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IBM 3380 direct access storage device

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1 Models A4, A4F, AA4, AAF, B4 and BF4 announced June 11, 1980

2 Models AD4, BD4, AE4 and BE4 announced February 5, 1985

3 Models AJ4, BJ4, AK4, BK4 and CJ2 announced September 1, 1987

4 Models A4F, AAF and B4F withdrawn October 21, 1981

5 Models AA4, A04 and B04 withdrawn May 6, 1986

When the IBM 3380 Direct Access Storage Device (DASD) was rolled out in June 1980, it gave customers the ability to store up to 2.52 billion characters of information, almost four times the amount of previous IBM storage devices. For users that needed rapid access to large amounts of stored information, the 3380 transferred data at three million characters a second, more than twice the rate of the IBM 3350. Design innovations improved the average time to locate information from 25 to 16 thousandths of a second. New film head technology allowed data to be read and written at three million characters a second -- two and a half times the previous rate.

New Technology
The new film head technology combined with a more compact design enabled IBM engineers to reduce power consumption on the 3380 by up to 70 percent, floor space by up to 65 percent and heat generation by up to 75 percent when compared to equivalent storage in IBM 3350 DASDs. Read and write heads, disks and two actuators were integrated into two head/disk assemblies to improve reliability and efficiency.
Dynamic path selection, an optional internal architectural function of the 3380, provided a second data path for attachment of the 3380 to a second storage director which controlled the transfer of data. This alternate path provided concurrent access to data and could improve availability if access was lost through malfunction of a channel, storage director or controller.

Versatility
The 3380 used "count-key-data" architecture to facilitate migration from IBM 3350 and 3340DASDs. The 3380 could attach to IBM 3031, 3032 and 3033 processors and 3042 Model 2 attached processors through a Data Streaming feature to permit the use of a data rate of three million characters per second. With an optional Speed Matching Buffer feature, the 3380 devices could be used at the 1.5 million characters per second data rate of the IBM 3031, 3032 and 3033 processors, 3042 Model 2 attached processors and the IBM System/370 Models 158 , 158-3, 168and 168-3.
To meet the need for growth, a "string" or group of four 3380s could store more than 10 billion characters of information, and each storage director could control up to two strings of four 3380s.
The IBM 3380 was initially available in six models, four of which included control functions, and three of which included fixed head technology.
Depending on the features selected, purchase prices at announcement for the 3380 Model A DASDs ranged from $97,650 to $142,200. Lease charges ranged from $2,170 to $3,713 a month. Model B devices could be purchased for $81,000 or $111,600, or leased for $1,800 or $2,480 a month.
First customer shipments for all 3380 models were initially scheduled to begin in the first quarter of 1981. In March of that year, however, IBM reported that initial deliveries would be delayed because of a technical problem identified during product testing prior to customer shipment. Six months later, the problem was corrected and the 3380 was operating in IBM laboratories and customer test locations with outstanding performance and excellent overall reliability. The first customer shipment of a 3380 from the IBM General Products Division plant in San Jose, Calif., took place on October 16, 1981.

In February 1985, IBM added two new model types to its 3380 family of direct access storage devices, offering up to a 15 percent increase in performance over the three standard IBM 3380 units. These new extended capability models were available in single capacity (AD4 and BD4) and double capacity (AE4 and BE4) versions. Double capacity models could store up to 5.04 billion characters of information per unit -- twice the storage capacity then available. The new single capacity models could be converted to double capacity at a customer location.

IBM 3380 Model E

The extended capability models had the same relative arrangement of tracks and cylinders as standard models, allowing customers to expand their current 3380 storage subsystems. (The storage requirements of typical large computer systems in the mid-1980s doubled every two years.)
To accommodate growth in existing installations, the extended capability 3380s were designed to share 3880 storage control units with standard 3380 models. In addition, the extended capability models could be used together in a string of up to four units to meet varying requirements for faster access and for storing larger volumes of data. Four double capacity devices could be connected in a string to store more than 20 billion characters of information. With

that configuration, a data processing installation could double its storage capacity without additional floor space, power or air conditioning.
The twofold increase in storage capacity was the result of advances in disk technology and design improvements in the recording heads that wrote information on the disks and retrieved it. The double capacity models had twice as many tracks on each disk "platter." Both new 3380 models had fewer components, which improved availability and reduced maintenance.
The AD4 and BD4 single capacity 3380 models were available at announcement at the same price as the standard AA4 and B04 models -- $88,780 and $64,440 per unit, respectively. The AE4 and BE4 double capacity models were priced at announcement at $134,740 and $110,400, respectively.

In September 1987, IBM announced a significant extension to the 3380 series: the Model K DASD that stored 7.5 billion characters of information, and the densest disk device IBM ever manufactured; and the high-speed Model J, which could locate data faster than any previous 3380 DASD. The Model J found the correct information track in an average time of just 12 thousandths of a second. Customers who installed Model Js, which could store 2.5 billion characters of data, could upgrade it to the denser Model K.

