Atari 2600 VCS (1977)

- 1 MHz MOS 6207
  - Low-cost version of 6502
- 128 bytes RAM
- First ROM cartridges 2K, later 4K
- Discontinued 1992
- Retro releases now on the market!

Atari 2600 Hardware Tricks

- Could put RAM on the cartridge
  - “Atari Super Chip”
  - 128 more bytes!
  - Jr. Pac-Man
- “Bank switching” to put more ROM on cartridge
  - Only 4K immediately addressable - game still has to operate within individual 4K chunks at a time
  - Mr. Do!’s Castle (8K), Road Runner (16K, 1989)
  - Fatal Run (only 32K game released, 1990)

“M Network” games
- Atari 2600 games produced by Mattel
- Controversial decision within Mattel
- Done by same group that designed the Intellivision: APh Technology Consulting

Super Charger added 2K RAM
- Originally planned as a hardware add-ons
- Public didn’t seem to like add-ons, so built in separately into each cartridge
- BurgerTime: Cleverness beats hardware!

www.intellivisionlives.com/bluesky/games/credits/atari2.shtml

Info & pics from AtariAge
Atari 2600 - The Chess Story (1)

• “Atari never intended to create a Chess game for the Atari 2600”

• “the original VCS box had a chess piece on it, and Atari was ultimately sued by someone in Florida due to the lack of an actual chess game”

• “Some time later Atari’s engineers began working on a version of Chess for the 2600”

Quotes from AtariAge page on Video Chess

Atari 2600 - The Chess Story (2)

• “Although Video Chess ended up shipping as a 4K game, earlier versions of the game were larger...This prompted Atari to invent bank-switching ROMs which would be used in later titles that needed more than 4K...”

Quotes & pics from AtariAge page on Video Chess

Atari 2600 Graphics

• Custom “Television Interface Adapter” for handling graphics and sound
• No graphics buffer!
• “Playfield” scanline 40 pixels wide, two colors
• Atari 2600 games have intricate timing loop
  – For each scanline, program has 76 cycles to do whatever computations it needs to do to load a scanline’s worth of pixels into the TIA
  – Have to do most the “game logic” during the vertical blanking period
• Two “players”: 8-pixel wide chunks, twice resolution of playfield, could be two colors different than playfield
• Missiles: single-bit players

Info from “Chris Crawford on Game Design”

Atari 2600 - Graphics Tricks

• Could change TIA registers, like color maps…
  – …from scan line to scan line
  – …if you were extremely careful with your timing, you could do it in the middle of a scan line!
• Multiplex a single sprite between multiple objects
  – Flickering ghosts in Pac-Mac man
    • Flicker varies depending on number of ghosts in play
• Programmers learned to exploit “undocumented features” in the hardware
  – Makes the Atari 2600 one of the hardest machines to emulate accurately
Rise of the third party developers

- Atari programmers unhappy
  - No credit
  - Salaried; little if any royalties
- Four top programmers split and form Activision (1979)
  - Responsible for over half of Atari’s titles
  - Promoted game creators along with games
  - Drew top talent
  - Didn’t pay royalties to Atari
    - Nintendo learned from this!
  - Atari sued
    - Settled in 1982
- Mattel and Coleco made the same mistakes in handling their programmers that Atari did!

Intellivision vs. Atari

- Plimpton Sports
  - [http://www.youtube.com/watch?v=IDza6eTXGEY](http://www.youtube.com/watch?v=IDza6eTXGEY)
- Major League Baseball
  - [http://www.youtube.com/watch?v=Y0KTjpaG3cg](http://www.youtube.com/watch?v=Y0KTjpaG3cg)
- Star Strike
  - [http://www.youtube.com/watch?v=VPB3H_a234s](http://www.youtube.com/watch?v=VPB3H_a234s)

Mattel Intellivision (1979)

- 1 MHz General Instrument CP1610 (16-bit!)
- 1352 bytes RAM:
  - 240x8 scratchpad memory
  - 352x16 system memory
  - 512x8 graphics memory
- 7168 bytes ROM
  - 4096x10 (5120) executive ROM
  - 2048x8 graphics ROM

