Project Ideas

…anything digital?

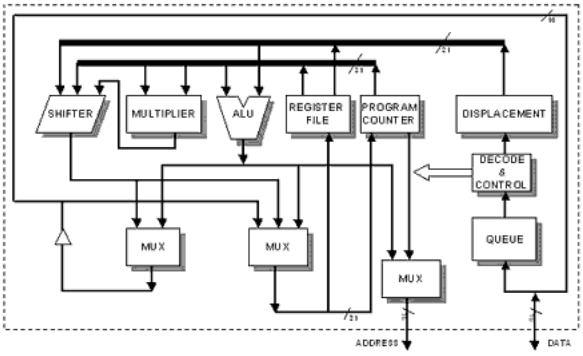
… something that's "interesting enough?"

What have people done?

- Lots of variations on processors
  - Usually 16-bit
  - Usually custom RF, perhaps custom ALU
  - Usually distinctive I/O
    - R/W pins, memory mapped I/O, UART, VGA, LCD, PS/2, etc.
- Some quite customized
  - CORDIC processor
  - Controller for a light-based toy
  - Stack-based processor
  - Communicating multiprocessor node

Processor Info

- Lots of good information on the CS/ECE 3710 class web site
  - http://www.eng.utah.edu/~cs3710/
  - OR http://www.ece.utah.edu/~kalla/index_3710.html



Baseline 3710 ISA

- ADD, ADDI, SUB, SUBI
- CMP, CMPI
- AND, ANDI, OR, ORI, XOR, XORI
- MOV, MOVI
- LSH, LSHI (restricted to shift of one)
- LUI, LOAD, STOR
- Bcond, Jcond, JAL

Class Encoding

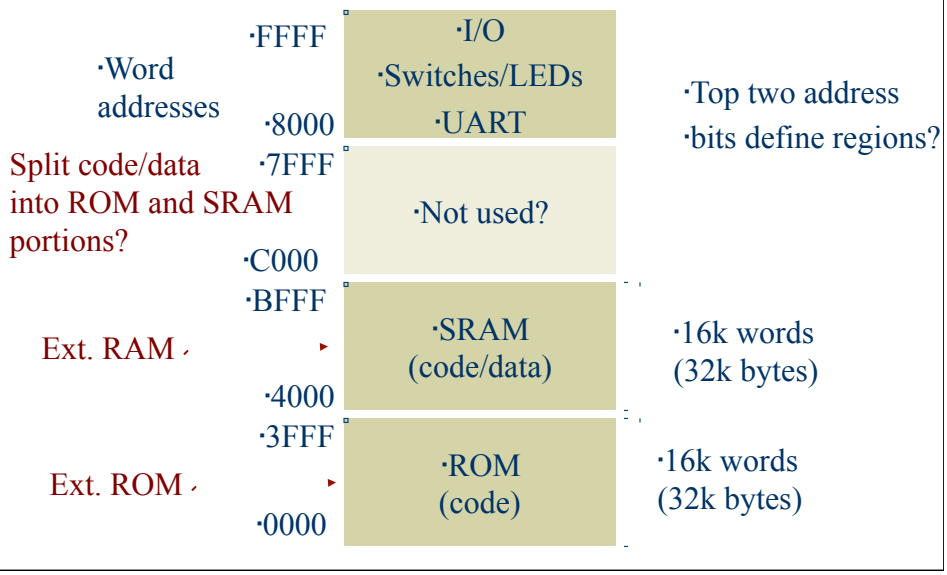
- In the handout on the web
- Much more regular than real CR16

		OP Code	Rdest	ImmHi/ OP Code Ext	ImmLo/ Rsrc	
Mnemonic	Operands	15-12	11-8	7-4	3-0	Notes (* is Baseline)
ADD	Rsrc, Rdest	0000	Rdest	0101	Rsrc	*
ADDI	Imm, Rdest	0101	Rdest	ImmHi	ImmLo	* Sign extended Imm
ADDU	Rsrc, Rdest	0000	Rdest	0110	Rsrc	
ADDUI	Imm, Rdest	0110	Rdest	ImmHi	ImmLo	Sign extended Imm
ADDC	Rsrc, Rdest	0000	Rdest	0111	Rsrc	
ADDCI	Imm, Rdest	0111	Rdest	ImmHi	ImmLo	Sign extended Imm
MUL	Rsrc, Rdest	0000	Rdest	1110	Rsrc	
MULI	Imm, Rdest	1110	Rdest	ImmHi	ImmLo	Sign extended Imm

Memory Map

- 16 bit PC and LOAD/STOR addresses
  - 64k addresses
  - Each address is a 16-bit word
  - So, 128k bytes of data, but organized as words
    - Clearly this needs to go off chip!
  - You probably need to reserve some I/O addresses
    - Up to you, but I recommend using the some top address bits
    - Upper 16k words (32kbytes) as I/O space?
  - You probably need to reserve some part of the address space for boot ROM
    - Up to you, but I recommend low addresses

Example Memory Map



RAM/ROM chips

- Lots of them out there!
  - Be careful – 5v Vdd is not all that common any more
- I have some of these…
  - Cy7C199-35: 32kx8 SRAM
    35ns access time = 28MHz max for one-read-per-cycle
  - 27C256: 32kx8 EPROM
    55ns access time = 18MHz max for one-read-per-cycle
  - Maybe you don't need one read per cycle…

What have people done?

- Application-specific circuits
- Many look a little processor-like…
  - Bike speedometer/odometer
  - Basketball scoreboard display (to VGA output)
  - Fingernail pressure sensor
  - Musicman tone generator
  - Waveform generator
  - Encryption/decryption
  - Digital metronome

What have people done?

- Circuits for parts of a more complex system
  - 2-way set-associative Cache controller with LRU replacement
  - Memory management unit for virtual memory system
  - Gshare branch predictor
  - Asynchronous FIFO
  - Asynchronous network interface
  - Network-on-chip router

What have people done?

