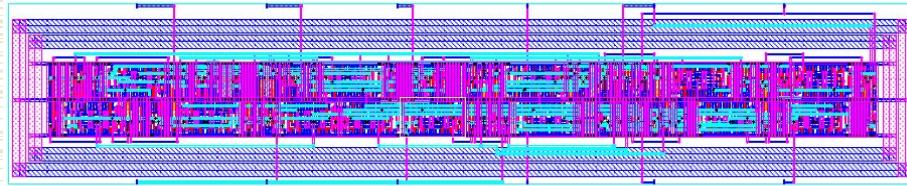


CS/ECE 5710/6710

Digital VLSI Design



Transistors are Tiny

- ◆ The Red part (the “gate”) is 0.5 microns
 - 0.5 microns = 0.0000005 meters
= 1/50,000 of an inch
 - Human hair = 100 microns
0.5 microns = 1/200 of a human hair
 - Modern chips are 0.045 microns (45nm)
 - 0.032 microns (32nm) is coming!
 - ... then 22nm, then 16nm, then ...

Analogy – City Street Map

- ◆ 1 city block = 1 transistor
 - Assume 100m square for a city block
- ◆ City streets are the connecting wires
 - Imagine a block-detail map of a city
- ◆ That's what designing an Integrated Circuit is like
 - Of course, we have tools to help...

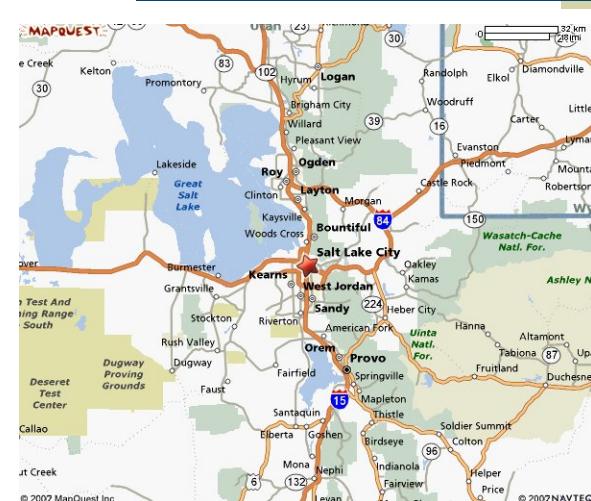
10,000 Transistors



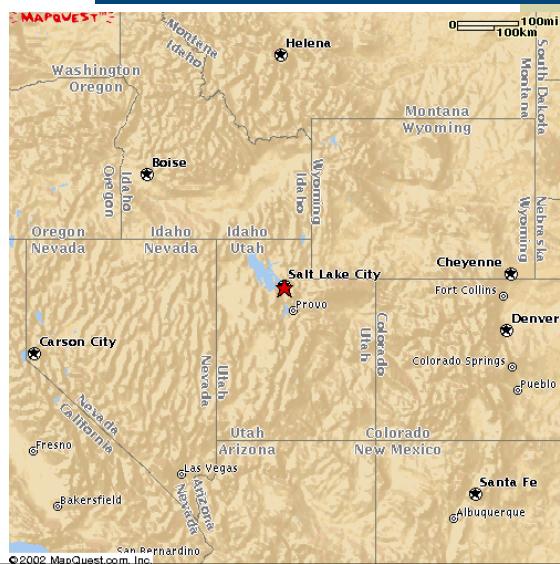
100,000 Transistors



1,000,000 transistors



10,000,000 transistors



100,000,000 Transistors



Are Chips Really that Big?

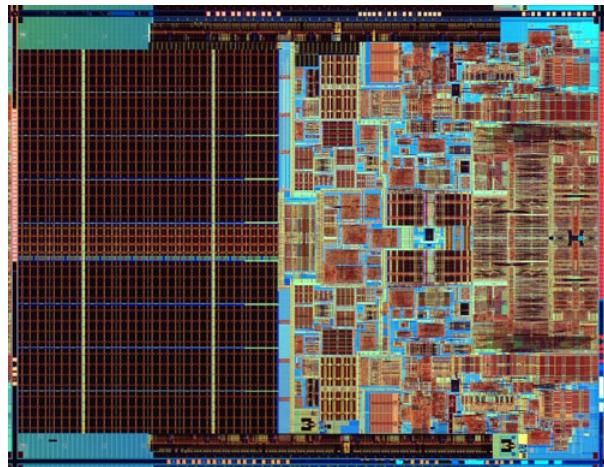
Chip	Date	Transistors	Feature Size
80286	1982	134,000	1.5 microns
80386	1985	275,000	1.5 microns
80486	1989	1,200,000	1.0 microns
Pentium	1993	3,100,000	0.8 microns
Pentium Pro	1995	5,500,000	0.6 microns
Pentium 3	1999	28,000,000	0.18 microns
Pentium 4	2001	42,000,000	0.13 microns
IA-64	2002	325,000,000	0.13 microns

Where are the Transistors?