Mattel Intellivision - Graphics

- 160x196, 16 colors
- 8 sprites
  - 8x8 or 8x16
  - Stretching: horizontal (1x, 2x) or vertical (1x, 2x, 4x, 8x)
  - Mirroring: horizontal and vertical
  - Collision detection: sprite to sprite, sprite to background, sprite to screen border
  - Priority: in front of or behind background
Example Intellivision code

```
CALL RSGB      ; Reset good guy bullets.
CALL FILLZERO,1p    ; 
DECLE 25;             ;   - nuke any remaining bad guys
DECLE BSMPTB      ; / 
CALL FILLZERO,1p    ; \     
DECLE 10;            ;   - and their sprites
DECLE SPAT;          ; /

; Draw the crater strip in selected color scheme. ;
MVI  COURSE, R1    ; 
ANDI R7, R1        ;   - Adjust color for course
SLR R1, 1          ;   
ADDI #BAC_CLR, R1   ;   
ADDI R1, R0        ;   
MOVR R0, R2        ;   
ADDI #7*8, R2      ;   City/crater ending card #
```

Source code for Space Patrol
From spatula-city.org/~im14u2c/intv/spteaser

Mattel Intellivision - Modern Homebrew Scene

```
jzIntv
spatula-city.org/~im14u2c/intv

SDK-1600
spatula-city.org/~im14u2c/intv
/homebrew/intel
spatula-city.org/~im14u2c/intv
/sdk-1600

Homework programming contest:
spatula-city.org/~im14u2c/intv/contest-2007

Atari Homebrew Scene

From www.bogost.com and www.quernhorst.de/atari/rf.html

Ian Bogost (LCC)
**ColecoVision (1982)**

- ≈3.6 MHz Zilog Z-80A (8-bit)
- 1KB scratch RAM
- 16 KB of separate VRAM
- Cartridges 8/16/24/32K
- Expansion Module #1 allowed user to play Atari 2600 games
  - Atari sued, but lost since EM #1 used off-the-shelf hardware
- Bundled with Donkey Kong - "killer app"
- 6 million sold
- Discontinued 1984
- Coleco also produced games for Atari 2600 and Intellivision
  - [http://www.youtube.com/v/5GpptJusOjM](http://www.youtube.com/v/5GpptJusOjM)

**ColecoVision - Graphics**

- Video Processor: Texas Instruments TMS9928A
  - Variants used in MSX, Texas Instruments TI-99/4
- 256x192, 16 colors
- 32 sprites
- First console that could seriously compete with stand-alone arcade machines

**Apple ][ series (1977)**

- ≈1 MHz MOS 6502
- 16K to 48K of RAM (64K with "Language Card")
- Expansion slots
- VisiCalc (first spreadsheet) - killer app
- Spurred IBM to make the IBM PC
- Hi-res graphics: 280x192, 5 colors (sort of)
  - Page flipping, Pre-shifted shapes

**Exodus: Ultima III screenshot from Moby Games**
**Other pics and info from Wikipedia**

**Atari HCS 400/800 (1979)**

- ≈1 MHz MOS 6502
- 16K to 48K of RAM
- Star Raiders - "killer app"
  - Created by engineer who designed POKEY (the I/O and sound chip)
  - Written to show off the machine’s capabilities
  - 3-D math!!! Remember, no divide instructions….  

**Star Raiders**

**Pics and info from Wikipedia**
Atari HCS 400/800 - Graphics

- Extremely flexible graphics system
- Amenable to all kinds of 2600-style tricks, although now with a much more powerful basic capabilities
  - Reprogramming color table for each scan line
  - Vertical smooth scrolling easy
  - Smooth scrolling horizontally via custom character set patterns

Atari 5200 (1982)

- Sort of a Atari 400/800 without a keyboard
- Not totally compatible
- Had trouble with new analog joysticks
  - Hard to center
- Atari paid more attention to 2600 line
- Discontinued in 1984

Commodore 64 (1982)

- ≈1 MHz MOS 6510 (close relative of 6502)
- 64K RAM
- Discontinued 1984
  - Followed up by many variations
- Classic sound chip: SID
- Launch price: $595

Commodore 64 - Graphics

- MOS VIC-II graphics chip
- 160x196, 16 colors
- 8 sprites
  - 8x8 or 8x16