- Hard-coded games
  Usually with VGA output
  Usually with very few colors
  - Snake
  - Bomb/Minesweeper
  - Pong
  - Tetris
  - Tic Tac Toe
  - Life

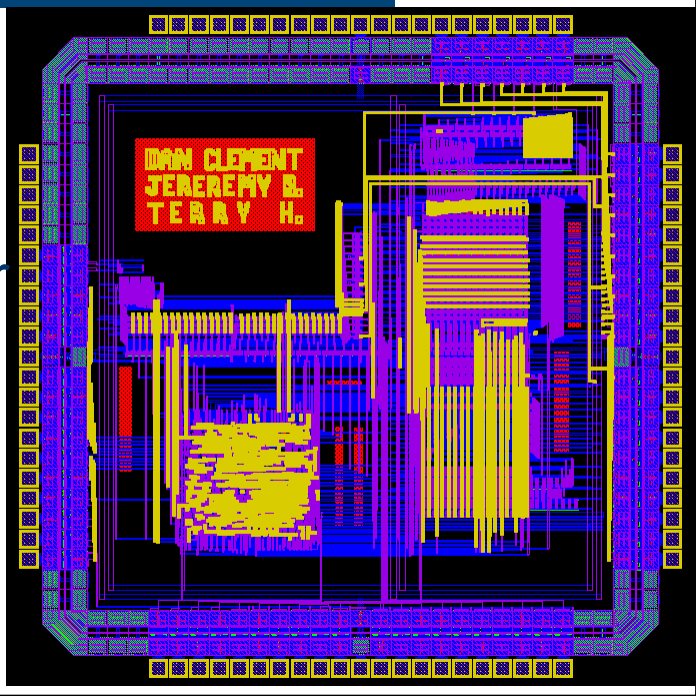
What have people done?

- Arithmetic circuits
  - Floating point multiplier
  - Floating point divider
  - Triangle intersection computation
  - Cross-product generator
  - Bilinear interpolation function unit

Other ideas…

- There are lots of interesting chips to interface to!
  - MAX7219 LED driver – drives up to 64 LEDs, can be chained together
  - LCD controller – many are based on a HD44780U controller so they'll be a standard interface
  - Hobby servos are controlled by PWM
  - Stepper motor controllers – build a CNC controller?
  - Go to Sparkfun.com, Adafruit.com, or RobotShop.com and look around!
- Lots of interesting protocols to explore
  - SPI, I2C, Serial (UART), VGA, PS/2, etc.

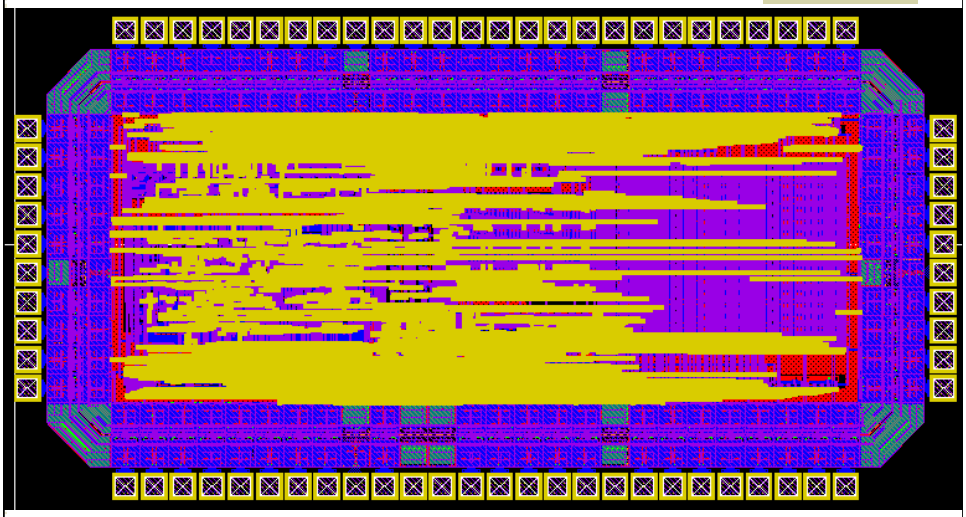
16-bit processor



·Approx 18,500 transistors

·3mm on a side

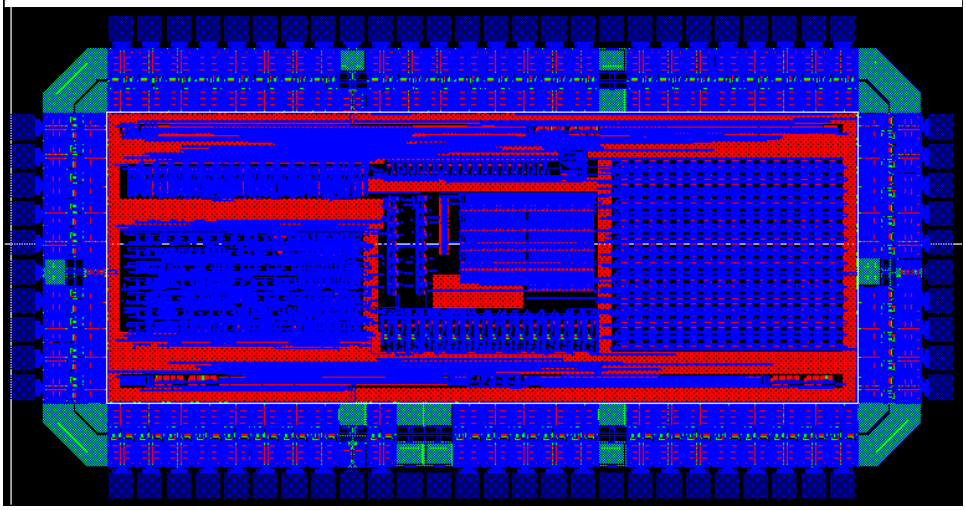
Another processor



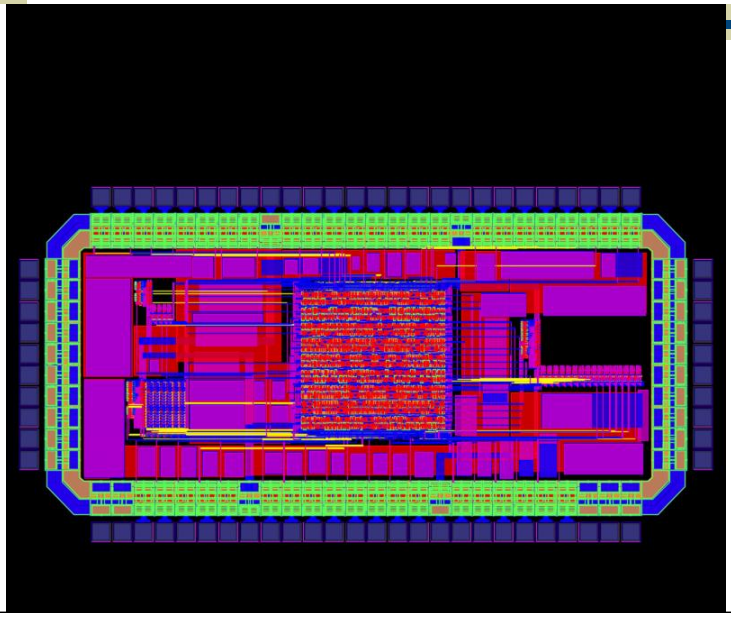
·16-bit Processor, approx 27,000 transistors

