EC-310 Microprocessor and Microcontroller Based Design

Introduction to Course

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Outline

1. Historical Background
2. Moore's Law
3. Evolution of IC Technology
4. Evolution Tree of Microprocessors (μPs)
5. Key Features of Microprocessor (μPs) and Microcontrollers (μCs)
6. Typical Applications
7. Educational Need
8. Course Outline

EVOLUTION OF IC TECHNOLOGY

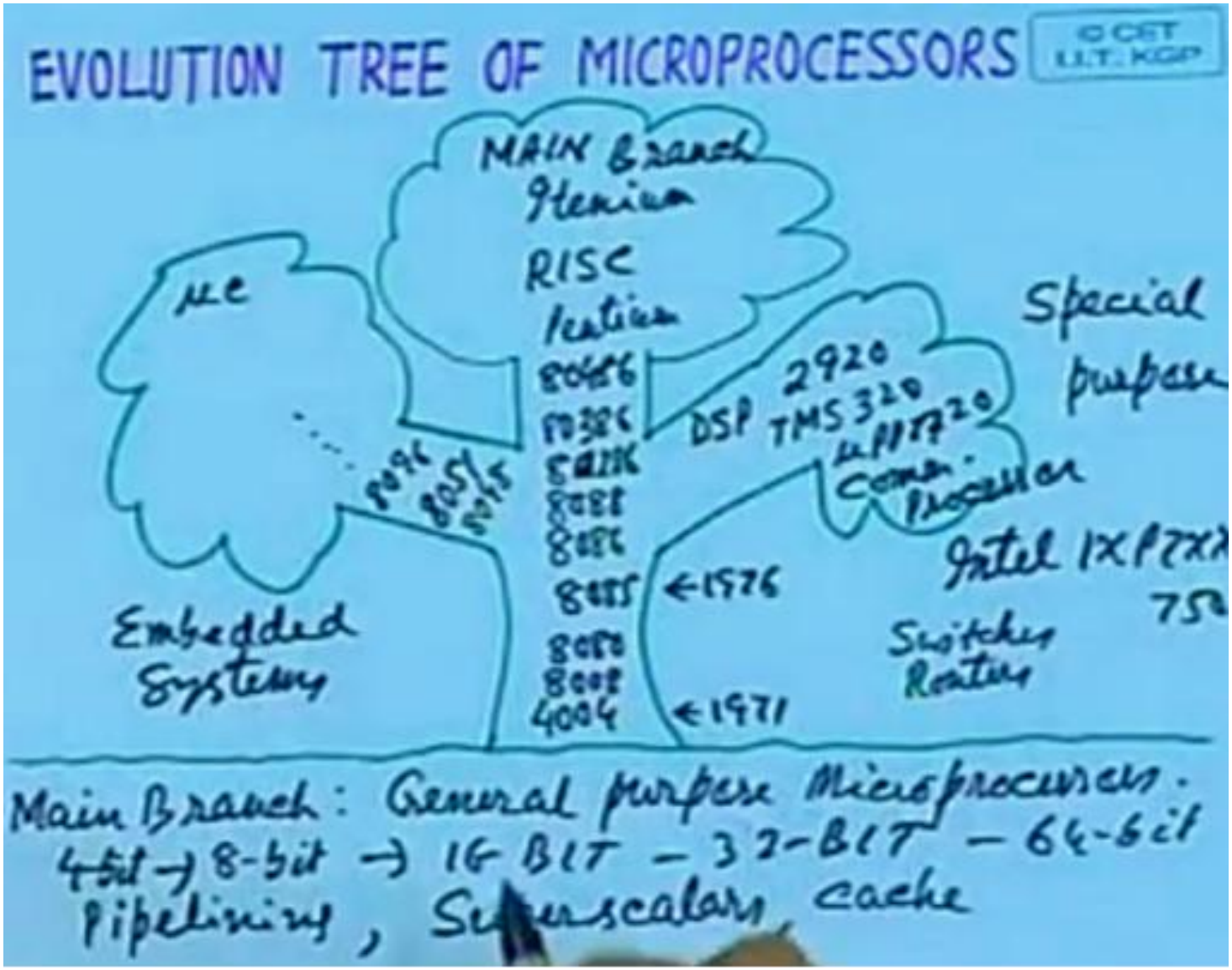
YEAR	TECHNOLOGY	# OF DEVICES	TYPICAL PRODUCTS
1947	INVENTION OF TRANSISTOR	1	–
1950–1960	DISCRETE COMPONENTS	1	JUNCTION DIODES, TRANSISTORS
1961–1965	SSI SMALL SCALE INTEGERTED CIRCUITS	10–100	Logic gates, FFs
1966–1970	MSI MEDIUM SCALE INTEGERTED CIRCUITS	100–1000	COUNTER, MUX, DECODER, ADDERS
1971–1979	LSI LARGE SCALE INTEGERTED CIRCUITS	1000–20000	8-BIT μP, RAM, ROM
1980–1984	VLSI VERY LARGE SCALE INTEGERTED CIRCUITS	20000–50000	DSP, RISC 16-BIT μP, 32-BIT μP
1985	ULSI ULTRA LARGE SCALE INTEGERTED CIRCUITS	750000	64-BIT μP

