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?

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

Intel Core2 Duo

- 65nm process, 75W, 144 mm² die
Pentium

- P4 Willamette
- 217 sq mm
- 0.18u CMOS
- 2 int double ALU
- 2 FP units
- 8k L1 D-cache
- L1 micro-op cache
- 256k L2 cache
- 50A @ 1.4GHz
Lots of Pentium 4’s

- 0.18u, 180nm
- 0.13u, 130nm
- 0.09u, 90nm
AMD K8 (Opteron)

Sony Cell
Apple A-8

Intel Ivy Bridge

3rd Generation Intel® Core™ Processor:
22nm Process

New architecture with shared cache delivering more performance and energy efficiency
Intel Haswell 8-core

Haswell 18-core version
Intel Xeon Phi coprocessor

Nvidia GK110 Kepler

7b transistors
More Pictures of Chips

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At The Leonardo
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