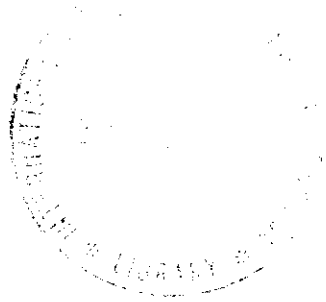

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UNITED NATIONS EDUCATIONAL, SCIENTIFIC AND CULTURAL ORGANIZATION

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COLLEGE ON MICROPROCESSORS:

TECHNOLOGY AND APPLICATIONS IN PHYSICS

7 September - 2 October 1981

DEVELOPMENT SYSTEMS

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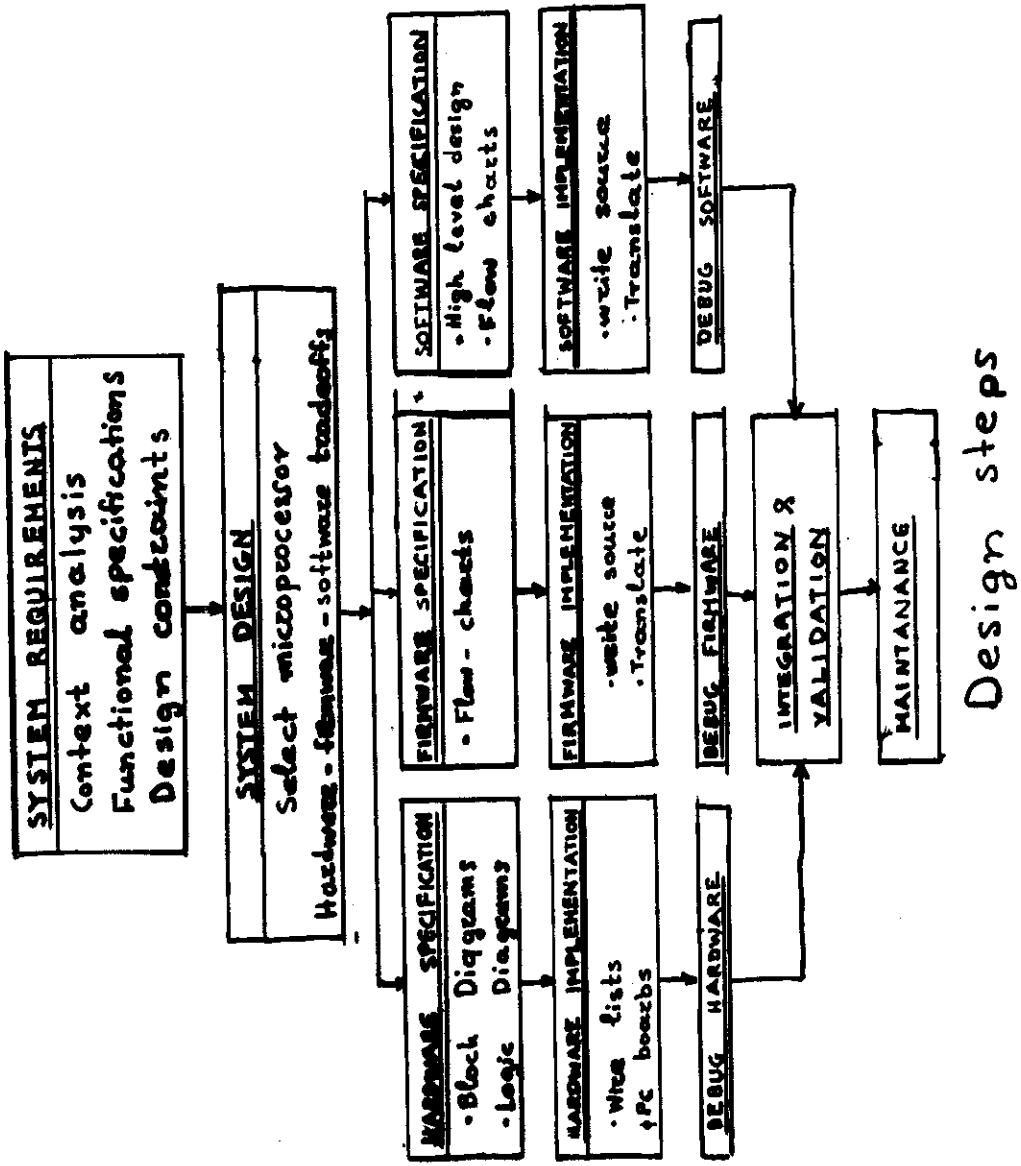
USER-DEFINED μP-BASED SYSTEMS