Same Chip (no M2, M3)

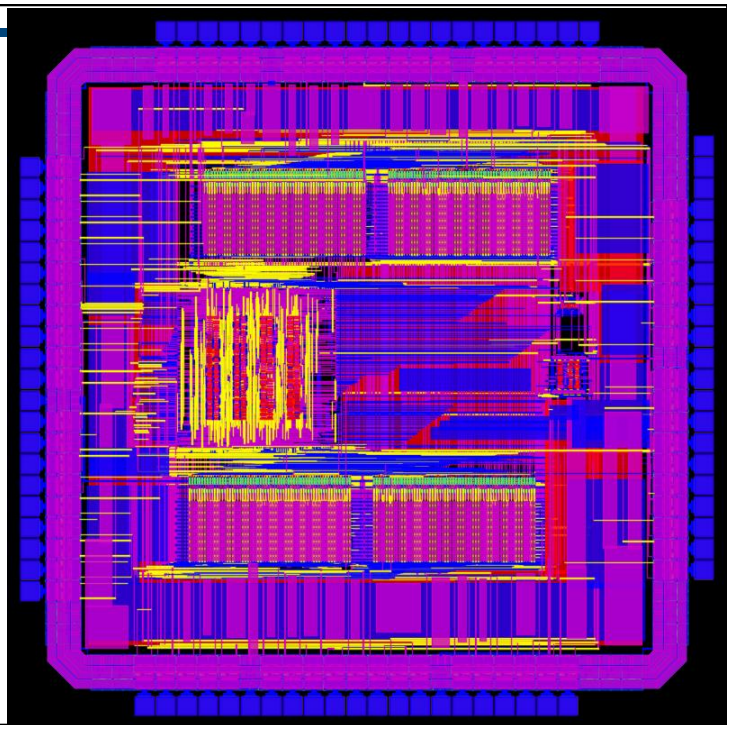
·1.5mm x 3.0mm, 72 I/O pads



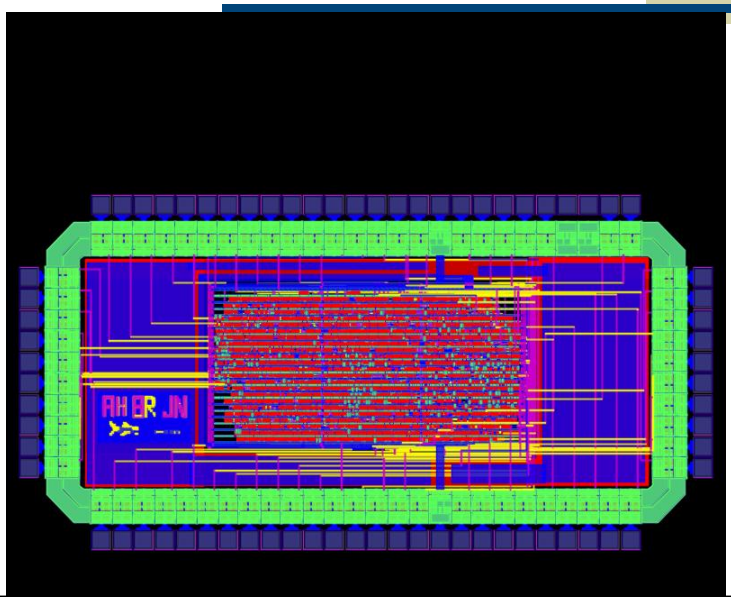
Processor?



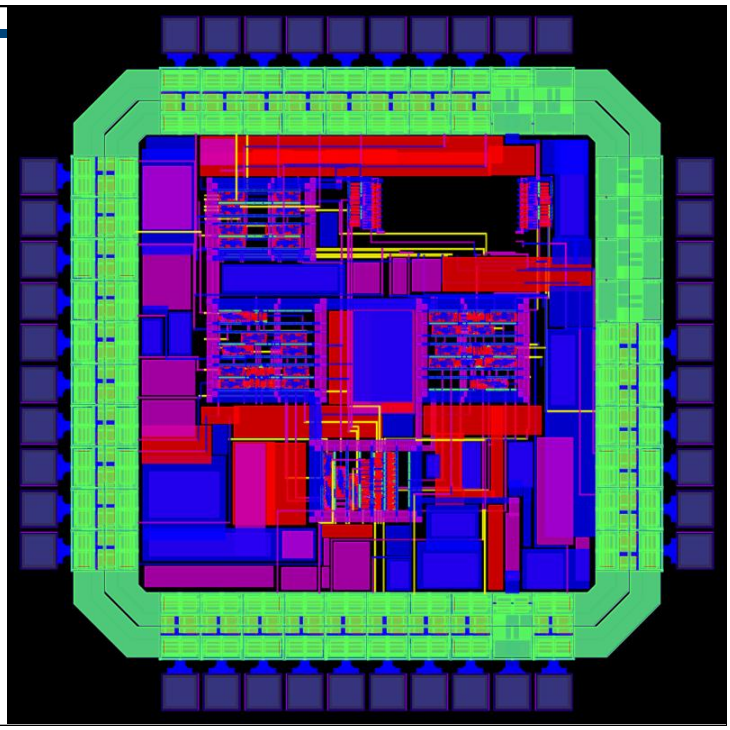
Processor ?