EVOLUTION TREE OF MICROPROCESSOR

Evolution tree consists of three branches:

- Main Branch: comprises Microprocessors, starting from 4-bit 4004 to 64-bit Itanium. These processors are typically general purpose computers.
- Second Branch: comprises Microcontrollers like 8048, 8051, 8096 etc. These processors are typically used to realize embedded systems.
- Third Branch: comprises Special Purpose Processor like DSP processors, network processors, etc. These are typically used in specialized applications such as DSP and communication equipment.

EVOLUTION TREE OF MICROPROCESSOR



MOORE'S LAW

Moore, Gordon. "Cramming More Components onto Integrated Circuits," *Electronics Magazine* Vol. 38, No. 8 (April 19, 1965).

"The complexity for minimum component costs has increased at a rate of roughly a factor of two per year."

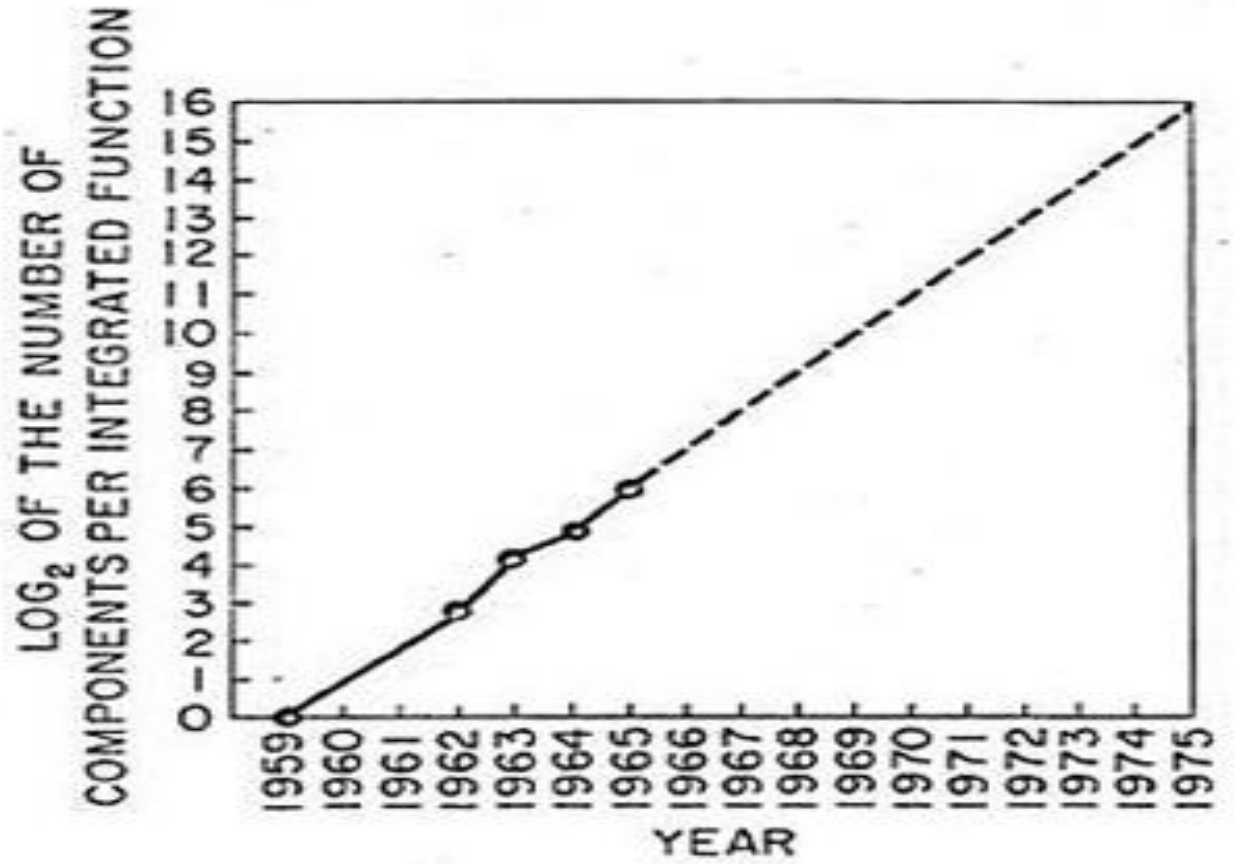


Fig: http://www.sp.phy.cam.ac.uk/~SiGe/Moore's%20Law.html

50 Years of MOORE'S LAW

Economic Impact

Performance—aka power—and cost are two key drivers of technological development. As more transistors fit into smaller spaces, processing power increased and energy efficiency improved, all at a lower cost for the end user. This development not only enhanced existing industries and increased productivity, but it ha spawned whole new industries empowered by cheap and powerful computi