Also announced at the same time was the new 3380 Direct Channel Attach Model CJ2 -- which combined new 3380 DASD technology and new storage control function in one unit.

Among the technological enhancements that extended the capabilities of the three new 3380 DASDs compared with their predecessors was a sophisticated head positioning mechanism that significantly reduced the minimum amount of time it took to locate data. The new DASDs could be attached to an appropriately configured IBM 3880 Storage Control and a new IBM 3990 Storage Control. Several configurations of the new DASDs also could attach to the new 3380 Model CJ2. Integrating the control function and 1.26 billion characters of disk storage in one unit made the Model CJ2 highly cost-effective. At the time, the CJ2 was IBM's lowest price 3380 disk storage subsystem for many customers, especially those with intermediate systems.

The new 3380 subsystems saved about 50 percent in floor space and about 33 percent in electricity and air conditioning compared with previous IBM storage subsystems configured with similar capacity.

The cost of storing information was also reduced. For example, the new 3380 Model K offered 50 percent more storage for only a slightly higher price than IBM's densest current 3380.

The new 3380 Models J and K were scheduled to be available in October 1987, and the 3380 Model CJ2 was scheduled for shipment in the third quarter of 1988.

Characteristics			
	AJ4 & BJ4	AK4 & BK4	CJ2
Actuators per head and disk assembly	2	2	2
HDAs per unit	2	2	1
Capacities:			
per actuator	630MB	1.89GB	630MB
per HDA	1.26GB	3.78GB	1.26GB
per unit	2.52GB	7.56GB	1.26GB
per max. 2-path string	10.08GB	30.25GB	
per max. 4-path string	20.16GB	60.50GB	
per max. string			23.94GB
Access times:			
Average seek (actuator motion)	12ms	16ms	12ms
Average latency	8.3ms	8.3ms	8.3ms

Prices	
3380 Model AJ4:	$82,000
3380 Model BJ4:	$59,000
3380 Model AK4:	$128,000
3380 Model BK4:	$105,000
3380 Model CJ2:	$70,000

The following is the text of an IBM Information Systems Group marketing brochure published in February 1985.

The IBM 3380 family of storage products meets the varied data storage requirements of today's large data processing systems. Advanced design and technology contribute to the excellent reliability. high performance and impressive environmental characteristics of the IBM 3380. It requires less electrical power, generates less heat, requires less floor space, and is priced less per megabyte when compared on an equal capacity basis with previous products.

Standard and Extended Capability models

IBM 3380s are identified as Standard or Extended Capability models. Extended Capability models have all the features of the Standard models and have Device Level Selection, a function designed to further improve availability and performance. Extended Capability models also can store or be upgraded to store 5.04 billion bytes (or gigabytes) in a single unit. Each IBM 3380 has four functionally independent actuators which access data stored on the two head and disk assemblies (HDAs) within each unit.

There are seven models of the IBM 3380 family: four 'A' models and three 'B' models. 'A' models (heads of string) contain additional logic to perform string controller functions. All models store data in count-key-data format with capacities of either 2.52 or 5.04 gigabytes of data, depending on the model.

IBM 3380 models available are:

Model	Capacity	controllers	Device type
A04	2.52GB	1	standard
AA4	2.52GB	2	standard
B04	2.52GB	—	standard
AD4	2.52GB	2	extended capability
AE4	5.04GB	2	extended capability
BD4	2.52GB	—	extended capability
BE4	5.04GB	—	extended

Purchased Models AD4 and BD4 can be field-upgraded to the double-capacity AE4 and BE4 models, respectively. The A04 can be field-upgraded to an AA4. All models are attached to processor channels through storage directors on the IBM 3880 Storage Control. The 'A' models with two string controllers (the Dynamic Path Selection function) support connection to two separate storage directors, providing improved availability and performance. These models provide two paths for data flow between the IBM 3880 Storage Control and the individual actuators in the string. The internal paths for the Extended Capability models have been enhanced to allow simultaneous data transfer from any two actuators within the string, even within the same HDA. This function, Device Level Selection combined with Dynamic Path Selection, provides improved data availability and performance. In the MVS environment, the Dynamic Path Reconnect capability of the System/370 Extended Architecture operating system exploits these hardware functions to provide increased performance.

A string of Standard model 3380s can consist of a single 3380 Model A04 or AA4 and up to three 3380 Model B04 units. A string of Extended Capability 3380s can consist of one 3380 Model AD4 or AE4 and up to three 3380 Model BD4 and BE4 units, in any combination. Two strings of 3380s can be attached to each storage director of a 3880 Model 3 or cache storage control Model 23. An A04 string is not supported by the Model 23. Strings headed by an AA4, AD4 or AE4 must attach to two storage directors (usually on two separate 3880 Storage Controls). An AA4 string and an Extended Capability string can be attached to the same storage directors.