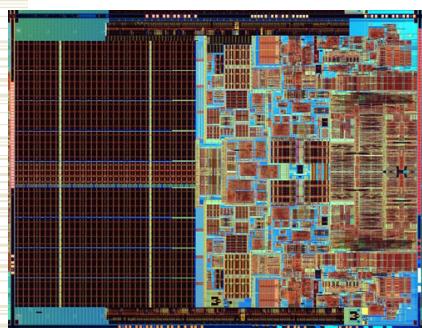
- ◆ That's a LOT of transistors
 - Core2 Duo has around 291,000,000 total transistors...
- ◆ Where are they used?
 - Mostly for memory!
 - Around 6 transistors per bit of memory
 - Intel Core2 Duo: 4MB shared L2 cache, 32K Icache 32K Dcache on each core
 - $4*1024^2*8 + 2(64*1024*8) = 34,603,008$ bits
 - $35,000,000$ bits * 6 = $210,000,000$ transistors
- Quad Core has around 820,000,000

Intel Core2 Duo

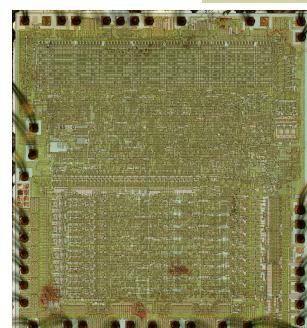
- ◆ 65nm process, 75W, 144 mm² die



Historical Comparison

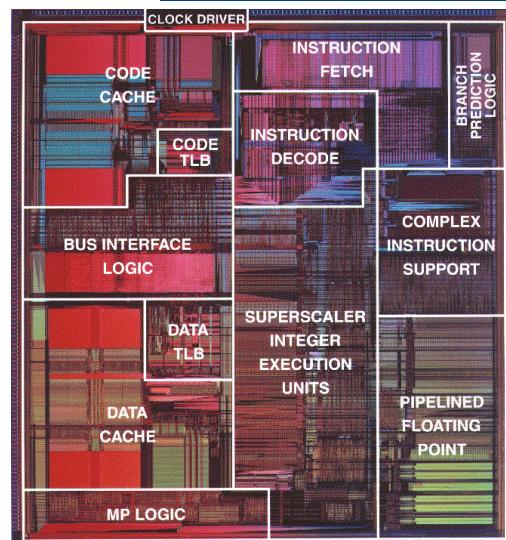


Core2 Duo
65nm devices
144mm² die
291,000,000 transistors
over 4MB (32Mbit) of on-chip storage
2200MHz

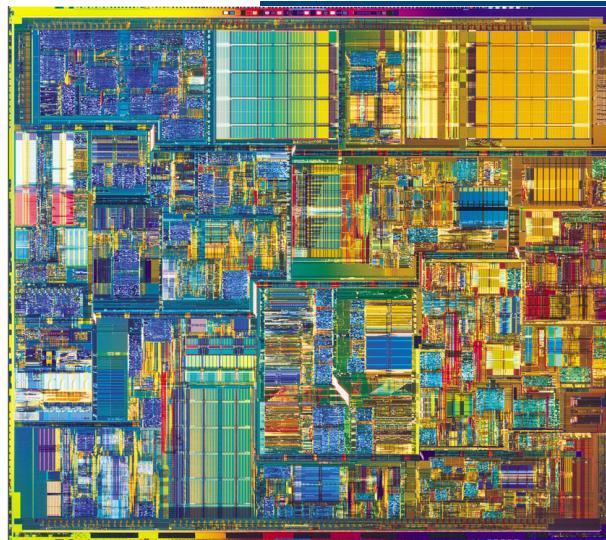


6502 (Apple II, Nintendo NES etc.)
6000nm devices (6 micron)
22mm² die
3510 transistors (nmos only)
56 total bits of state
1MHz

