Design of Analog CMOS Integrated Circuits

<Chapter 1>

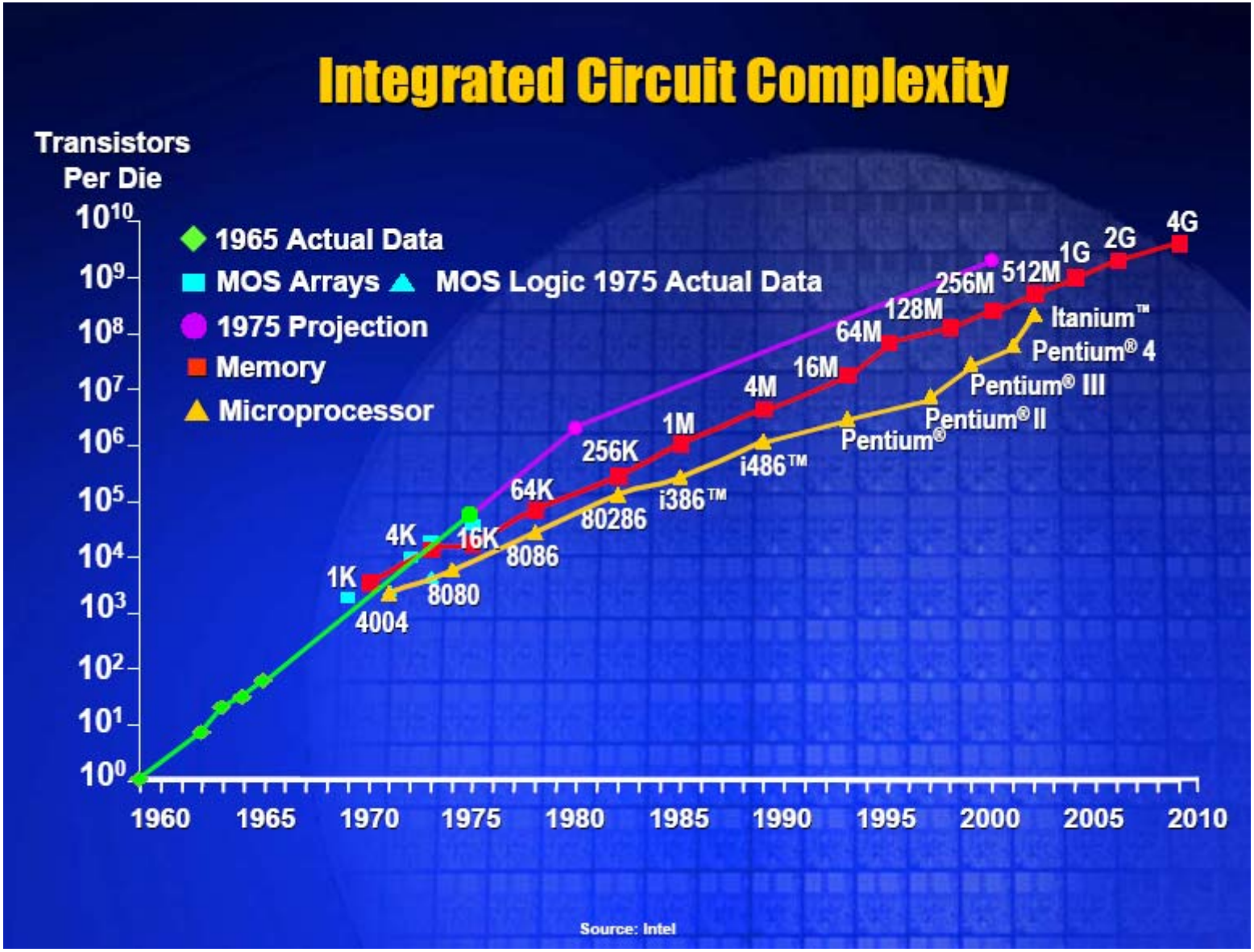
Introduction to Analog Design

양병도

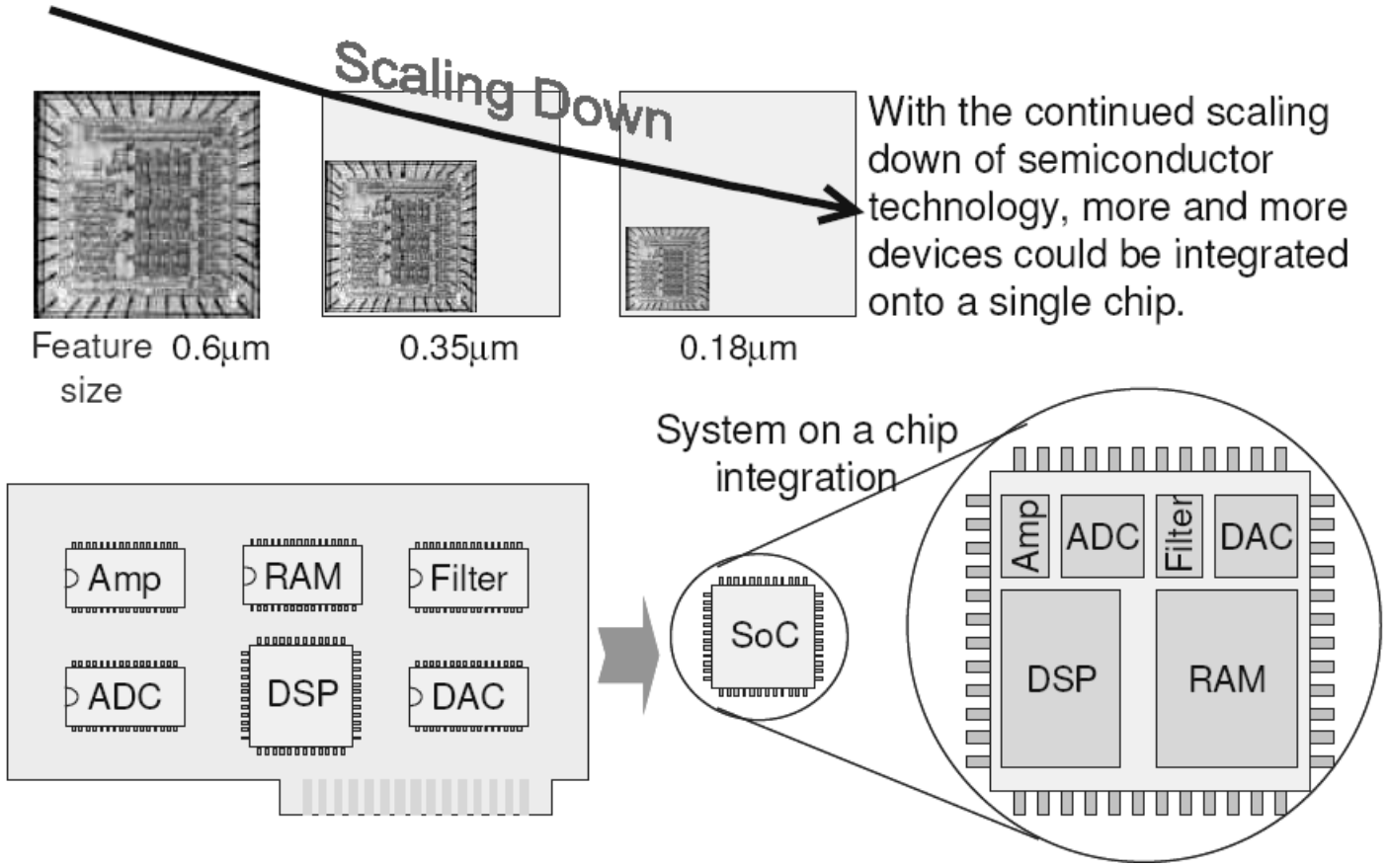
IC (Integrated Circuit) Trend

- Digital will take over System IC implementation
  - ✓ Two State(0, 1), Immune to Noise
  - ✓ Simple, Easy to Design, Reliable
  - ✓ CAD Tools