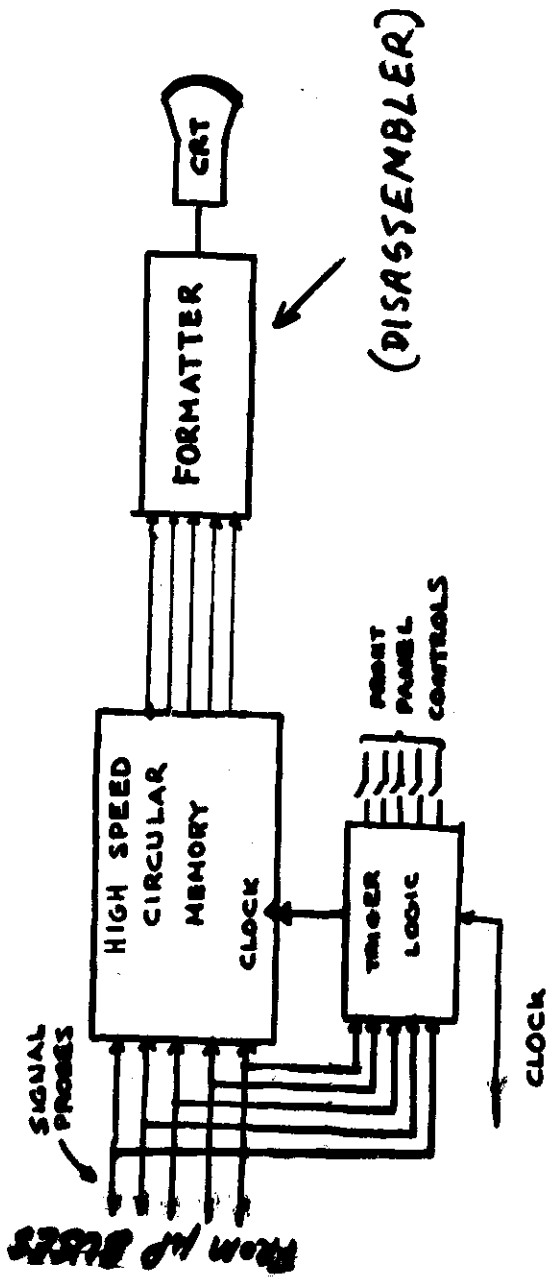
ASPECTS TO BE TAKEN INTO ACCOUNT

- HARDWARE/FIRMWARE/SOFTWARE ARE SYNERGISTIC
- RANGE OF FUNCTIONS NEED TO BE IMPLEMENTED
- ORDERED SEQUENCE OF DESIGN STEPS



- MINI & LARGE COMPUTERS
- INTEGRATED μP DEVELOPMENT SYSTEMS
- IN-CIRCUIT EMULATORS
- MICRO-BASED DEVELOPMENT SYSTEMS
- PROTOTYPING KITS
- PROGRAMMER PANELS
- PROM PROGRAMMERS
- μP ANALYSERS
- LOGIC ANALYSERS
- OSCILLOSCOPES

Spectrum of μP Development tools



Block diagram of a typical logic analyser

LOGIC ANALYZERS - MODES OF OPERATION

• SYNCHRONOUS MODE

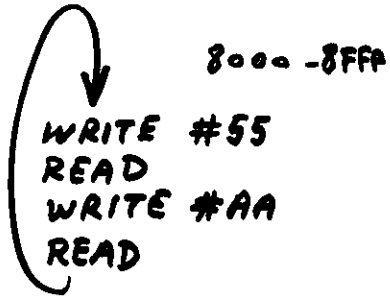
- USES THE CLOCK OF THE SYSTEM UNDER EXAMINATION
- SAMPLES THE μP buses AT THE EDGE OF THE CLOCK (the Tektronix 7D02 samples 64 ch)
- PERFORMS STATE ANALYSIS
- OUTPUT IN BINARY, HEX, OR DISSASSEMBLY
- PERSONALITY MODULES FOR VARIOUS μP'S

• ASYNCHRONOUS MODE

- USES ITS OWN CLOCK
- SAMPLES THE μP buses AT MUCH HIGHER SPEED THAN THE μP CLOCK
- HENCE MORE EXPENSIVE
- PERFORMS TIME ANACYSIS. YOU CAN OBSERVE THE TIMING RELATIONSHIPS BETWEEN LOGIC LEVEL TRANSITIONS ON THE CONTROL LINES OF THE μP
- OUTPUT IN WAVEFORM TIME DIAGRAMS

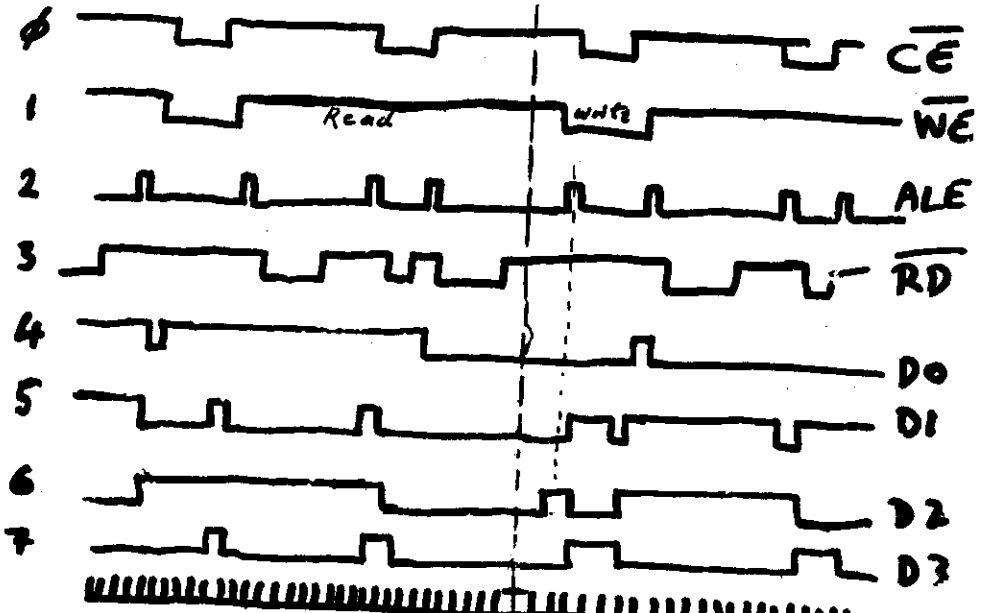
EXAMPLE: RAM TEST USING 7D02 of Tektronix

```
1 IF                                          LOOP WHILE <
  NOT
  WORD RECOGNIZER #1                          no RAM read
  DATA = XX
  ADDRESS = 8XXX
  IO/M = X  INRQ = X  FETCH = X  R/W = 1
  INACK = X  HOLD = X  EXT TRIG IN = X
  TIMING WR = X
  OR                                          OR
  WORD RECOGNIZER  #2                         READ 55
  DATA = 55
  ADDRESS = XXXX
  IO/M = X  INRQ = X  FETCH = X  R/W = X
  :
  OR                                          OR
  WORD RECOGNIZER  #3                         READ AA >
  DATA = AA
  ADDRESS = XXXX
  IO/M = X  INRQ = X  FETCH = X  R/W = X
  :
  THEN DO
    GO TO 1                                   LOOP-END
  ELSE DO

  TRIGGER Ø - MAIN                            TRIGGER
      2 - AFTER DATA
      0 - SYSTEM UNDER TEST CONT
      ● - STANDARD CLOCK QUAL
  TRIGGER 1 - TIMING
      - CENTERED
      THRESHOLD V = Ø - PLUS 1.4Ø
      SAMPLE PERIOD 1 x 1 - 100NS
      WORD RECOGNIZER = XXXX XXXX

  END TEST 1
    QUALIFY
Q   STORE ON                          store
Q   WORD RECOGNIZER #1                Read
Q   DATA = XX                         cycles
Q   ADDRESS = 8XXX
      R/W = X
    END QUALIFY
```



