

# Projecting the Cost of Magnetic Disk Storage Over the Next 10 Years

The following table shows the cost per GigaByte and the cost per TeraByte (one thousand GigaBytes) in each year from 1992 through the year 2010. As shown in the

table, one GigaByte is sufficient storage for two file cabinets of scanned documents and one TeraByte is sufficient storage for two thousand file cabinets of scanned documents.

The table is generated using an assumption of a price reduction of 37.5 percent each year (All trademarks are the property of their respective holders.)

Year	Cost For 1 GigaByte 1,000 MBytes (US Dollars) (Storage for 2 Scanned File Cabinets)	Cost For 1 TeraByte = 1,000 GigaBytes (US Dollars) (Storage for 2,000 Scanned File Cabinets)			
		EIDE PC Disk No Online Redundancy	EIDE or SCSI PC Disk Software RAID Redundancy	SCSI PC Disk Name Brand Fault Awareness Hardware RAID	Mainframe
		1X	2 X	5X	10X
1992	1,000.00	1,000,000.00	2,000,000.00	5,000,000.00	10,000,000.00
1993	625.00	625,000.00	1,250,000.00	3,125,000.00	6,250,000.00
1994	390.63	390,625.00	781,250.00	1,953,125.00	3,906,250.00
1995	244.14	244,140.63	488,281.25	1,220,703.13	2,441,406.25
1996	152.59	152,587.89	305,175.78	762,939.45	1,525,878.91
1997	95.37	95,367.43	190,734.86	476,837.16	953,674.32
1998	59.60	59,604.64	119,209.29	298,023.22	596,046.45
1999	37.25	37,252.90	74,505.81	186,264.51	372,529.03
2000	23.28	23,283.06	46,566.13	116,415.32	232,830.64
2001	14.55	14,551.92	29,103.83	72,759.58	145,519.15
2002	9.09	9,094.95	18,189.89	45,474.74	90,949.47
2003	5.68	5,684.34	11,368.68	28,421.71	56,843.42
2004	3.55	3,552.71	7,105.43	17,763.57	35,527.14
2005	2.22	2,220.45	4,440.89	11,102.23	22,204.46
2006	1.39	1,387.78	2,775.56	6,938.89	13,877.79
2007	0.87	867.36	1,734.72	4,336.81	8,673.62
2008	0.54	542.10	1,084.20	2,710.51	5,421.01
2009	0.34	338.81	677.63	1,694.07	3,388.13
2010	0.21	211.76	423.52	1,058.79	2,117.58

### The Basis for the Assumptions in the Table

The assumption of an annual price decrease of 37.5 percent is based on an increase in disk storage density of 60 percent per year. With this increase, for a given price, one can purchase 1.6 times as much storage capacity next year as one can purchase this year. The corresponding annual decrease in price per unit of storage is therefore 37.5 percent.

The estimated increase in disk storage density is based on IBM's predictions for its magnetoresistive (MR) head technology. IBM invented the MR technology, and MR is currently the technological basis for advancements in the magnetic disk industry. IBM has been increasing the areal bit density of magnetic disks at a rate of 60 percent per year since 1989. IBM projects that the 60 percent rate of increase will continue for the foreseeable future. (Source: *The Era of Magnetoresistive Heads*, Ed Grochowski, IBM Research Division, Almaden Research Center, San Jose, CA., 1994).

In a press release issued on December 29, 1997, IBM stated that the trend is continuing on track. On October 4, 1999 IBM issued a press release stating that the rate of increase in disk storage density had increased from 60 to 100 percent per year in each of the last two years.

IBM also announced that it had demonstrated very stable bit densities in the lab. This could soon lead to the manufacture of 500 GigaByte 3 1/2 inch form factor magnetic disk drives (2 of the 500 GigaByte drives would store 1 TeraByte). IBM anticipated that the increase in density would continue. On October 15, 1999, IBM announced a 73 GigaByte, 3.5 inch, multi-platter, disk with a 2 Gigabit per second, serial, fiber channel, interface.

### A Longer Perspective for Retention Periods

IBM introduced the 5 MegaByte RAMAC disk drive in June 1957, at a monthly rental of US\$ 3,200.00 (in 1957 dollars). (Source: *IBM's Early Computers*, by Charles J. Bashe, MIT Press, Cambridge, MA, 1986.) In 1957 RAMAC magnetic disk storage cost 100 thousand dollars (US) per MegaByte, or 100 million dollars (US) per GigaByte, to purchase. (Adjusted to current dollars, and adjusted for IBM's historic practice of renting rather than selling.) In 1998, magnetic disk storage cost 60 dollars (US) per GigaByte. This represents a decline of over one-million-to-one (from 100 million dollars (US) to less than 100 dollars (US) per MegaByte) in forty-one years or about a 29.8 percent decline per year.

The advances described here are based on magnetic disk technology. The study of the history of

technology has shown that over long periods of time, as older technologies are exhausted, new technologies replace them, and a steady rate of advancement is maintained. Holographic and molecular machine nano- technology have been under development for some time and promise several more orders of magnitude improvement in price and physical size reduction, as well as increases in speed, when advances in magnetic disk technology slow.

### Cost Adjustment for Advanced Hardware and Support Technology

There are many configurations of magnetic disks available. The simplest disk configuration is in the PC (Personal Computer) on one's desk. In the preceding table, this configuration is assigned an approximate relative cost of 1X. 1X is the base cost for the cost comparison of the disk configurations. The next configuration adds redundancy by storing the same data on two or more disks. This is assigned a relative approximate cost of 2X because the disk storage cost is roughly twice as much as the disk storage cost in a generic PC. The third configuration adds hardware support and fault awareness to the redundancy. This is assigned a relative approximate cost of 5X. Finally, mainframe disk configurations adds more hardware and software features to data storage, resulting in approximately a 10X cost. (All trademarks are the property of their respective holders.)

Compiled by Steve Gilheany, CRM, CDIA.