Microcontrollers

Microcontroller Unit - MCU

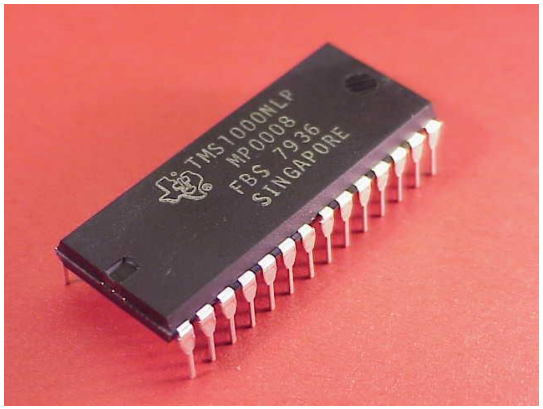
- Typically includes:
  - Processor (MPU-Microprocessor Unit)
  - Support circuitry
  - Memories (ROM/RAM)
  - I/O
  - Other specific peripherals

Usage

- Monitoring & control
  - Industrial manufacturing, automotive, environment, traffic, connectivity, security systems, …
- Home appliances
  - MW, TV, Hi-Fi, …
- Computer insides and peripherals
  - Bus, storage, I/O ports, power mgmt., …
  - Drives, displays, printers, keyboards, mice, …
- … … … … … … … … … …