- System on-a-Chip
  - ✓ Scaling down of semiconductor technology
  - ✓ Combining Memory with Microprocessor or DSP Logic
  - ✓ System IC with Mixed Signal Technology
    - ➢ No more pure Analog Signal Processing


Integrated Circuit Complexity
Transistors
Per Die
10^{10}
10^{9}
10^{8}
10^{7}
10^{6}
10^{5}
10^{4}
10^{3}
10^{2}
10^{1}
10^{0}
1965 Actual Data
MOS Arrays
MOS Logic 1975 Actual Data
1975 Projection
Memory
Microprocessor
1K
4K
16K
64K
256K
1M
4M
16M
64M
128M
256M
512M
1G
2G
4G
4004
8080
8086
80286
i386™
i486™
Pentium®
Pentium® II
Pentium® III
Pentium® 4
Itanium™
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
Source: Intel

Integrated circuits of today

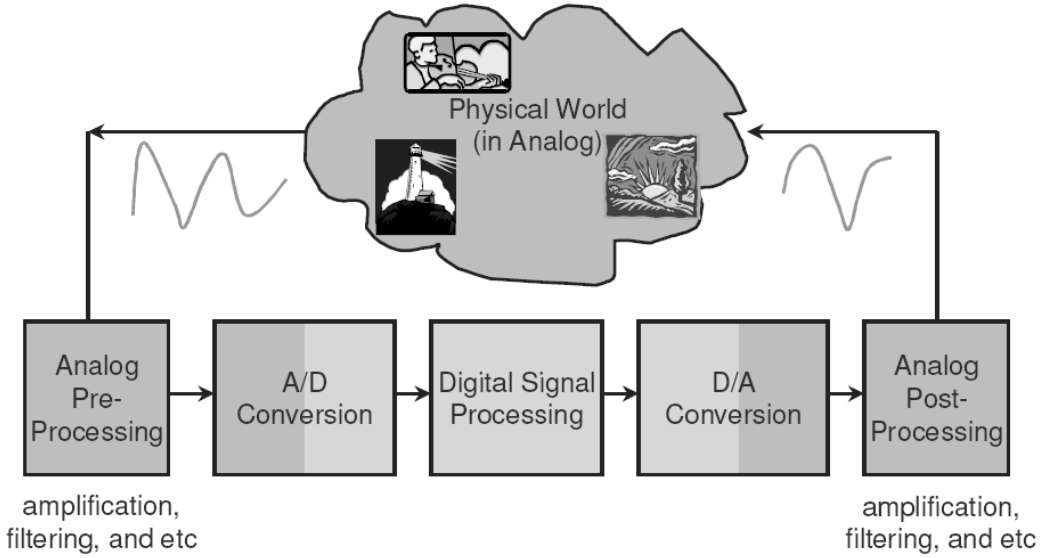


Analog design in a digital world

- Digital circuits:
  - ✓ Cost/function decreases by 29% each year
  - ✓ A factor 30 in 10 years
- Analog circuits:
  - ✓ Cost/function is constant
  - ✓ Lower supply voltage makes analog designs hard
- Transition to DSP !!

Why analog?

