Mini-Computers

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Origin of the Name

- Mini-minor
- Mini-skirt
- DEC Europe sales person

Comparison with Main-Frames

Mainframes:
- Leased (rented)
- HW modifications not allowed
- HW & SW sold together

Minicomputers:
- Sold, not rented
- Much cheaper
- Open spec, modifications encouraged
- OEM model

Defining Facets

1. Architecture
2. Packaging
3. Role of third-party in apps development
4. Price
5. Financing

Word Length

- Typical 1960s IBM Mainframes used 36-bits
  - 10 decimal digits
- Manufacturers assumed less would not be enough
- Shorter instructions reduce addressing abilities

Short Word Workarounds

- More complex instructions
  - Address stored in a different register
- Using double precision math (add with carry)
DEC PDP-1

- Included many of the TX-0 features
- Designed from the ground using transistors
- Capable of 100,000 additions per second
- Core memory of 4K words
- About 50 machines sold

PDP-1 I/O - DMA

- I/O flows directly from the device to memory
- Multiple interrupts
- HW support for correct handling (priority)
- Cheap: a single IBM I/O channel cost more than a complete PDP-1 ($120K)

PDP-1 Space Invaders

- Developed by MIT students
- Using 1024x1204 CRT
- Planet Map
- Simulated Gravity


Business Model / Interaction with Customers

- IBM rented its computers
  - Modifications need IBM approval
- DEC model:
  - PDP-1 was sold, not leased

DEC openness

- Encouraged modification by the customers
- Published detailed specs on cheap paper
- Didn’t develop specialized HW and SW
DEC PDP-8

- 12 bit word length
- 50,000 computers installed
- Successful - performance, storage, packaging, price
- Improvements in logic and core memory reduced the cycle time to 1.6 microsec.

PDP-8 Addressing

- 7 bits were used for the address field (small)
- Memory: 32 blocks of 128 words (4KW)
- Access across a block achieved by setting bits in the opcode

PDP8 packaging

- Constructed from a series of compact modules
  - Each performed a specific function
- Modules plugged into a chassis
- Wire wrap connection
- Small, embedded in other equipment
- 8 cubic feet (volume), 250 pounds

PDP8 pricing

- Very cheap: $18K
- Price dropped to $10K after a few years
- Price shocked the industry, many orders
- Once again estimates of the computer market size were proved incorrect

PDP8 programming

- Limited memory prevented high-level programming
- Simple, easy to understand computer
- Gave rise to OEMs

OEMs

- OEM: a separate company that bought minicomputers, added specialized HW & SW and sold them under their own label
- Relieved DEC of developing specialized SW
- Ranged across all segment of society:
  - Medical instrumentation
  - Small business records
  - Industrial controllers
OEM example
- LS-8 used to operate theatrical stage lighting
- Cited as a key element in the success of the Broadway hit "A Chorus Line"
- Contained a PDP-8A, introduced 1975
- Application specific control panel

DEC PDP-10
- One of the most influential computers
- The machine that made time-sharing common
  - The basis of the ARPANET
  - The platform upon which many applications were first developed:
    - EMACS
    - TeX
    - ISPELL
    - Kermit

PDP-10 Architecture
- An improved HW implementation of the PDP-6
- Shared the same 36-bit word length
- Slightly extended the instruction set

KA-10
- The original PDP-10 processor was the KA10

Wire Wrap Backplane
- Backplanes wire wrapped, semi-automated manufacturing process

PDP-10 Memory Management
- KA10: maximum main memory of 256 Kwords
- Management consisted of 2 sets of protection & relocation registers - "base and bounds" registers
- This allowed separate read-only shareable code segment and read-write data/stack segment
PDP-11
- A successor to the PDP-8
- Was easier to program than its predecessors
- The world's most successful family of minicomputers
- Was replaced by VAX-11

PDP-11 Instruction Set
- A highly-orthogonal instruction set:
  - Operation; operand access mode
- Any addressing mode would work with any operation

PDP-11 I/O
- New architecture: no dedicated I/O bus
- It had only a memory bus, the Unibus
- I/O devices are memory mapped
  - No need for special I/O instructions
- Four levels of interrupts
- Interrupting device puts its address on the bus

DEC VAX Minicomputers

VAX
- An extension of the PDP-11, with mainframe performance
- Design began 1974
- VAX = Virtual Address eXtension (of PDP-11)
- VAX was able to execute PDP-11 instructions in a 32 instead of 16-bit address space
- PDP-11 compatibility bit that was later dropped

VAX - a virtual memory computer
- Making small but fast main memory seem to be bigger by swapping data from a slower disk
- Overall performance not seriously degraded
- User is not aware that swapping is done
- The VAX provided a 32-bit virtual address
- Memory divided into pages
VAX Instruction Set
- Sixteen general purpose 32-bit registers
- Rich set of 250 instructions
- Two and three operand formats
- Register or memory operand in most instructions
- The quintessential CISC processing architecture

VAX Commercial Aspects
- Successful: 100,000 units in 10 years
- General purpose computer that came with standard languages and SW
- Biggest impact in engineering and science
- Prices started at $120K
- Cheap enough to serve a division in the aerospace, automotive, chemical firms

MIPS
- The performance of VAX 11/780 became known as MIPS (million instructions per second)
- Later used as a benchmark of performance

A Brief VAX Timeline

VAX Kickoff
- The VAX Architecture Committee began work on a computer with 32-bit architecture
- Image: inside of VAX-11/780

First VAX
- VAX-11/780 introduced
VAX OS

- V1.0 of the VMS operating system ships
- FORTRAN IV and DECnet, a 64 megabyte memory limit, an event driven priority scheduler, process swapper, process deletion/creation/control

LSI VAX

- Introduction of the VAX-11/750
- The industry's first Large Scale Integration (LSI) 32-bit minicomputer

ECL VAX

- VAX 8600: the first VAX implementation in ECL technology

“Personal “ VAX

- VAX station I.
- A powerful, single-user computing system supporting the professional user

VLSI VAX

- MicroVAX: VAX on a VLSI chip

VAX Station Best-Seller

- The VAXStation 2000 is introduced.
- DIGITAL's first workstation with a cost of less than $5,000
- Became the highest volume workstation in the industry
Last VAX

- VAX 7000 series, DIGITAL’s most powerful VAX system, field-upgradeable to the Alpha 64-bit processor

Summary

- Computer class between big-iron mainframes and personal computers
- The basis for nowadays servers (VAX)
- Continuing trend of bringing the computer to more people
- Introduced important architectural aspects

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