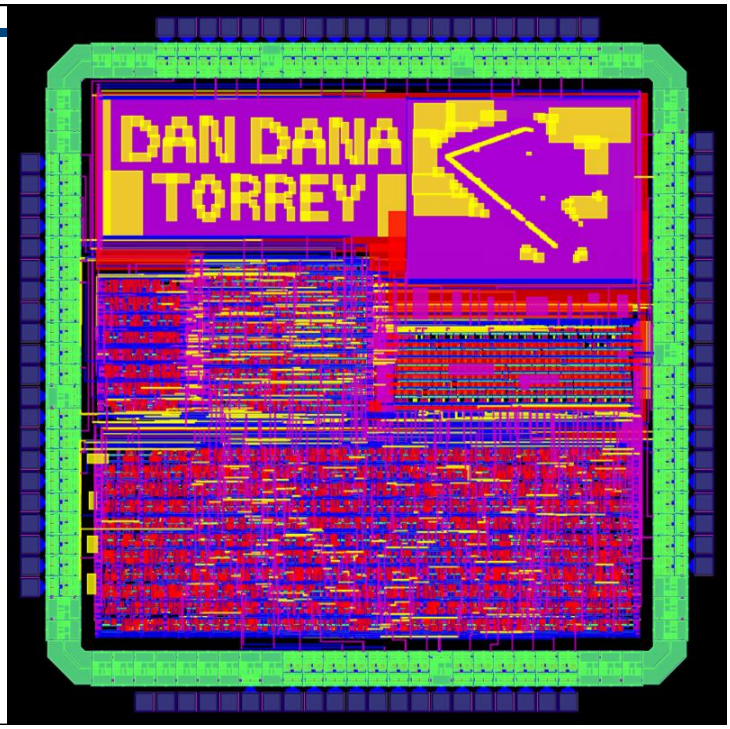
Processor



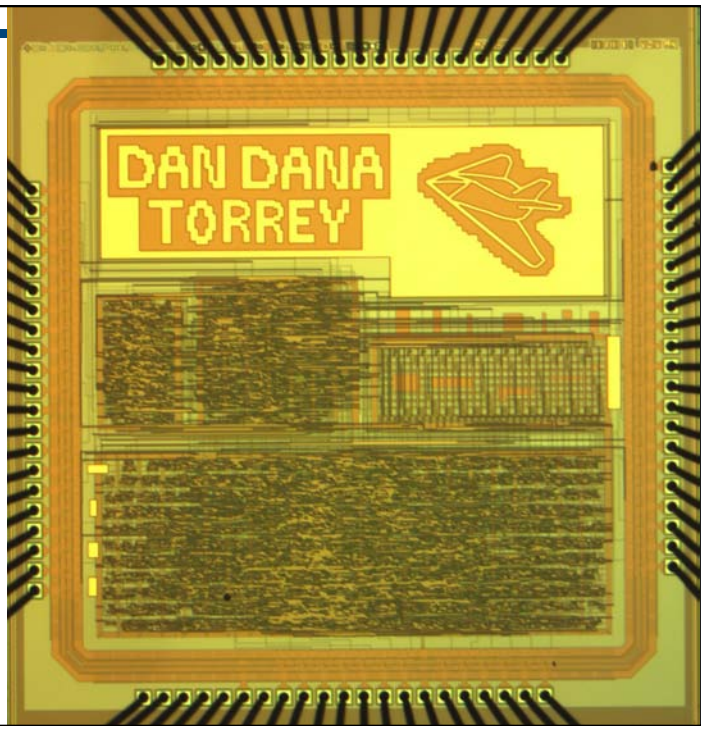
Asynchronous FIFO



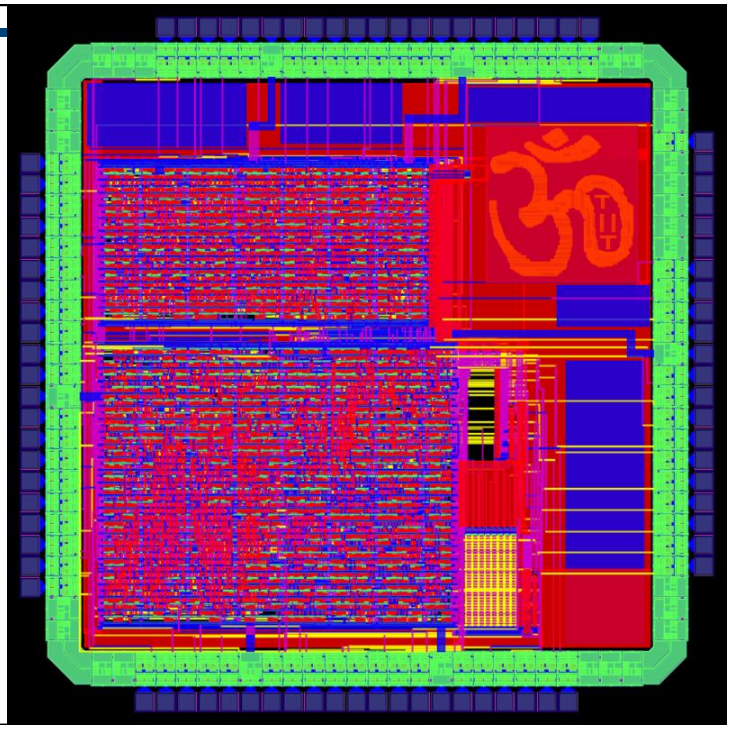
Array multiplier with testing circuitry



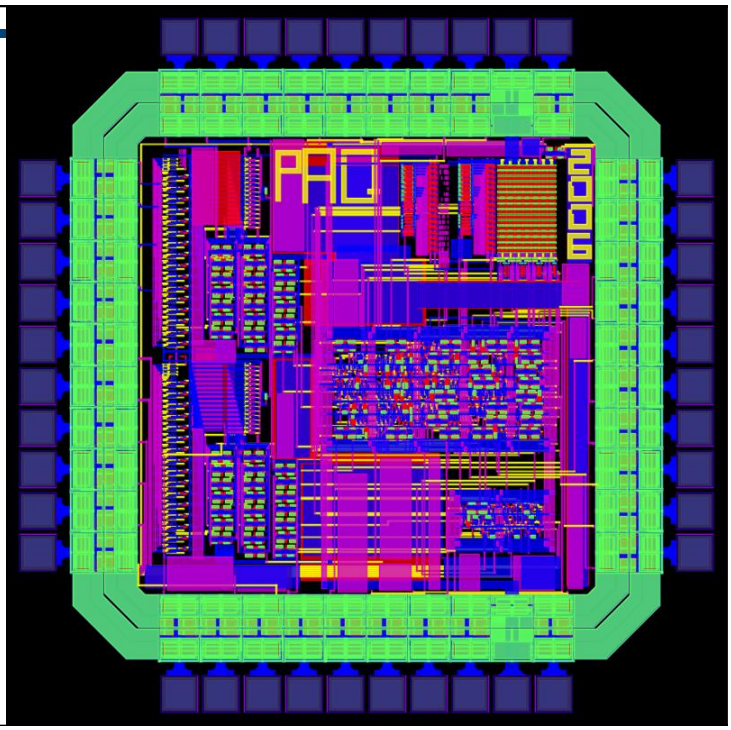
