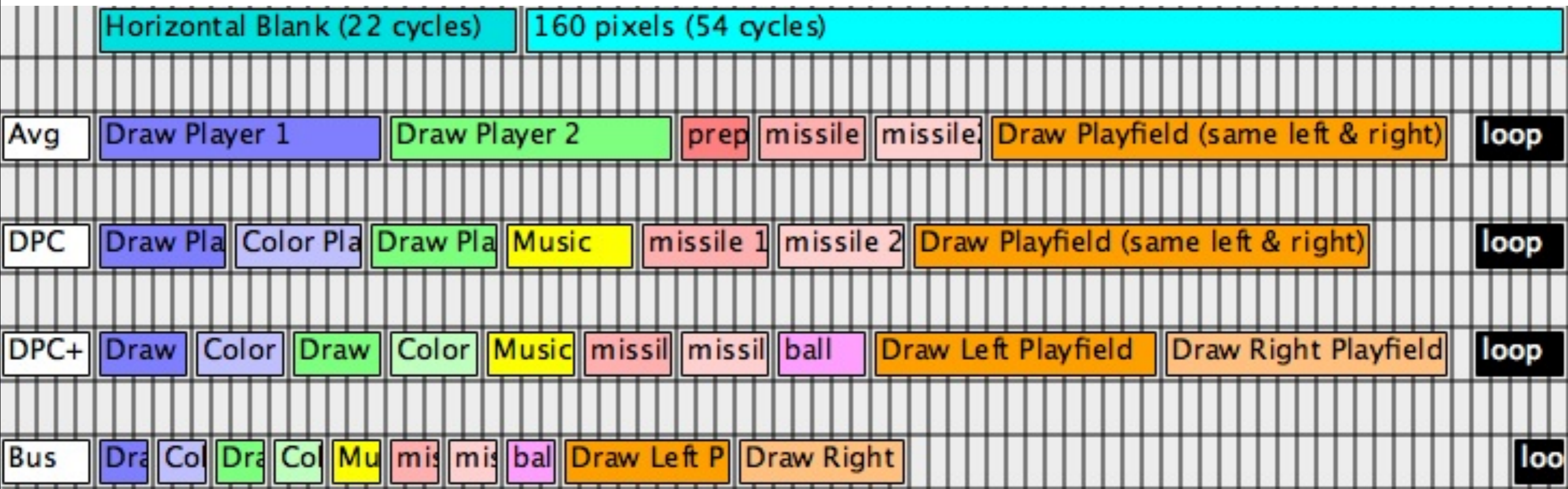
- 1 multicolor player
- 1 single color player
- 4 bit digital music
- 2 missiles
- Simple reflected or repeated playfield

DPC+ Kernel



- 2 multicolor players
- 4 bit digital music
- 2 missiles
- Ball
- Complex playfield

Bus Stuffing Kernel



- 2 multicolor players
- 4 bit digital music
- 2 missiles
- Ball
- Complex playfield
- Extra time for TIA tricks, such as extra copies of players

Resources

Atari Age

<http://www.atariage.com/>

Mini dig

<http://www.qotile.net/minidig/>

Stella

<http://stella.sourceforge.net/>

Harmony

<http://harmony.atariage.com/>

Dasm

<http://dasm-dillon.sourceforge.net/>

Atari 2600 Programming

[http://www.atariage.com/forums/
forum/50-atari-2600-programming/](http://www.atariage.com/forums/forum/50-atari-2600-programming/)

2600 Programming for Newbies

[http://www.atariage.com/forums/
forum/31-2600-programming-for-](http://www.atariage.com/forums/forum/31-2600-programming-for-)

batari Basic

batari Basic

<http://bataribasic.com/>

Atari Age forum

<http://www.atariage.com/forums/forum/65-batari-basic/>

Random Terrain

<http://www.randomterrain.com/atari-2600-memories-batari-basic-commands.html>

Visual bB

<http://www.atariage.com/forums/topic/123849-visual-bb-1-0-a-new-ide-for-batari-basic/>

Questions?

Presentation will be made available at

<http://www.spiceware.org>