LOC	ADDR	OPERATION
231	80F9	55 READ
232	80F9	AA READ
233	80FA	55 READ
234	80FA	AA READ
235T	80FB	5F READ
236	80FB	AA READ
237	80FC	55 READ
238	80FC	AA READ
239	80FD	55 READ
240	80FD	AA READ

STATE ANACYSIS OUTPUT



TIMING ANALYSIS

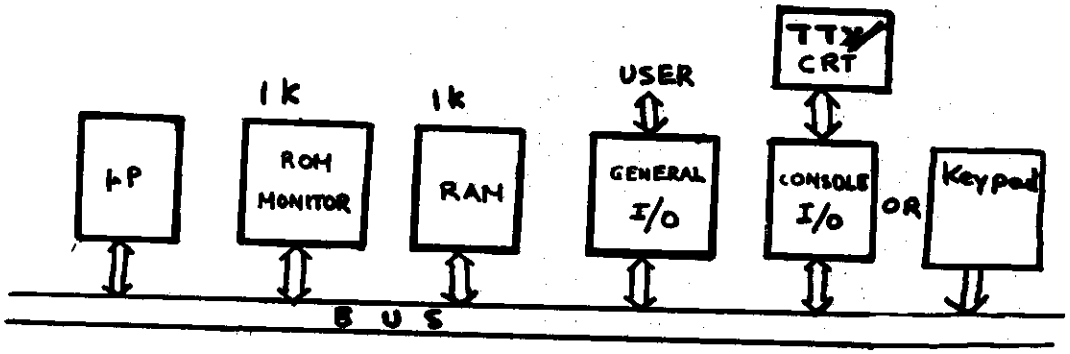
MICROCOMPUTER DEVELOPMENT SYSTEMS

USED MAINLY FOR

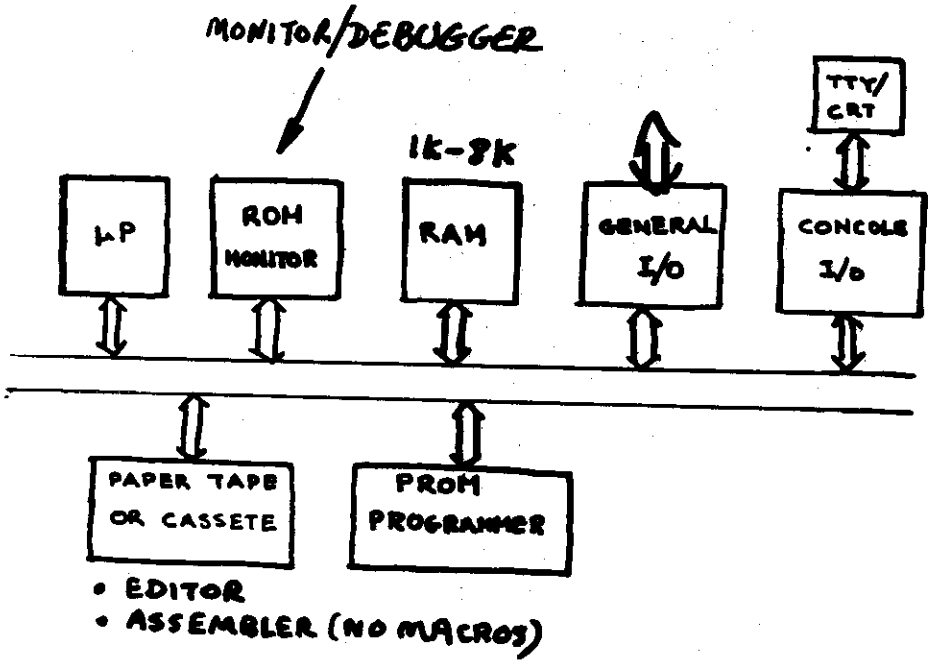
- SOFTWARE DEVELOPMENT
- DEBUGGING
- INTEGRATION