Array multiplier with testing circuitry



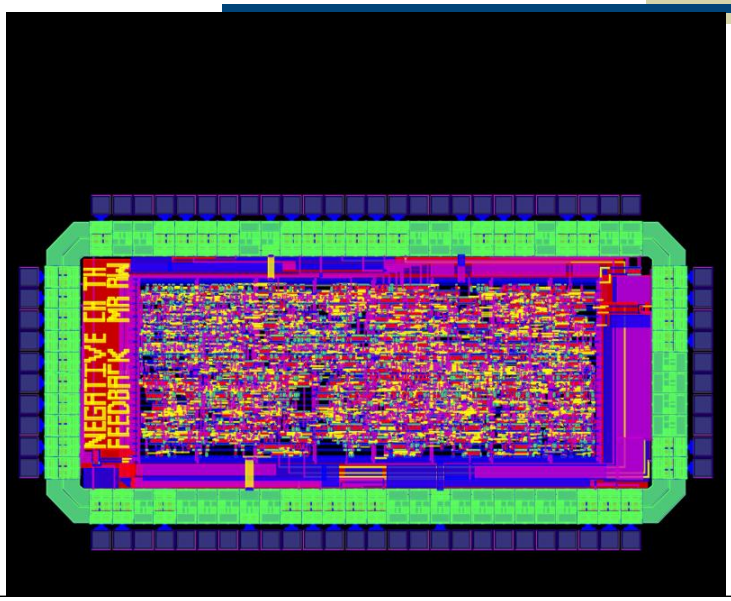
Processor



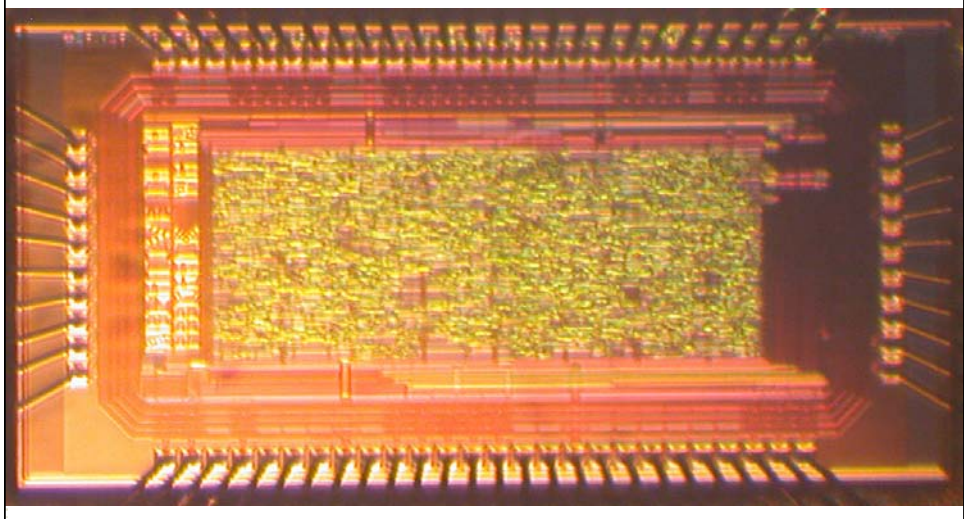
Waveform Generator



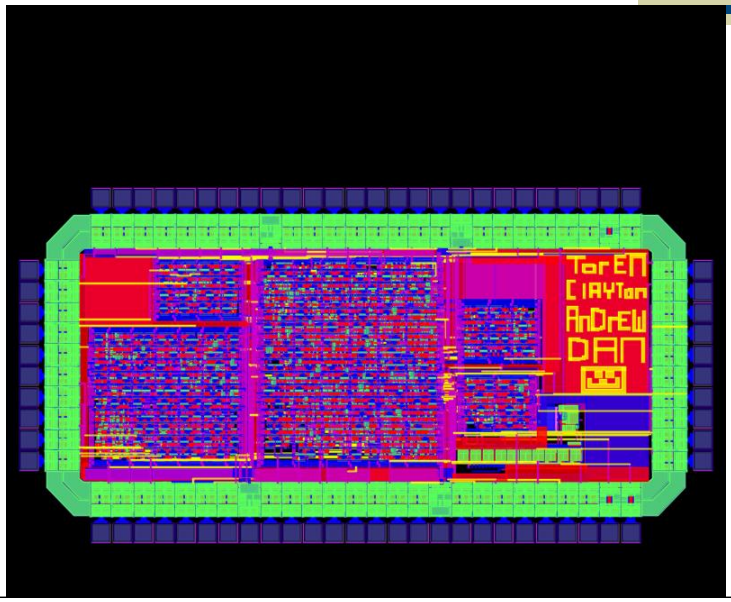
Pong



