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Development of magnetic bubble domain memories will have completed their experimental stage within few years. However, from the user's point of view, several different technologies are also expected available for the similar purpose. Such technologies are CCD(charge coupled device), DOT(magnetic domain tip device), and electron beam addressed memories. They are characterized as block oriented random access memories("BORAM") or "electronic disks". Semiconductor RAM and fixed/movable head disks are expected also competing because their cost-performance will continue remarkable improvement. Josephson junction devices and some kinds of optical memories are too early to decide their technical reality.

Table 1 compares the important parameters of these technologies for 1975. At this moment, cost and capacity of CCD, bubble and electron beam memories cannot estimate precisely on industrial base. However, these devices are expected two orders of magnitude cheaper than computer main memory and faster than rotating disk/drum devices.⁽⁵⁾ The cost per bit is mostly effected by the integration scale which means number of bits on a batch fabricated medium. Decreasing the power dissipation of a memory cell is needed for increasing areal storage density.

Among these technologies the "Winner" will be decided finally by their cost-performance, which will have strong influence from not only their own development schedule but also wide industrial backgrounds of their fields.

References

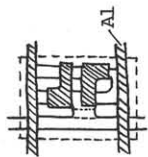
- (1) N. Suzuki et al: IEEE Trans. Electron Device, ED-21 (1974) 73.
- (2) L. Altman: Electronics, 47 No.16 (Aug. 8, 1974) 91.
- (3) R. F. Fischer: IEEE Trans. Magn., MAG-7 No.3 (1971) 741.
- (4) J. Kelly: Computer 8 No.2 (Feb.1975) 32.
- (5) R. R. Martin et al: Computer 8 No.2 (Feb. 1975) 24.

Table 1 Comparison of Memory Characteristics

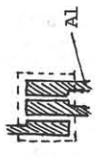
Item	Memory Type	MOS-RAM	CCD	Bubble	Electron Beam	Fixed Head Disk	Movable Head Disk
Type of Access		Word Random	Block Random				Track Random
Archival		No		(Yes)	No		Yes
Volatile		Yes					
Access Time (μ sec)		0.5	10^2	10^3	3.0	5×10^3	30×10^3
Transfer Rate (Mbit/Channel)		2.0	2.0	0.4	10	10	10
Cost/bit (yen) 1975		1.0	(0.3)	(0.3)	(0.3)	0.1	0.01
Capacity (bits/unit)		10^7	(10^7)	(10^7)	(10^7)	10^8	10^{10}
Storage Media		Silicon		Ferronagnetic Garnet	Silicon Base Capacitor	Ferronmagnetic Coating	
Cell Structure		(1) Conductor, Diffusion	(2) Conductor	Permalloy (3) Pattern	Metal Pattern (4)	Continuous Media (No structure)	
Cell Size ($\mu\text{m}^2/\text{bit}$)		10^3 (1)	4×10^2 (2)	4×10^2 (3)	10^2 (4)	10^3	
No. of bits on a Medium		4k	16k	16k	4×10^6	10^7	10^8
Power/bit (μ Watt)		40	5	10^{-3} *	7.8 (4)		
Power x Delay (p Joule)		20	2.5	2.5×10^{-2} *			
Access Method		Electrical		Electro-Magnetic	Beam-Electrical	Electro-Mechanical	
Memory Hierarchy		Main	Fast Auxiliary (on-line)				File
Status at 1975		Commercial	Sample	Development		Commercial	
Technical Problems		Large Integration	Non-volatility	Speed, Interface	Beam Technique	Mechanics, Head	

Notes on Table 1

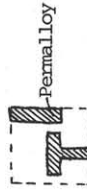
(1) A SOS RAM Cell ($1500 \mu\text{m}^2$)



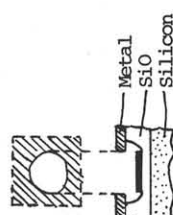
(2) 3ϕ CCD 1 bit Cell



(3) Bubble Shifter 1 bit Cell



(4) Electron Beam Storage Medium



* Cell dissipation only