  - Stretching: horizontal (1x, 2x) or vertical (1x, 2x, 4x, 8x)
  - Mirroring: horizontal and vertical
  - Collision detection: sprite to sprite, sprite to background, sprite to screen border
  - Priority: in front of or behind background
- Smooth scrolling
The Video Game Crash of 1984 (1)

- Partially arose from a cascade effect of Atari’s hubris
- E.T. rushed to market in only 5 weeks to hit stores in time for holiday season
  - Widely considered Worst Game Ever
  - Atari paid $20-25 million for the rights
    - 8th best selling Atari cartridge of all time
    - 4 million manufactured
- Rushed, weak port of Pac-Man
  - 12 million manufactured
  - Only 10 million Ataris in homes at the time
    - Atari assumed people would buy 2600s to play Pac-Man
  - 7 million sold
  - Ms. Pac-Man port & homebrew Pac-Mans are better

Photo and info from Wikipedia

The Video Game Crash of 1984 (2)

- Millions of cartridges of E.T. and Pac-Man encased in concrete and secretly dumped in landfill
- In 1982, Atari CEO Ray Kassar sells off 5,000 of his Warner (Atari’s parent company) stock just before a low earnings report drops Warner stock by 40%
  - SEC investigated for insider trading
  - Settled, returned profits
  - Later cleared by SEC
  - Forced to resign in 1983

Info from Wikipedia

Nintendo NES (1985 U.S. release)

- ≈1.8 MHz 6502 core, with DMA controller and sound hardware on-die (Ricoh)
- Called “Famicom” in most of Asia (1983 in Japan)
- Bundled with Super Mario Bros. - “killer app”
- Launch price: $200; final bundle: $50
- Discontinued in 1995
- 62 million sold
- Competition:
  - Sega SG-1000 (1985 Japan)
  - Renamed Sega Master System (1986 U.S.)
    - Didn’t catch on in the U.S.
  - Atari 7800 - last gasp, bombed

Pics and info from Wikipedia

Nintendo NES - Graphics

- Ricoh-made “Picture Processing Unit”
  - ≈5.4 MHz, RP2C02
- 256x240 resolution
- 64 sprites (8x8 or 8x16 for all), 8 per scanline
- Tile patterns
- 25 colors per scanline:
  - 1 background
  - 4 sets of 3 tile colors
  - 4 sets of 3 sprite colors

Photo and info from Wikipedia
Sega vs. Nintendo

- Young Bobby Engles
  - http://www.youtube.com/v/GWaU-6juWik
- Blast Processing
  - http://www.youtube.com/v/K03fQKkN7Vl
- Genesis Does what Nintendon’t
  - http://www.youtube.com/v/k7nsBoqJ6s8

Sega Genesis (1989)

- ≈7 MHz Motorola 68000
- ≈3.5 MHz Zilog Z80
  - Sound coprocessor
  - Backward compatibility with Sega Master System
- 64K main RAM for 68000
- 64K video RAM, not directly accessible
- 8K secondary RAM for Z80
- 8K audio RAM
- ROM cartridges up to 4M
  - Can use bank switching for larger games
- Released as “Sega Mega Drive” in Japan (1988)
- 29 million sold

Sega Genesis - Video

- “Video Display Processor”
- 320x224 resolution (complicated)
- 4 planes (2 scrolling playfields, 1 sprite plane, 1 ‘window’ plane)
- Up to 64 sprites
- 61 on-screen colors
- Nintendo’s answer, the Super NES, came later
  - 1990 Japan, 1991 U.S.
  - 49 million sold
  - Slower CPU, but nice graphics & audio chips

IBM PC compatibles

- Original IBM PC (1981)
  - ≈4.8 MHz 8088
  - 16K to 640K
  - CGA (640x200 B&W, 320x200 4-color, 160x100 16-color w/tricks)
- IBM PC AT (1984)
  - 6 MHz 80286, later 8 MHz
  - 256K to 16M
  - EGA (640x350 16-color)
- VGA (1987)
  - 640x480, 16-color
  - Expansion slots
- Killer app: Lotus 123
Doom (1993)

- Followed in footsteps of Wolfenstein 3-D (1992)
- Released as shareware!
  - Downloaded by 10 million people in two years
- Cleverness over hardware

Images and info from Wikipedia