- Signal of Real World
  - ✓ Audio/Video (Nature) Signal
  - ✓ Flow, Pressure, temperature etc. (Physical Signal)
- Speed-Power Requirement
  - ✓ High Speed Analog Front-End



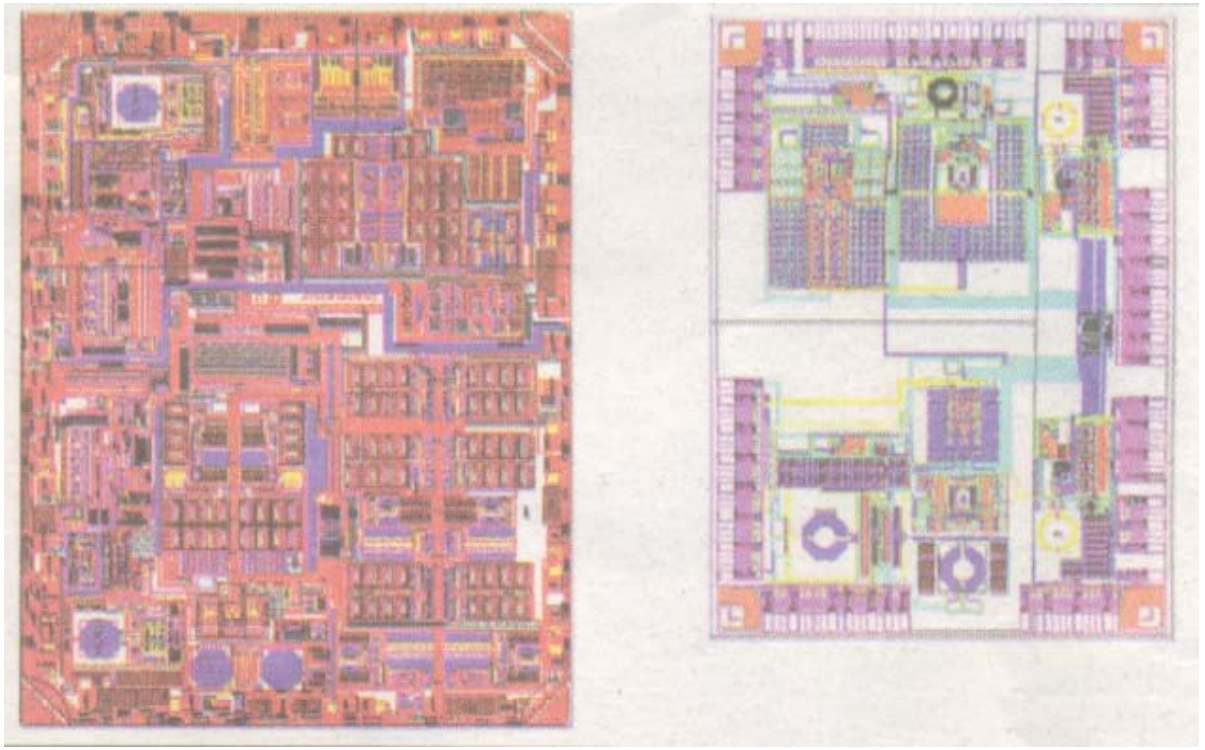
Analog Application

- General
  - ✓ Amplifier, Comparator, Sample-and-Hold,
  - ✓ Reference, Driver, ADC/DAC, PLL,
  - ✓ Sigma-Delta Codec, Filter, Mixer, Multiplier
- Communication
  - ✓ Codec, Modem, ISDN, LAN, FDDI,
  - ✓ Wireless RF, ATM, SONET, Ethernet
- Sensor
  - ✓ Image Sensor, Smart Sensor, MEM
  - ✓ Transducer, Neural Network
- Signal Processing
  - ✓ Audio/Video Signal Processing(Data Acquisition)
  - ✓ Disk Drive, Magnetic Recording, DVD

Why CMOS?

- Simple Process
  - ✓ CMOS helps scaling
  - ✓ CMOS vs. BiCMOS = 0.13 μm vs. 0.35 μm
- Small Die Area (Cost Effective)
- Low Power
- Integrate both analog and digital circuits in one chip
  - ✓ → System on a Chip

Layout example: RF circuit



0.35um BiCMOS

0.13um CMOS

-40% power -50% area