Pentium



Pentium 4



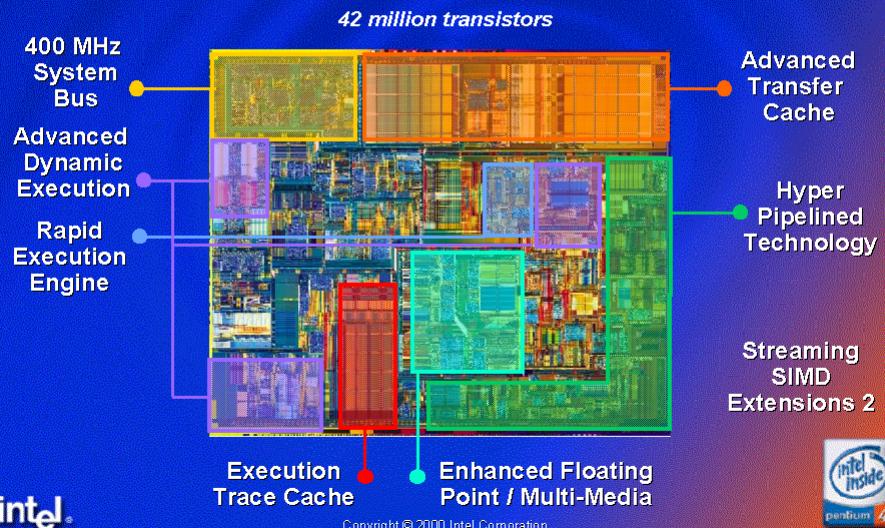
P4 Willamette

217 sq mm
0.18u CMOS

2 int doubleALU
2 FP units
8k L1 D-cache
L1 micro-op cache
256k L2 cache

50A @ 1.4GHz

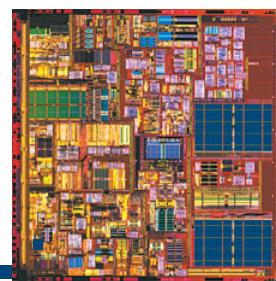
The Intel® Pentium® 4 Processor Takes A Leap Forward, Delivering...