Technological Impact

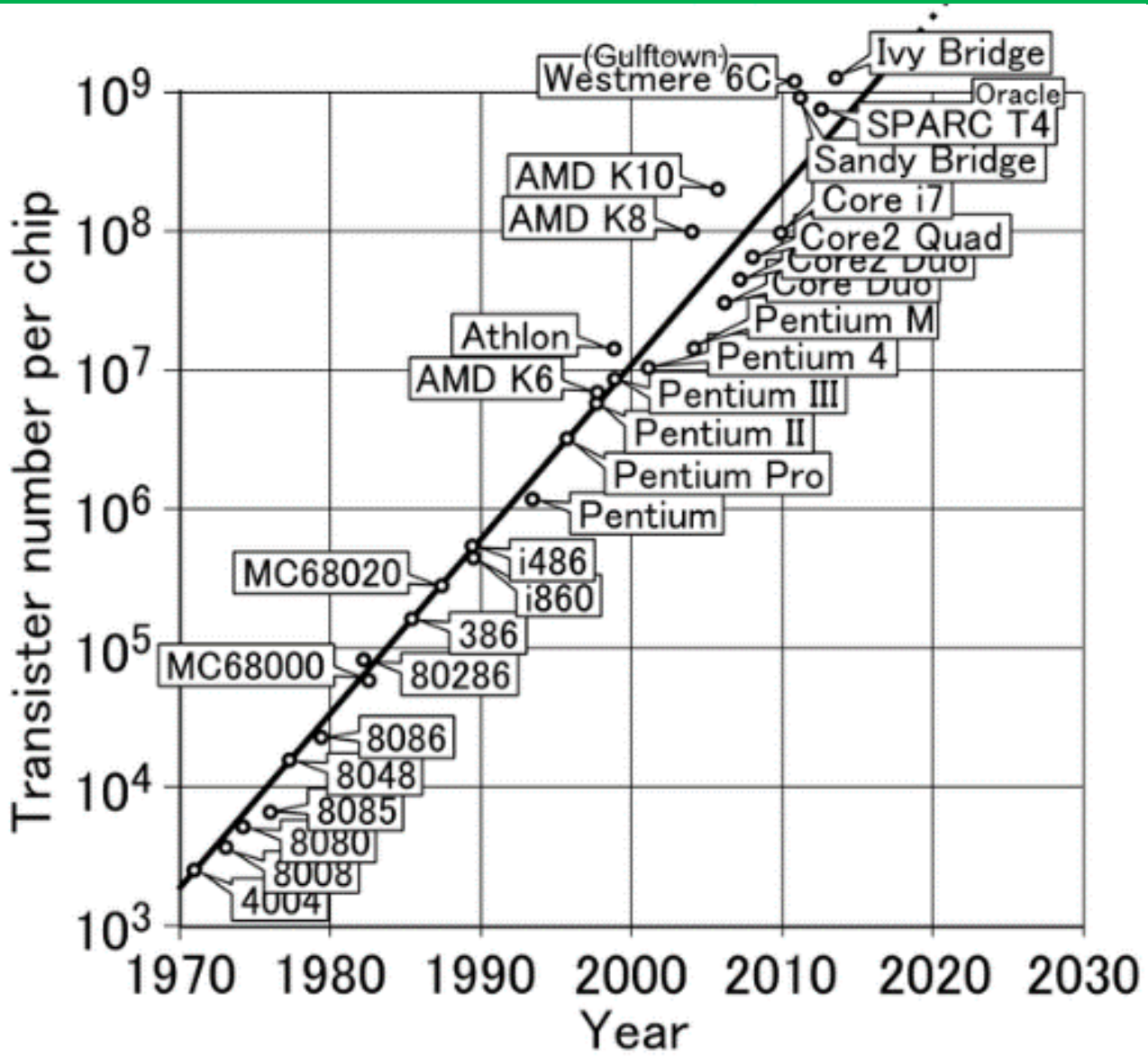
Moore's observation transformed computing from a rare and expensive venture into a pervasive and affordable necessity. All of the modern computing technology we know and enjoy sprang from the foundation laid by Moore's Law. From the Internet itself, to social media and modern data analytics, all these innovations stem directly from Moore and his findings.

Societal Impact

The inexpensive, ubiquitous computing rapidly expanding all around us is fundamentally changing the way we work, play and communicate. The foundational force of Moore's Law has driven breakthroughs in modern cities, transportation, healthcare, education, and energy production. In fact, it's quite difficult to envision what our modern world might be like without Moore's Law.

http://www.intel.com/content/www/us/en/silicon-innovations/moores-law-technology.html