Monitor Commands : Load, Punch, Registers, Memory, Go

- HANDCODING
- NO ASSEMBLER
- NO EDITOR
- NO DEBUGGING FACILITIES (except SWI)



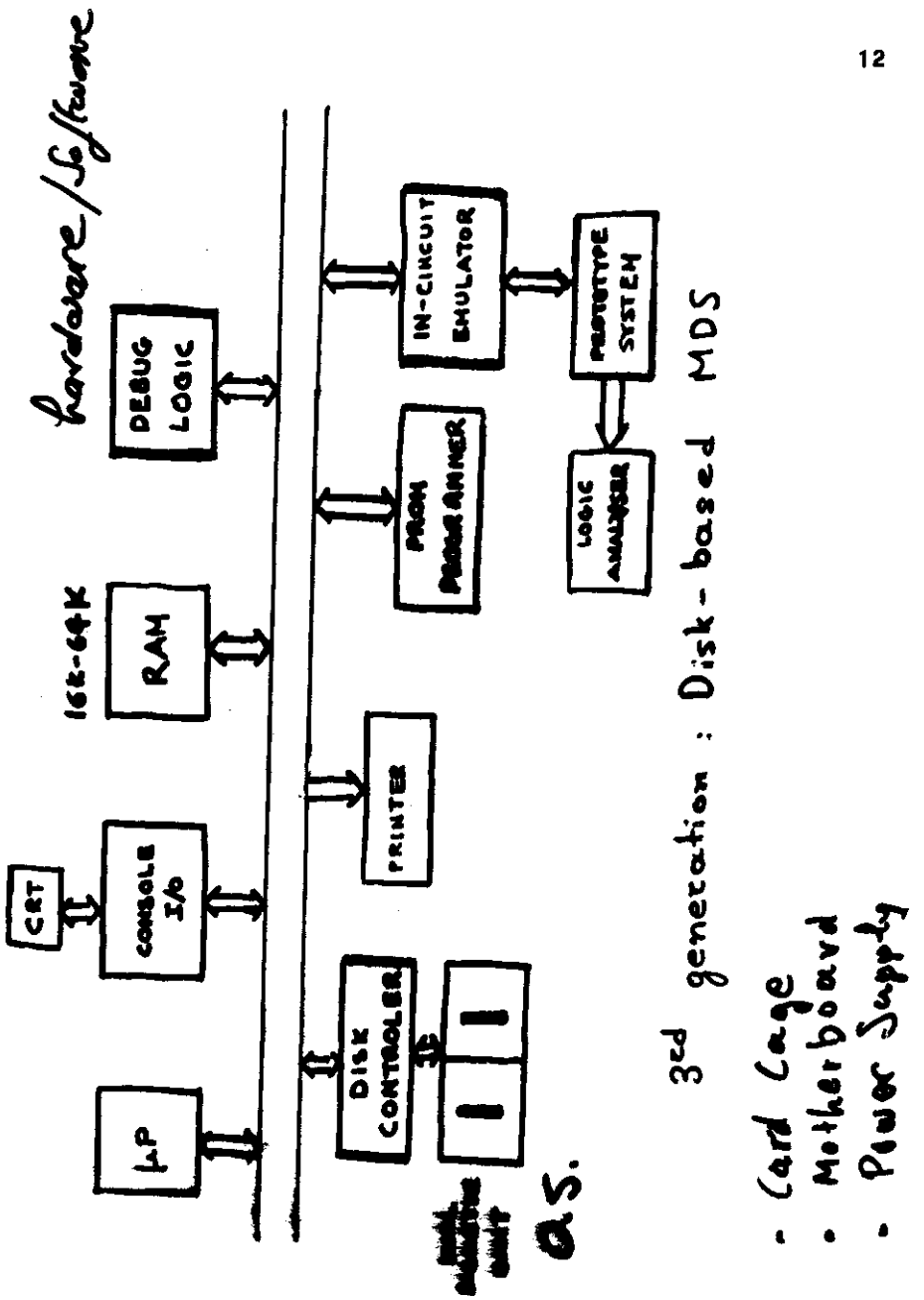
1st generation MDS; No main storage



2nd generation : Tape based MDS

Typical Monitor/Debugger Functions

- Display/Set Registers
- Display/Set Memory
- Set/Remove Breakpoints
- Set Trace Mode
- Single Instruction Step
- Start Execution of a program
- Load program
- Dump program
- Prom program



3rd generation : Disk-based MDS

- Card Cage
- Motherboard
- Power Supply

Example:

M MDOS COMMANDS

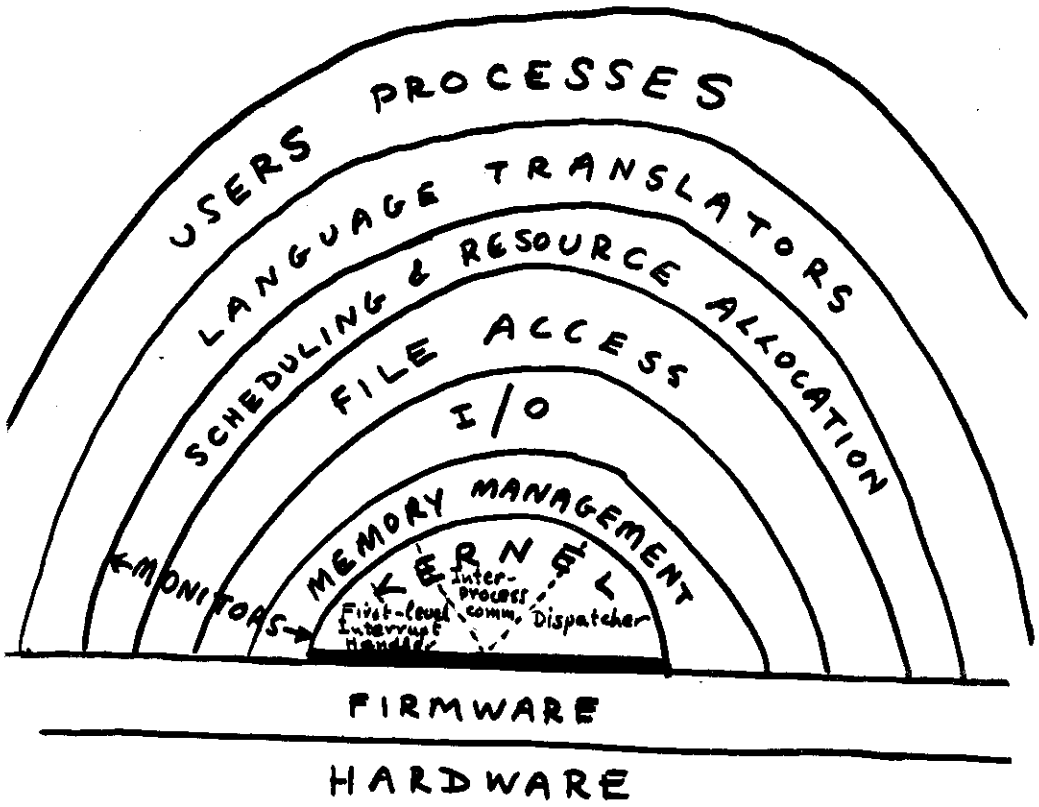
DIR	Display the file directory information
COPY	Copy file Disk → Disk, Disk → Device, Device → Disk
DEL	Delete file from directory and free space
LIST	Display a disk file
LOAD	Load object disk file into memory
MERGE	Concatenate files to form a new file
NAME	Change file name and/or file attributes
PATCH	Patch Object disk file
CHAIN	Chain Console input to a disk file
BLOKEDIT	Copy selected lines from text files to a new file
BINEX	Convert Binary Object file to EXORciser Object
BACKUP	Create copy of disk; Optional file reorganization
DOSGEN	Create DOS tables & files
DUMP	Display disk sectors
EMCOPY	Convert EDOS files to MDOS files
FORMAT	Format Disk
FREE	Display Free Space on disk
REPAIR	Examine and allow repair of System disk tables
ROLLOUT	Write memory block to disk

Example:

M MDOS SYSTEM CALLS SCALLS

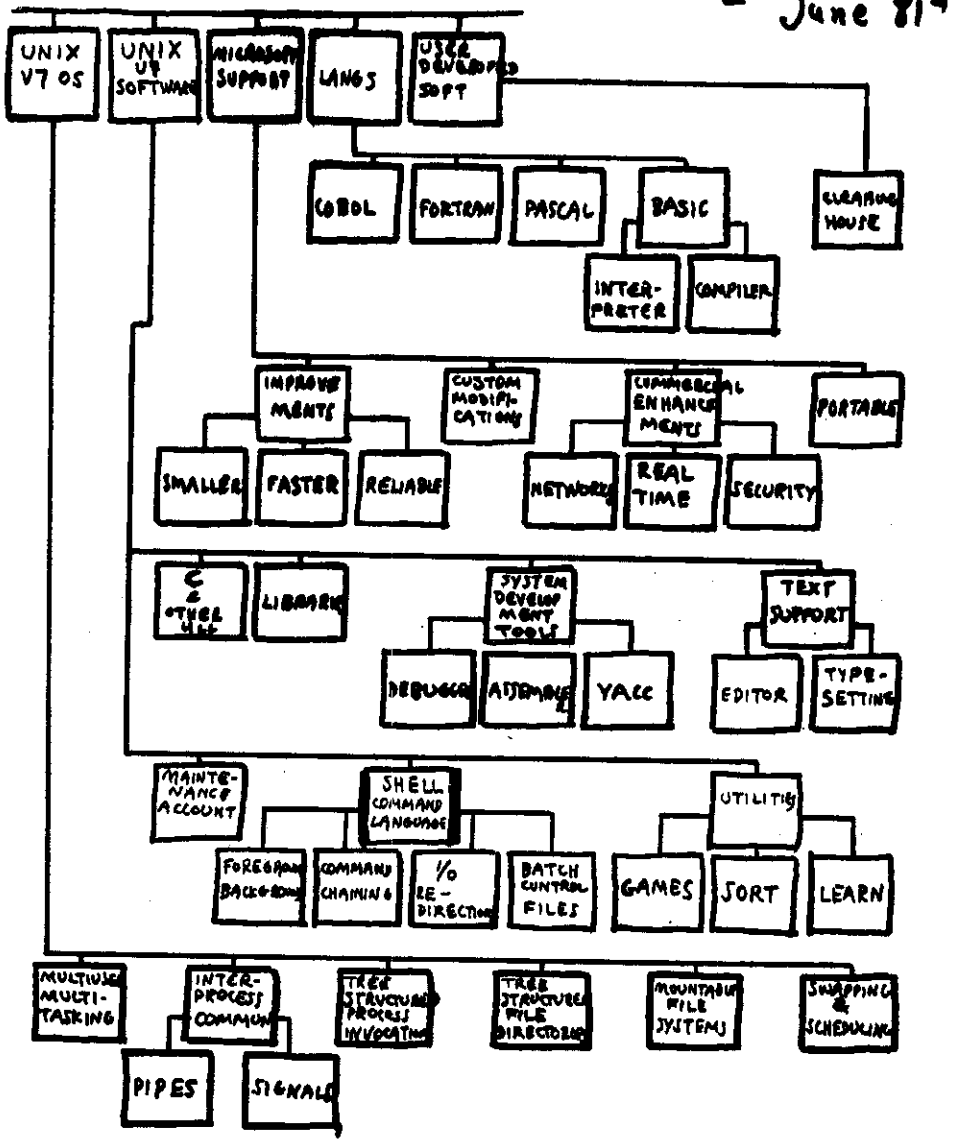
via SWI XX — [system calls / user defined calls