- A string of IBM 3380s with 16 actuators can provide from 10.08 gigabytes to 20.16 gigabytes, depending on model configuration.
- Models AA4, AD4 and AE4 provide Dynamic Path Selection which make two string controllers available with independent paths for simultaneous command and data transfers to and from actuators, These models provide improved data availability and subsystem performance.
- In all models, actuators can operate independently. A maximum of two actuators in a string can transfer data simultaneously. Extended Capability models have Device Level Selection, allowing data transfer from any two actuators.
- Models AD4 and AE4 have an operator interface panel with lights that indicate path and actuator status for all actuators on the string. The panel also has operator switches to assist with problem determination, system recovery and backup procedures.
- Standard models of the 3380 can be used with the Speed Matching Buffer feature on the 3880 Storage Control Model 3 to attach to block multiplexer channels with data rates of less than three megabytes per second. Data transfers at 1.5 megabytes per second in this Speed Matching Buffer configuration.
- The 3880 Storage Control can attach to IBM 303X, 308X, and 43XX processors having three megabyte-per-second channels.
- For high-performance applications, IBM 3380 performance can be improved by attachment to the 3880 Storage Control Model 23. The IBM 3380 Model A04, however, is not attachable to a 3880 Storage Control Model 23.
- Two strings of IBM 3380s can be attached to each storage director on the IBM 3880 Storage Control.
- Command retry enables the IBM 3380 to recover from some errors without having to utilize processor error recovery programs.
- The Maintenance Device, containing a microprocessor, is used by IBM Customer Engineers to help minimize the time needed to diagnose and repair problems. Guided maintenance planning is also part of the complete maintenance approach IBM utilizes in the servicing of IBM 3380 storage products. The IBM 3380's engineering design includes field-replaceable units. This can help the IBM Customer Engineer replace parts to correct failures more quickly.

  Maintenance of a single actuator in any model, or a controller in a Dynamic Path Selection model, can generally be performed without interruption to the operation of the remainder of the string.

Model	A04, AA4, B04	AD4, BD4	AE4, BE4
General characteristics:			
HDAs per unit	2	2	2
Actuators per HDA	2	2	2
Actuators per unit	4	4	4
Bytes per actuator	630MB	630MB	1,260MB
Bytes per unit	2.52GB	2.52GB	5.04GB
Bytes per full string	10.08GB	10.08GB	20.16GB
Tracks per cylinder	15	15	15
Cylinders per actuator	885	885	1,770

Performance:			
Average seek time	16ms	15ms	17ms
Minimum seek time	3ms	3ms	3ms
Maximum seek time	30ms	28ms	31ms
Average latency	8.3ms	8.3ms	8.3ms
Data transfer rate	3.0MB/s	3.0MB/s	3.0MB/s
Features:			
Dynamic Path Reconnect capability using XA	Yes[1]	Yes	Yes
Dynamic Path Selection	Yes[1]	Yes	Yes
Device Level Selection	No	Yes	Yes
3880 Model 3 or 23 attach	Yes[2]	Yes	Yes
3880 Speed Matching Buffer	Yes	No	No
Model intermix within string	B04 only	BD4 BE4	BD4, BE4
Upgradable	A04 to AA4	AD4 to AE4[3] BD4 to BE4	Not applicable

1. Except with AO4 models
2. The AO4 does not attach to 3880 Model 23
3. Purchased AD4 and BD4 units only via purchased field upgrades

Physical Characteristics						
Model	**AO4 AA4 BO4**	**D**	**E**	**CJ2**	**J**	**K**
Actuators per unit	4	4	4	2	4	4
Data cylinders per device	885	885	1770	885	885	2655
Data tracks per device	13,275	13,275	26,550	13,275	13,275	39,825
Alternate data tracks per device	15	15	15	15	15	15
Bytes per track	47,476	47,476	47,476	47,476	47,476	47,476
Bytes per cylinder	712,140	712,140	712,140	712,140	712,140	712,140
Gigabytes per device	.630	.630	1.260	.630	.630	1.890
Gigabytes per unit (box)	2.520	2.520	5.041	1.260	2.520	7.562

Performance Characteristics (in milliseconds)						
Model	**AO4 AA4 BO4**	**D**	**E**	**CJ2**	**J**	**K**
Min. seek time [single cylinder in milliseconds (ms)]	3	3	3	2	2	2
Average seek time	16	15	17	12	12	16
Max. seek time	30	28	31	21	21	29
Full track rotation time	16.6	16.6	16.6	16.6	16.6	16.6
Average rotational delay	8.3	8.3	8.3	8.3	8.3	8.3

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