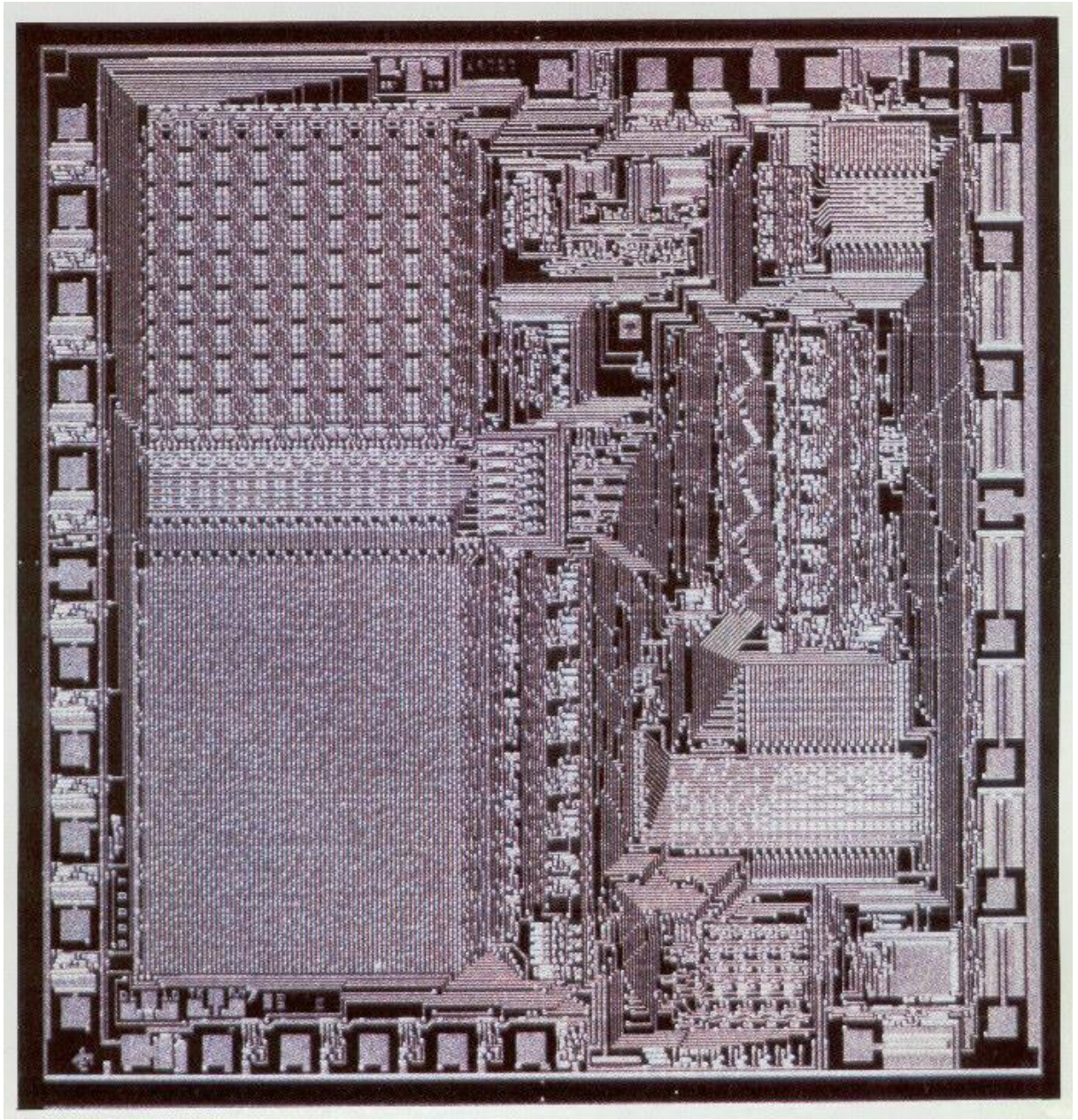
History

- Two root branches
  - Intel
    - 4004/4040 → 8048 (MCS48) → **8051 (MCS51)**
  - Texas Instruments
    - **TMS1000**



TMS 1000

- 1974 Gary W. Boone
- P-channel MOS/LSI
- Single chip contains:
  - clock
  - processor (11+32 instructions)
    1024 mikroinstructions
  - Instruction ROM (1024*8)
  - Data RAM (64*4)
  - I/O support



Architectures

- von Neumann
  - Single bus
  - Single memory
  - More complex instruction set
- Harvard
  - Separated instruction and address busses (and often other busses too)
  - Separate memories for program and data
  - Simpler instruction set

Instruction set

- RISC
  - Typically Harvard architecture
  - pipelining
  - ortogonal
- CISC
  - Typically 80+ instructions, specialities
- SISC
  - E.g. combined with DSP

Program memories

- Masked ROM
- OTP
- EPROM
- EEPROM, FLASH
- External memory

Data memories

- Very often static RAM

  ⇨ Can run arbitrarily slow
- Persistent memory (EEPROM, batery-backed SRAM)
- External memory

I/O

- communication
- A/D, D/A
- PWM
- pulse accumulator
- input capture
- comparator
- …