1) Physical disk I/O functions
2) System console/printer I/O functions
3) file/memory functions
4) Register functions - Extend Instruction Repertoire
5) Arithmetic functions - Word Arithmetic
6) Unified I/O functions
7) String functions



ONION-SKIN VIEW OF COMPUTER SYSTEM

XENIX OPERATING SYSTEM [see BYTE June 81]



Single-board μC's

- Over 70 manufacturers (E.D. March 1981)
- 8-bit & 16-bit μP's
- RAM 128 bytes - 64 kbytes
- ROM 1 kb - 32 kbytes
- DMA capability
- Buses : multibus, Flexibus, EXORciser, Cyberbus, Exorbus, P, S-100, STD
- Parallel I/O lines : 8 - 48
- Serial I/O ports : 1 - 8
  Baud rate 110 baud — 500 kbaud
- Interrupt provisions
- Multi-processor capability
- Counter-times : 1 - 16
- Monitor/debugger up to O.S.
- Assembler up to HLL's (resident)
- Interfaces for : Audio-cassette, Printer, Video etc
- Special features

Most known MDS's (see Mini-Micro Systems Sept 79)

Motorola : EXORciser (6800) EXORmacs (68000)

Intel : Intellec MDS (8080)

H/P : 64000 (6800, 8080, Z80)

Tektronix : 8002A (8080, 6800, Z80, 9900)

Texas : 990 (9900, TMS-1000)

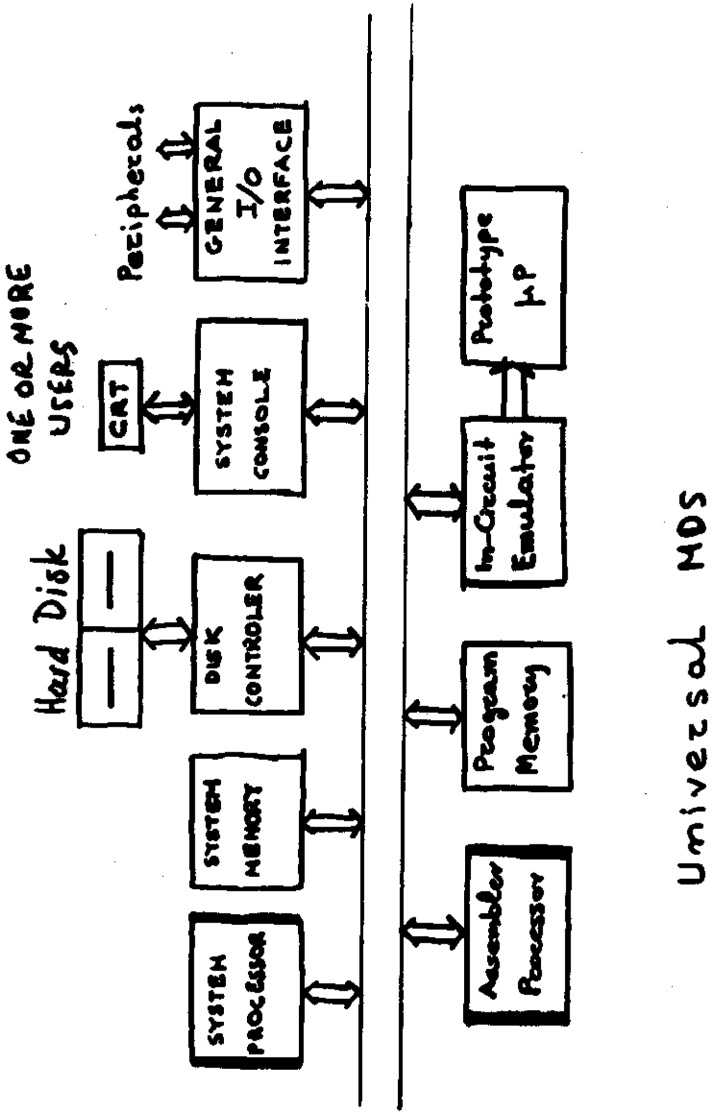
Zilog : PDS-8000 (Z80 - Z8000)

Advanced Micro-Computers : AmSYS 8/8 (Z9000, 8080, Z80)

GenRad/Futuredata : GR 2300 (8080, 6800, Z80, 6502)

International Data Services : MUDS 11 (Z8000, 8080, Z80, 68000, 6502)

Rockwell : System 65 (6502)



DEBUGGING AIDS ON AN MDS

* MIXTURE OF HARWARE & SOFTWARE

- SINGLE INSTRUCTION STEPPING
- PROGRAM TRACING
- BREAKPOINTS — HARDWARE / SOFTWARE (SWI)

- SYMBOLIC DEBUGGING
- MULTIPLE BREAKPOINTS

  AND, OR

  OF BREAKPOINT CONDITIONS

- IN-CIRCUIT EMULATORS

  They extend the debugging facilities of an MDS <u>into</u> the user's prototype system!