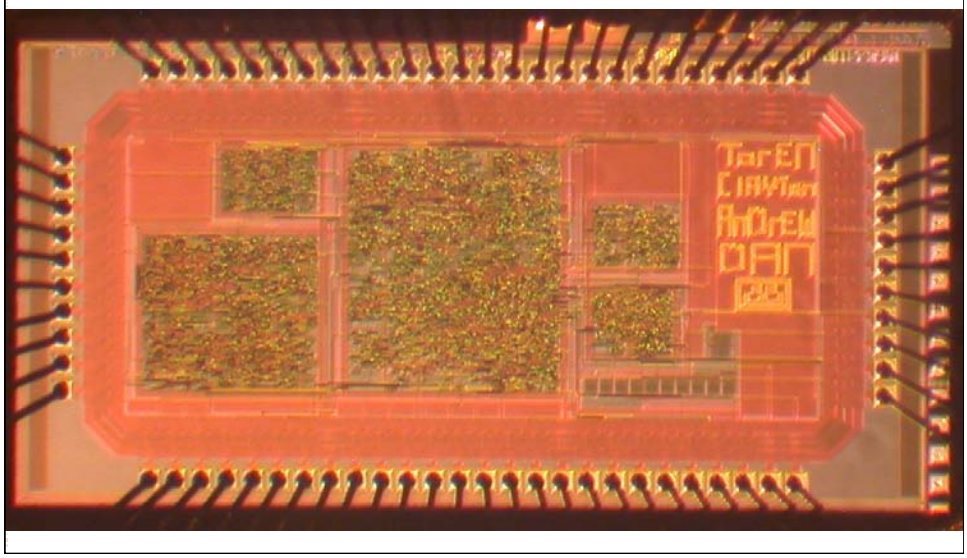
Pong



Processor



Processor



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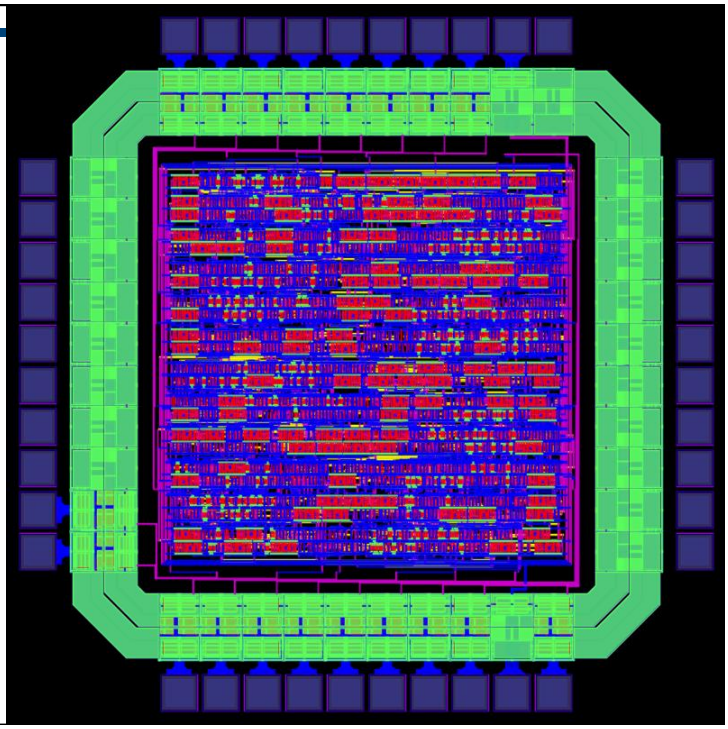
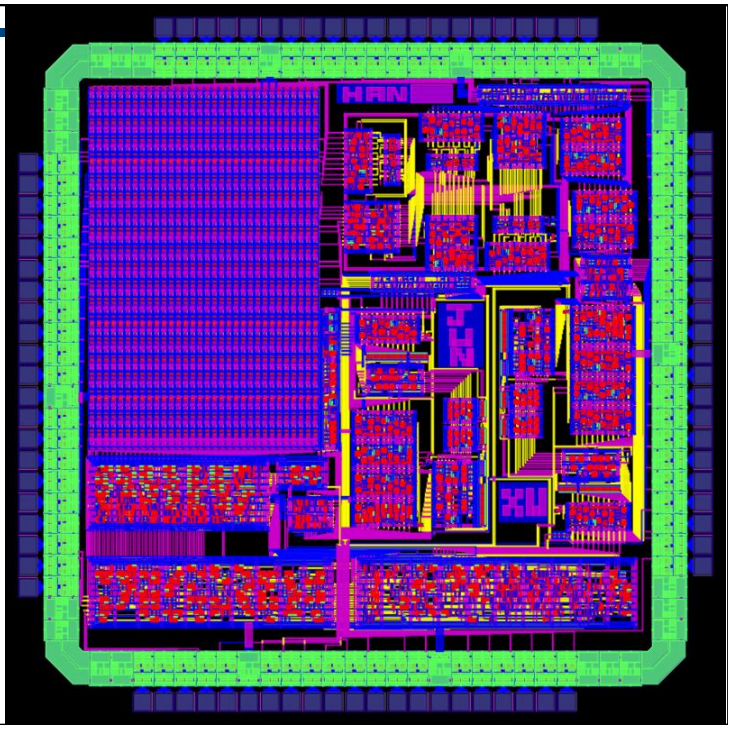
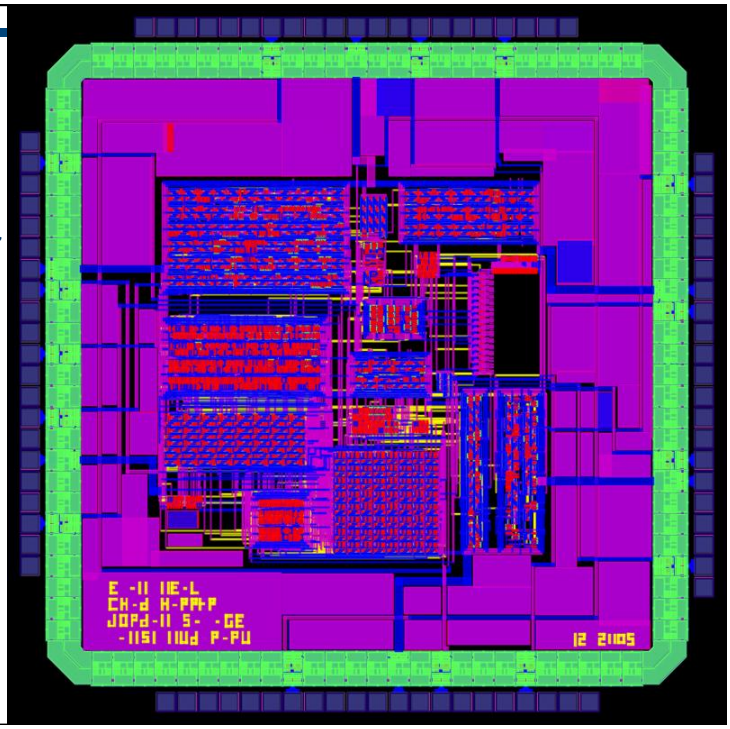