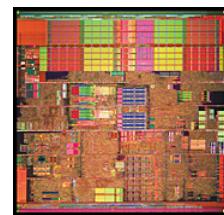
Lots of Pentium 4's



0.18u
180nm

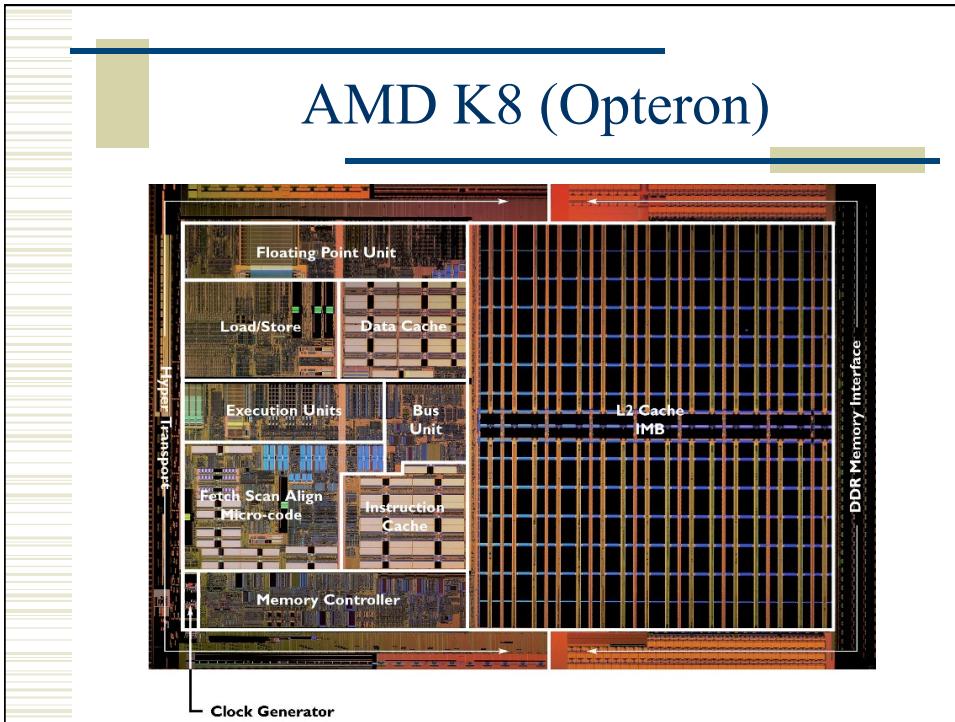


0.13u
130nm

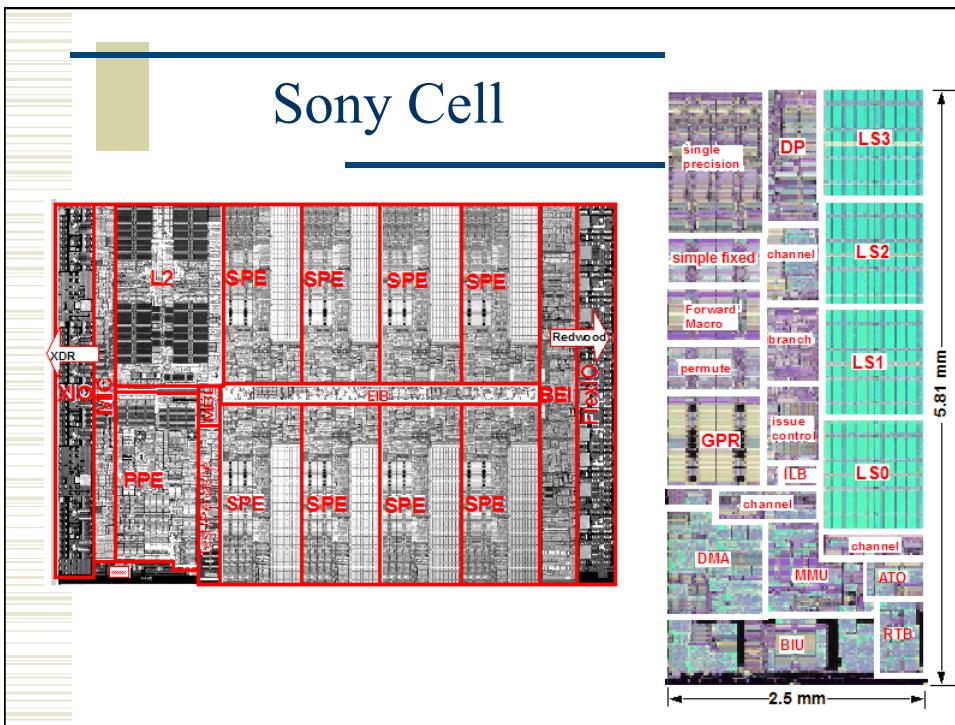


0.09u
90nm

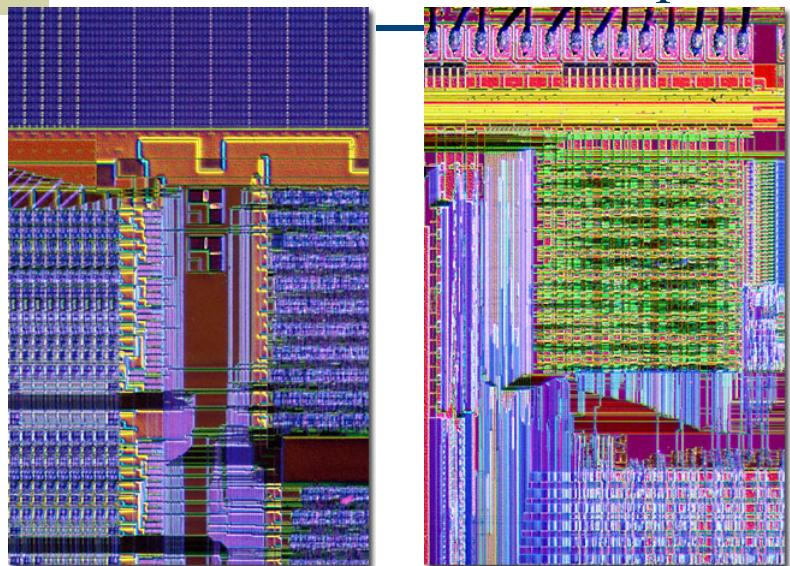
AMD K8 (Opteron)