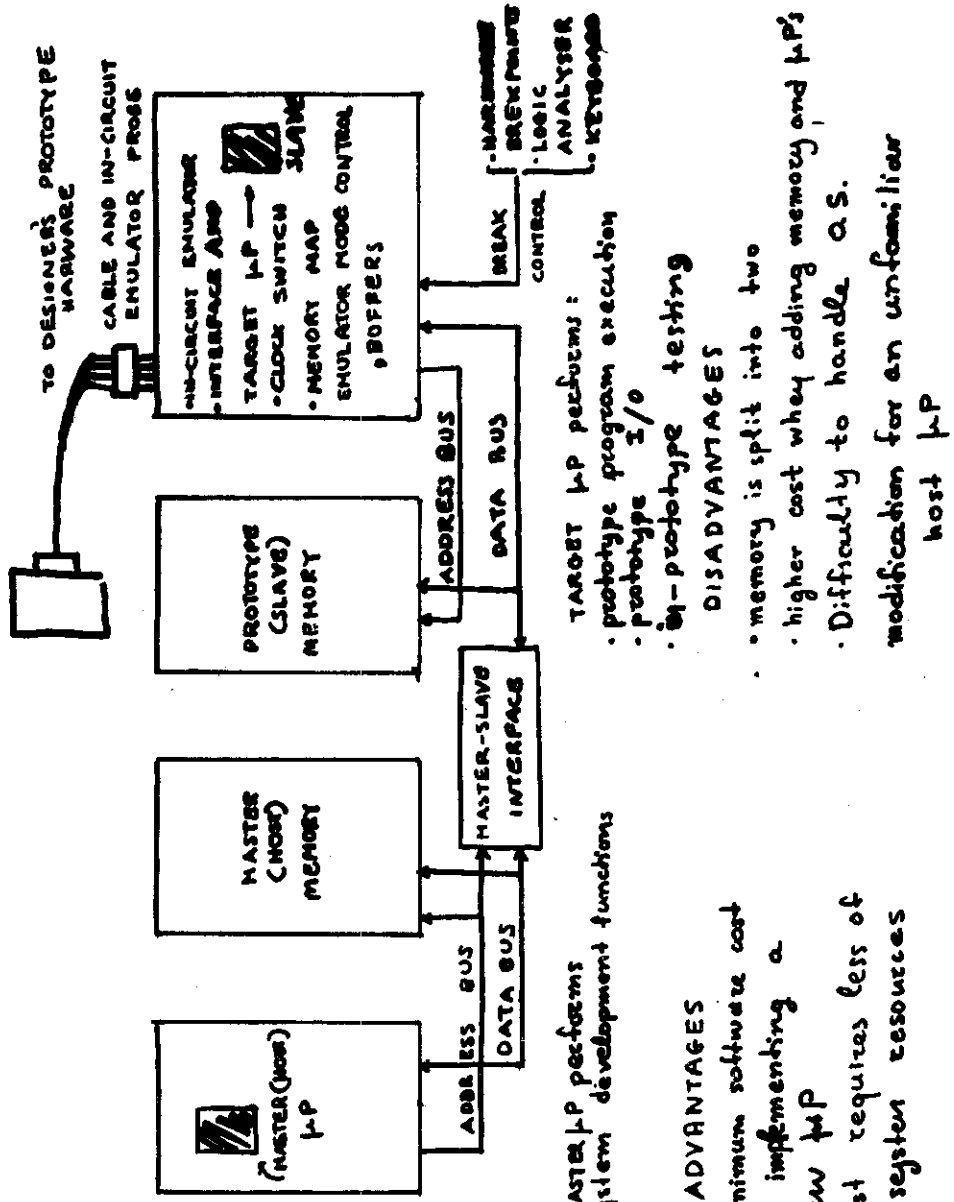
IN-CIRCUIT EMULATOR

DEBUGGER + LOGIC ANALYSER

- CPU EMULATOR (Debugging)
- LOGIC ANALYSER
- ROM/RAM SIMULATOR

IT HELPS THE DESIGNER TO
MONITOR, CONTROL, AND MODIFY
IN AN INTERACTIVE / DYNAMIC WAY
THE INTERPLAY BETWEEN
THE HARDWARE - SOFTWARE
OF THE PROTOTYPE SYSTEM

MASTER - SLAVE ICE architecture



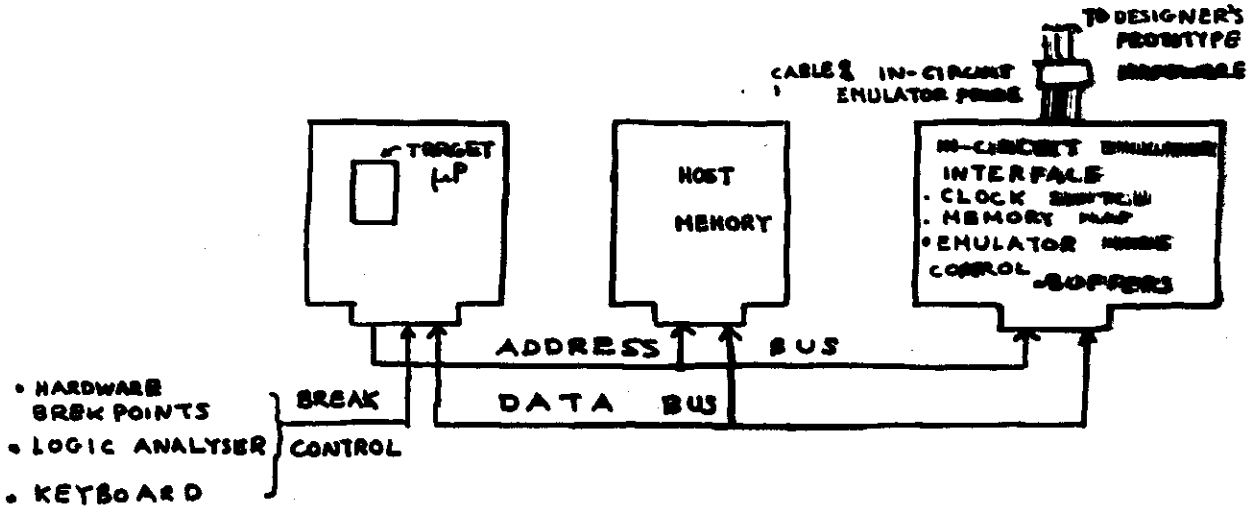
TARGET µP performs:
- prototype program execution
- prototype I/O
- in-prototype testing