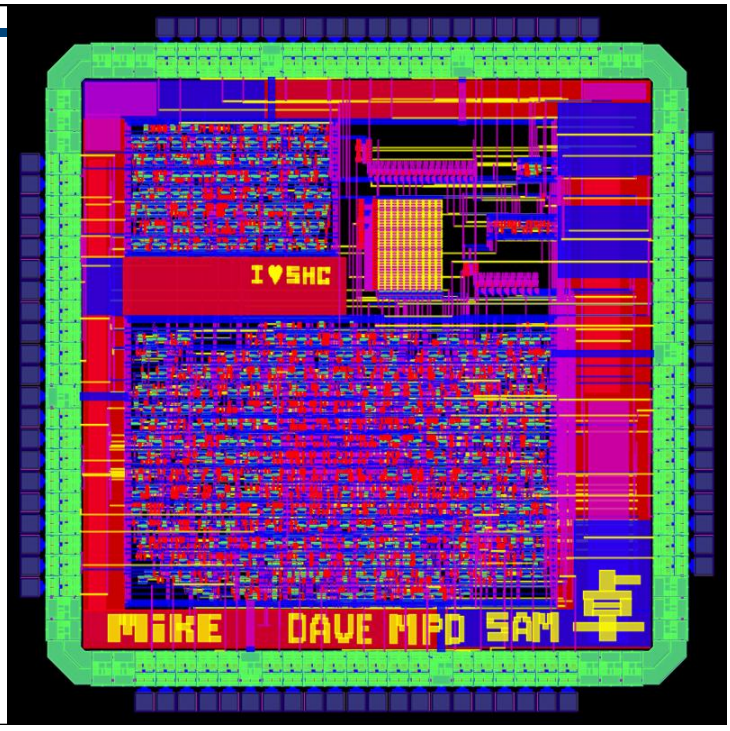
I Don't Remember …



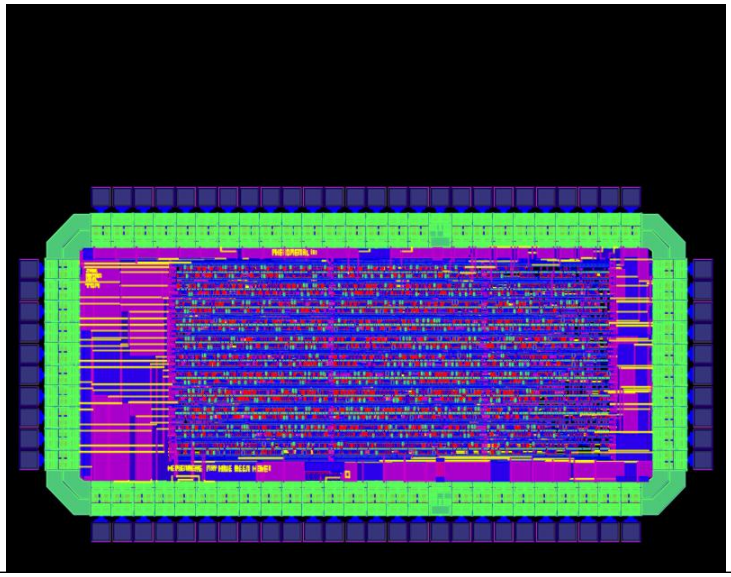
Minesweeper



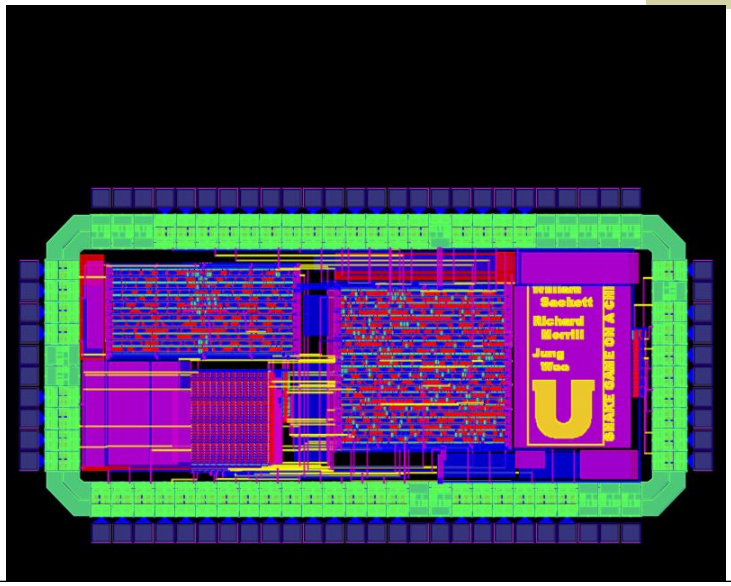
Bike Computer



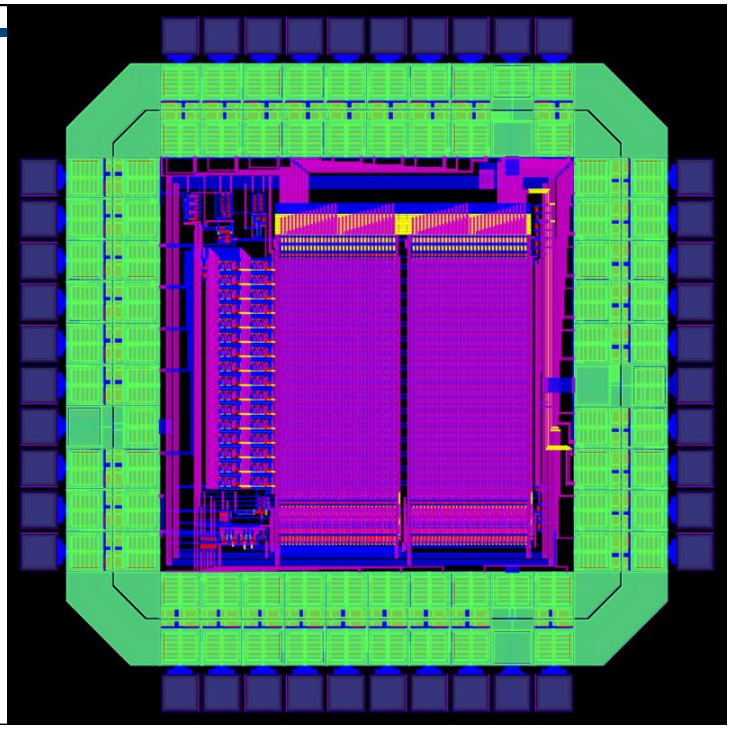
Stack Processor



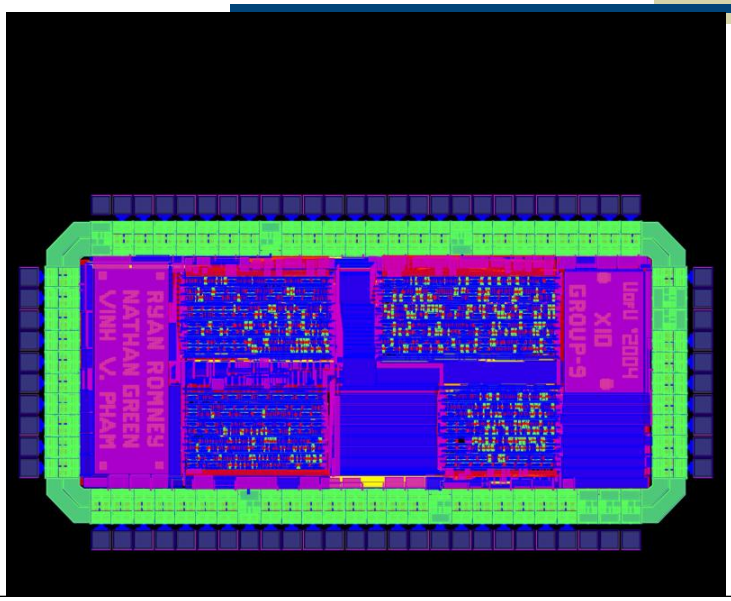
Snake Game



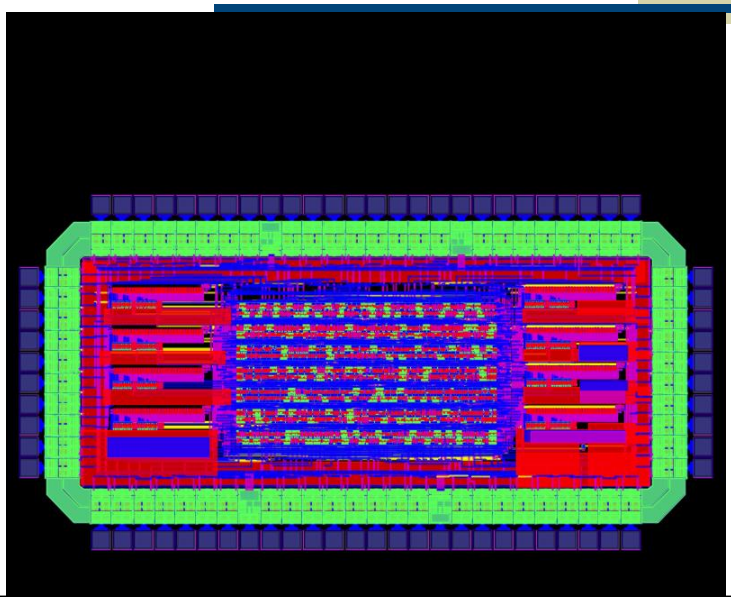
SRAM