MOORE'S LAW : Microprocessor's Evaluation



http://commons.wikimedia.org/wiki/File:Moores_law_(1970-2011).PNG

The course: Microprocessor and Microcontroller based Design

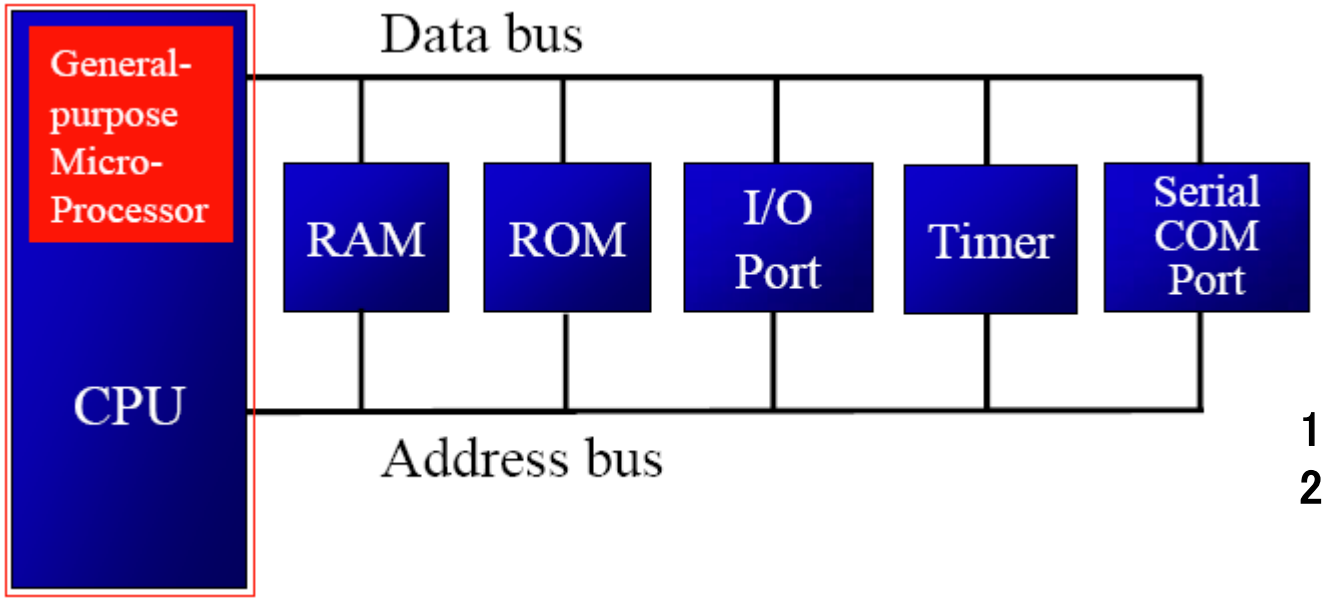
What is the difference b/w Microprocessor and Microcontroller?

What is the difference between Microprocessor and Microcontroller?

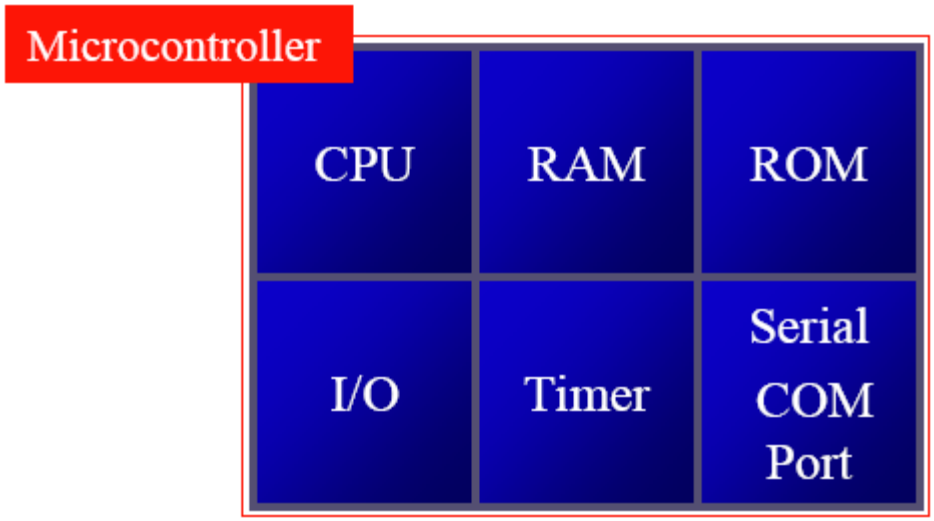
- General-purpose Microprocessors contains
  - CPU
  - No RAM
  - No ROM
  - No I/O ports

- Microcontroller has
  - CPU (microprocessor)
  - RAM
  - ROM
  - I/O ports
  - Timer
  - ADC and other peripherals

What is the difference between Microprocessor and Microcontroller?



1. CPU ON CHIP
2. First µP – Intel 4004



1. COMPUTER ON CHIP
2. FIRST µC – Intel 8048

Microprocessor vs Microcontroller

General-purpose Microprocessors

- Must add RAM, ROM, I/O ports, and timers externally to make them functional
- Make the system bulkier and much more expensive
- Have the advantage of versatility on the amount of RAM, ROM, and I/O ports

Microcontroller

- The fixed amount of on-chip ROM, RAM, and number of I/O ports makes them ideal for many applications in which cost and space are critical
- In many applications, the space it takes, the power it consumes, and the price per unit are much more critical considerations than the computing power

What is an Embedded System?