DISADVANTAGES
- memory is split into two
- higher cost when adding memory and µP's
- Difficulty to handle O.S.
- modification for an unfamiliar host µP

MASTER µP performs
- system development functions

ADVANTAGES
- minimum software cost for implementing a new µP
- Host requires less of the system resources

Single-processor ICE architecture



ADVANTAGES

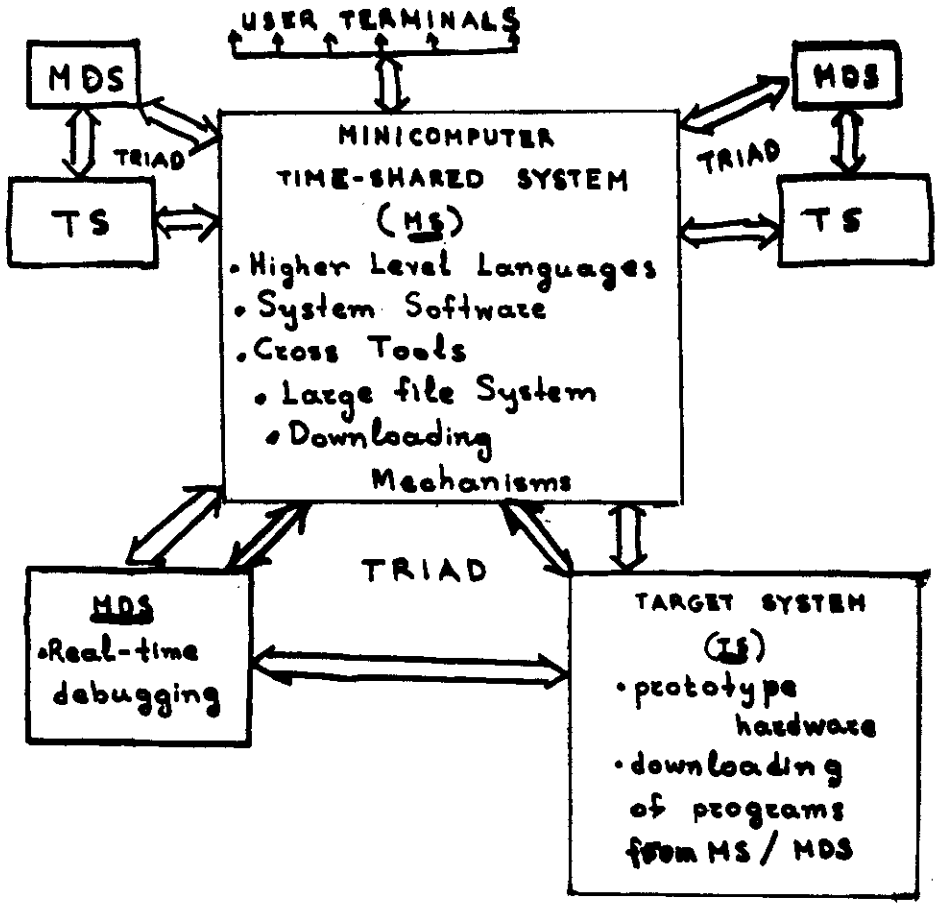
- low cost
- one large memory

DISADVANTAGES

- need to rewrite software for new µP
- emulation is not completely separate

The ICE-90 in-circuit emulator of Intel

- **Emulation/Single step Commands**
  - GO — set up emulation conditions & start emulation
  - STEP BY n — step emulation n times
  - RANGE — if memory for tracing is real-time emulates interrupt handling routine
  - CALL
  - CONTINUE emulation
- **Interrogation Commands**
  - BASE — mode of display (decimal, Hexa, oct)
  - DISPLAY — display data in memory/register
  - CHANGE — define memory or I/O mapping
  - X FORM
  - SEARCH — search over memory
- **Utility Commands**
  - LOAD — load the symbol table
  - SAVE — save a piece of code
  - EQUATE — Enter new name to symbol table
  - FILL — fill memory with specific value
  - MOVE — move block of data in memory



. TRIAD structure (Integrated μP development system)

[see MICRO 77]

Advantages of an integrated μP Development System

- The system is suited to both engineers & programmers
- The system allows easy access to the entire spectrum of development tools
- the software development tools are closely linked to the hardware under development allowing thus rapid tailoring of the development system to the application under consideration
- The system has high throughput and quick turnaround to modifications
- The system is modular both in size and flexibility, making very easy future extensions.