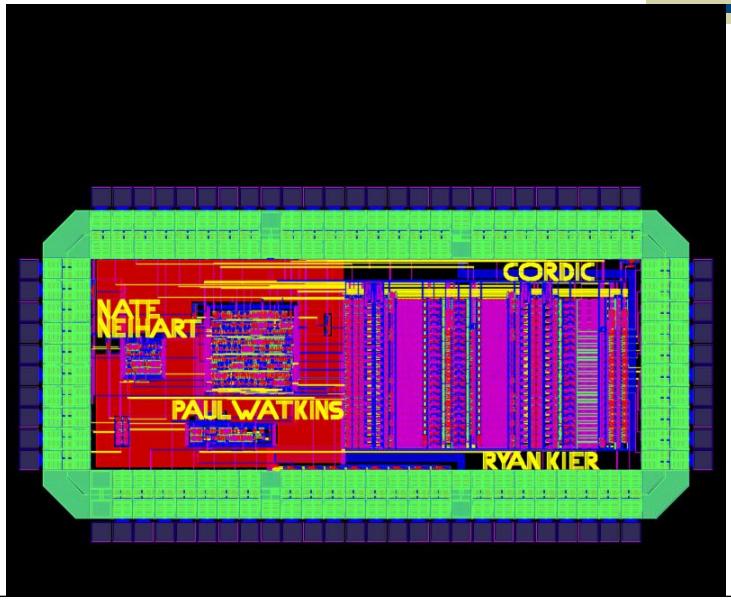
X10 home automation controller



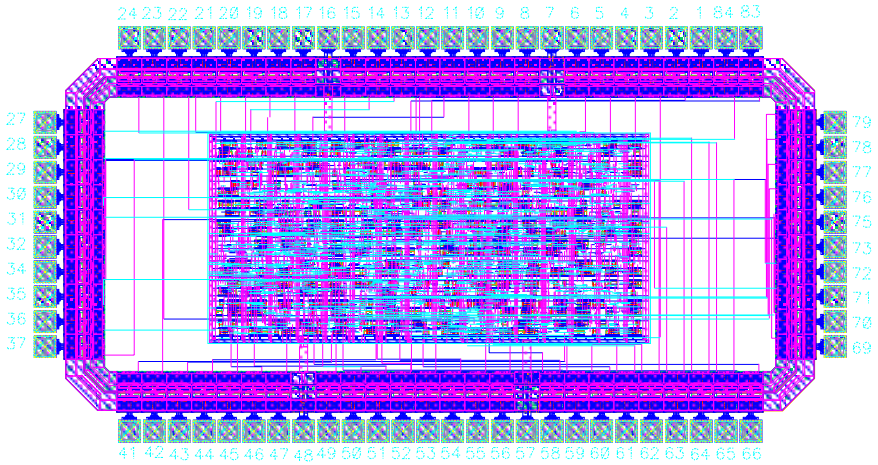
DES encrypt/decrypt



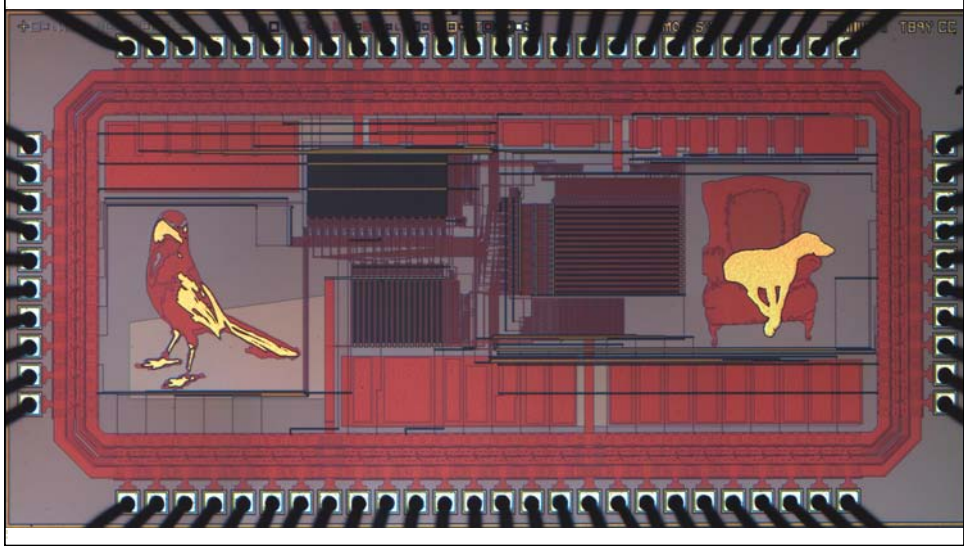
16-bit CORDIC processor



Life Processor/Game

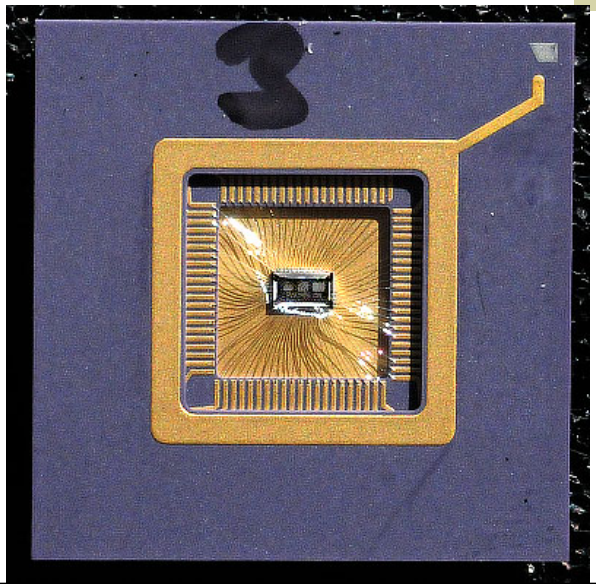


More Pictures of Chips



More Pictures of Chips

Chip in Package



My First Chip