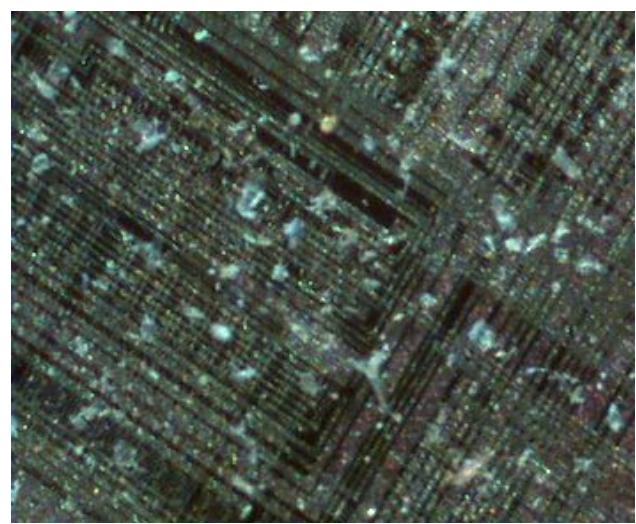
Sony Cell



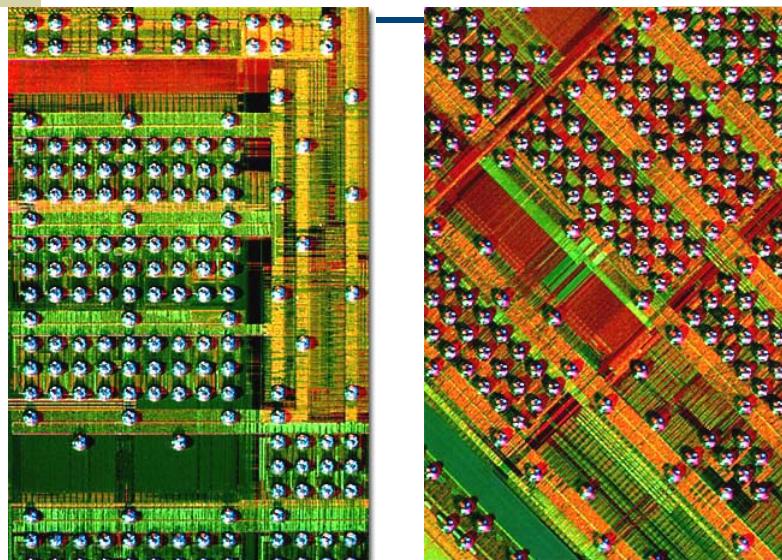
More Pictures of Chips



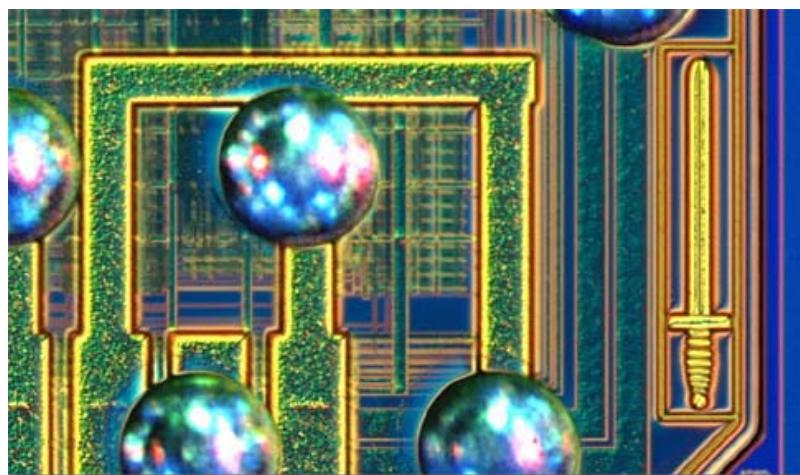
More Pictures of Chips



More Pictures of Chips



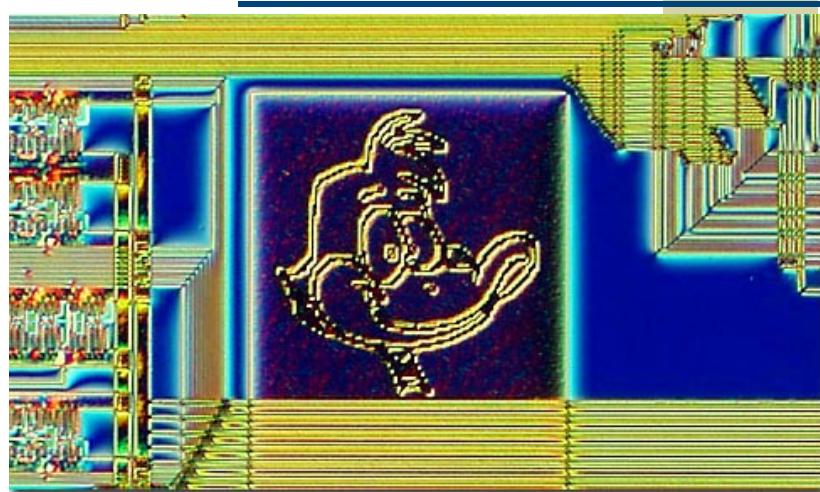
More Pictures of Chips