Communication

- UART, USART, SSP, SCI

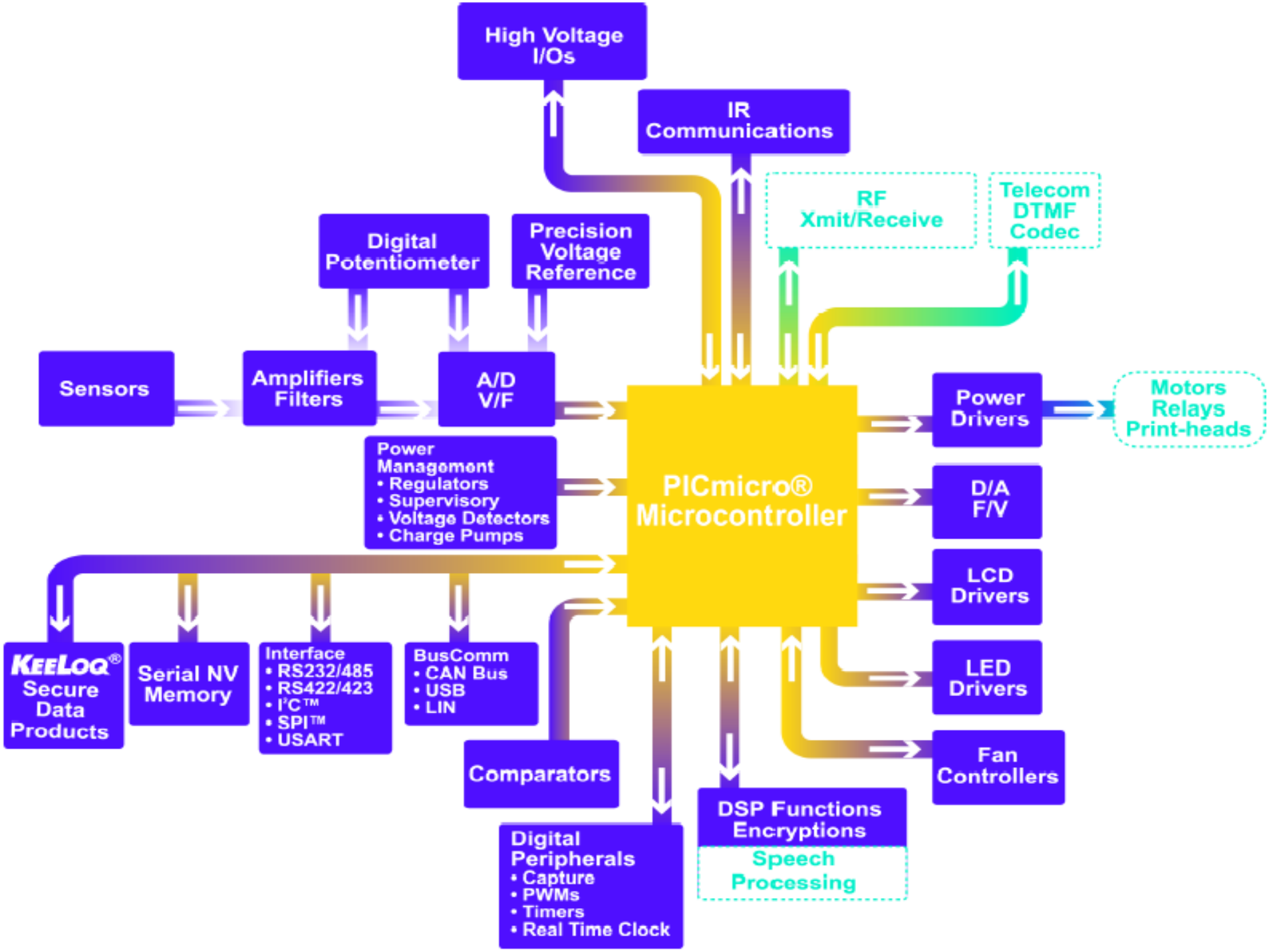
  Universal synchronous/asynchronous serial
- SPI (Motorola)
  - Serial peripherals interface
- I^2C (Phillips) http://www.semiconductors.philips.com/buses/i2c/
  - Inter-IC bus
- Microwire (National Semiconductor) http://www.national.com AN-452
  - Serial bi-directional interface

Communication

- CAN & J1850 (Bosh)
  - Controller Area Network
- LIN
  - Local Interconnect Network http://www.lin-subbus.org/
- USB http://www.usb.org
- RSxxx
- .....

Special units

- Power management
  - Brown-out detection, power-on delay, oscillator control
- Timers
- Watchdog timer
- Interrupts
- Monitor, debugger, loader
- Power-saving & sleep control


High Voltage I/Os
IR Communications
RF Xmit/Receive
Telecom DTMF Codec
Digital Potentiometer
Precision Voltage Reference
Sensors
Amplifiers Filters
A/D V/F
Power Drivers
Motors Relays Print-heads
Power Management
• Regulators
• Supervisory
• Voltage Detectors
• Charge Pumps
PICmicro® Microcontroller
D/A F/V
LCD Drivers
LED Drivers
Fan Controllers
KEELOQ® Secure Data Products
Serial NV Memory
Interface
• RS232/485
• RS422/423
• I²C™
• SPI™
• USART
BusComm
• CAN Bus
• USB
• LIN
Comparators
DSP Functions Encryptions
Speech Processing
Digital Peripherals
• Capture
• PWMs
• Timers
• Real Time Clock

Programming

- Compilers
  - Assembler
  - C, C++
  - … … …
- Interpretters
  - Forth
  - BASIC
  - Python
  - JavaScript
  - … … …

Similarities and differences of MCU vs. PC programming

- Similarity
  - Just another computer
- Difference
  - Limited resources
  - Way different Runtime
  - User interface
  - Typically cross-development