Embedded System

- An embedded system is combination of software and hardware that performs a specific task
- An embedded product uses a microprocessor (or microcontroller) to do one task and one task only
  - There is only one application software that is typically burned into ROM
- Not controlled by external but its own controller
  - e.g. Like printer, get the data and print it

PC

- A PC, in contrast with the embedded system, can be used for any number of applications
- It has RAM memory and an operating system that loads a variety of applications into RAM and lets the CPU run them
- A PC contains or is connected to various embedded products
- Each one peripheral has a microcontroller inside it that performs only one task

Examples of Embedded Systems

Home

Appliances, intercom, telephones, security systems, garage door openers, answering machines, fax machines, home computers, TVs, cable TV tuner, VCR, camcorder, remote controls, video games,
cellular phones, musical instruments, sewing machines, lighting control, paging, camera, pinball machines, toys, exercise equipment

Office

Telephones, computers, security systems, fax machines, microwave, copier, laser printer, color printer, paging

Auto

Trip computer, engine control, air bag,, instrumentation, security system, transmission control, entertainment, climate control, cellular
phone, keyless entry

Choosing a Microcontroller?

TYPICAL FEATURES OF MICROPROCESSORS

1. Smaller in size
2. Lowest cost
3. Higher reliability
4. Higher flexibility and versatility
5. Functionally more powerful
6. Lower power consumption

Current Trend

- One of the most critical needs of an embedded system is to decrease power consumption and space
- In high-performance embedded processors, the trend is to integrate more functions on the CPU chip and let designer decide which features he/she wants to use
- In many cases using x86 PCs for the high-end embedded applications
  - Saves money and shortens development time
    - ✓ A vast library of software already written
    - ✓ Windows is a widely used and well understood platform

Choosing a Microcontroller

- ✓ **8-bit microcontrollers**
  - ➢ Motorola's 68C08/68HC11
  - ➢ Intel's 8051
  - ➢ Atmel's AVR
  - ➢ Zilog's Z8
  - ➢ Microchip's PIC
- ✓ There are also 16-bit and 32-bit microcontrollers made by various chip makers
- ✓ They have different instruction set and registers-not compatible

Which is the best ???????

Criteria for Choosing a Microcontroller

Criteria 1: Meeting the computing needs of the task at hand efficiently and cost effectively:

- Speed – highest speed a microcontroller can support?
- Packaging – 40-pin DIP (dual in line package), QFP (quad flat package) to address space issue
- Power consumption – critical for battery-powered products
- The amount of RAM and ROM on chip
- The number of I/O pins and the timer on chip
- Ease of upgrade to higher performance or lower power-consumption versions
- Cost per unit – important in terms of the final product

Criteria for Choosing a Microcontroller

Criteria 2: How easy to build products around it.

- ✓ Availability of software development tools, such as compilers, assemblers, and debuggers
- ✓ Wide availability and reliable sources of the microcontroller
- ✓ The 8051 family has the largest number of diversified (multiple source) suppliers
  - **Intel (original)**
  - **Atmel**
  - **Philips/Signetics**
  - **AMD**
  - **Infineon (formerly Siemens)**
  - **Matra**
  - **Dallas Semiconductor/Maxim**
- ✓ Support from chip manufacturer

Criteria for Choosing a Microcontroller

Criteria 3: Readily availability in needed quantities both now and in the future

- ✓ For some, even more important than previous two
- ✓ Companies have massive support for their products available in large number
- ✓ Companies have built in libraries to sell
- ✓ 8051 offer the largest resources
- ✓ Other companies now doing the same

EDUCATIONAL NEEDs

- Hardware Designer
- Software Designer
- System Integrator