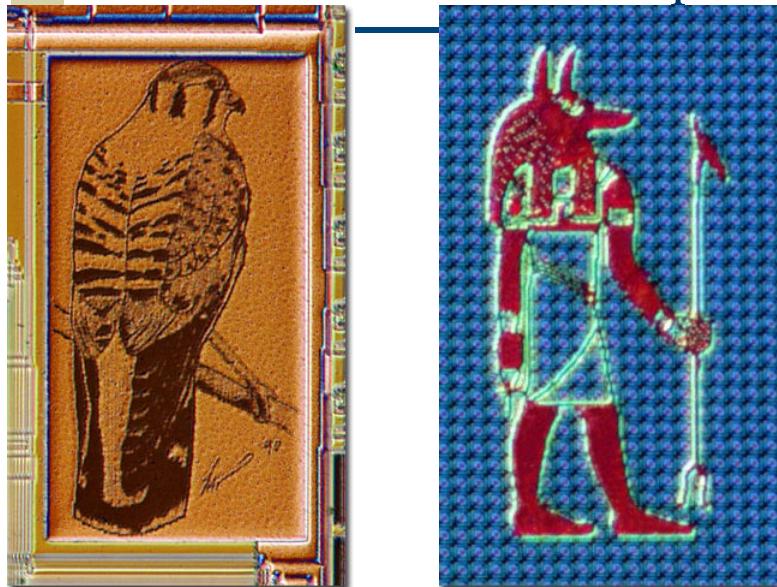
More Pictures of Chips



More Pictures of Chips



More Pictures of Chips



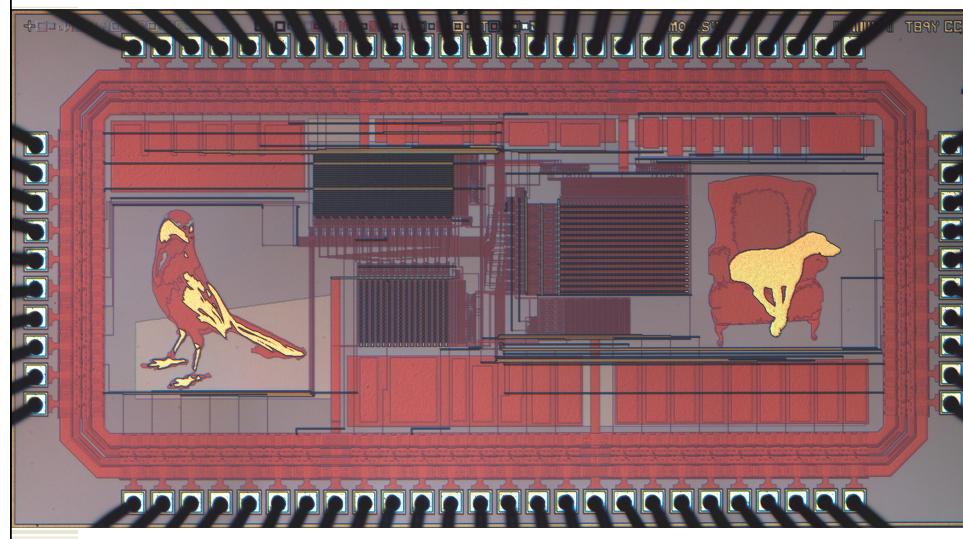
More Pictures of Chips



More Pictures of Chips



More Pictures of Chips



More Pictures of Chips



One More...

