Technical Information

For Release:

Immediate

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Provides Up To 16 Million Bytes . . .

IBM SYSTEM/370 VIRTUAL STORAGE

FREES COMPUTER USERS FROM MAIN STORAGE CONSTRAINTS

WHITE PLAINS, N. Y., Aug. 2 . . . Virtual storage, announced today by IBM for System/370, makes the system's power more readily available than ever by helping the user overcome limitations of main storage size.

Virtual storage links as much as 16 million bytes, or characters, of direct access storage to a computer's main storage through a combination of circuitry and programming. This fully automated resource allows programmers, computer operators and other users to work with their computer as if it had up to 16 million bytes of main storage -- even though the computer's real main storage may be only a fraction of that capacity.

Basic to the implementation of virtual storage is a machine facility called dynamic address translation, which is available now with System/370 Models 135 and 145. It will be standard on the Models 158 and 168, and may be ordered for already purchased Models 155 and 165.

New versions of IBM's Disk Operating System (DOS) and Operating System (OS) interact with the dynamic address translation unit, automatically transferring programs and data between main storage and the direct access device in an operation that is transparent to the user.

- more -

The new system control programming -- with compatibility that allows growth from existing versions of DOS or OS -- is:

-- Disk Operating System/Virtual Storage (DOS/VS)

-- Operating System/Virtual Storage 1 (OS/VS1), the Virtual Storage extension of OS/MFT (Multiprogramming with a Fixed number of Tasks)

-- Operating System/Virtual Storage 2 (OS/VS2), the Virtual Storage extension of OS/MVT (Multiprogramming with a Variable number of Tasks)

IBM also announced a fourth system control program, Virtual Machine Facility/370 (VM/370).

Essentially, virtual storage is a means of managing a computer's main storage dynamically so that a program -- or more than one in a multiprogramming environment -- can be run on a computer even though total program size exceeds main storage capacity.

In conventional computer operations, programs being executed generally must be in main storage in their entirety, even though large sections of each program are idle for lengthy periods of time, tying up vital main storage space.

With virtual storage, only the active sections of each program need occupy main storage; the rest of each program can be stored automatically on the direct access device. Main storage space is automatically allocated to meet the changing demands of each program as it is being executed.

Extra Freedom For User

The new flexibility provided by virtual storage can help a computer user's staff to make more productive use of their time both in carrying out existing data processing applications and in developing new ones.

Special, high-priority jobs, for example, can be run immediately, without disrupting operations. A sales analysis program could be processed to provide a "rush" report for management -- even though the System/370's main storage is filled to capacity with regularly scheduled applications, such as payroll or inventory control programs.

Instead of stopping one of these programs to make room, a computer operator enters the rush job immediately into the System/370. Main storage space required for processing is provided by removal of inactive portions of the other programs.

Accommodating the rush job could add to the total running time of the regular programs. Typically, the additional time would have no significant effect upon the departments served by the programs.

The operation of computer terminals -- located across the hall or across the country from a central System/370 -- can be scheduled for longer periods of time each day without impacting the computer center's own batch operations.

An insurance company, for example, might have its agency offices linked to its central computer by means of television-like terminals. Agents use such a system for various applications, such as inquiry into customer policies, entering prospect information and receiving data for the tailoring of special proposals. Without virtual storage, a major portion of main storage would have to be dedicated to handle each application program segment -- even though usage of some occurs infrequently. Dedication of this "teleprocessing partition" would prevent the running of all batch jobs during the period the terminals are in use. Typically, therefore, terminal activity is scheduled during normal business hours, with batch operations, such as the processing of premium-due files, scheduled for the second shift.

By dynamically allocating main storage to meet the computing needs of the moment, a System/370 with virtual storage could allow the coexistence of both batch and all teleprocessing operations during the entire period the computer is in operation, automatically taking advantage of low application usage periods to allow batch processing.

Virtual storage also helps a data processing center make more effective use of system resources. At a multi-computer installation, a small System/370 with virtual storage could be used to back up a larger computer during periods of higher-than-normal data processing activity. In addition, selection of job combinations can be made easier. For example, a payroll program with many input-output operations is ideally suited to run concurrently with a simulation program that requires a great deal of computation. Even though the two programs may exceed main storage size limitations, virtual storage allows them to be run concurrently.

Besides providing increased flexibility in day-to-day operations, virtual storage enables the user to develop and implement large-scale applications earlier and more smoothly.

A programmer writing an application program can spend less time coping with main storage size limitations; he no longer has to create special techniques to "telescope" the program into a limited amount of main storage. Allowed to concentrate on the application itself, he can produce new programs more quickly and -- equally as important -- can alter and expand programs more easily because of the straightforward manner in which they can be written.

Program testing and debugging -- an important part of application development -- can be expedited because virtual storage allows a System/370 to accommodate program test runs on an immediate basis, despite main storage size limitations. This reduces a programmer's non-productive waiting time to a minimum.

Virtual storage could shave months from the implementation of a new application by allowing it to be run on a smaller computer before the higher-performance computer targeted for the application is even installed.

For example, a manufacturing company may be developing a plant floor communications system for a System/370 Model 158. The application can first be installed on a Model 135 which, with virtual storage, could handle the same storage requirements as the Model 158, but at slower processing speeds and longer response times. Using the Model 135, the plant can test, alter and prove out the system and then install it with little or no change upon the arrival of the Model 158.

How Virtual Storage Works

When programs are placed into virtual storage, they are automatically divided into small sections called pages. For ease of addressing, these pages are assigned to larger groups called segments. Initially, a page must occupy real storage -- the computer's main storage -- but as real storage space becomes needed elsewhere, the page is transferred to external page storage on the direct access device. When required again by an operating data processing job, one or more pages are automatically copied back into real storage. The ongoing transfer of pages between real storage and external page storage is termed demand paging.

Demand paging can take place because all instructions and data are referenced by their virtual storage addresses -- regardless of whether, at a given time, they occupy real storage.

When an instruction or a data record is referenced by a program, the System/370's dynamic address translation facility automatically breaks the virtual storage address into segment number, page number within segment, and the position of the instruction or record with regard to the beginning of the page.

Segment tables and page tables maintained by the system control programming indicate whether the needed page is already in real storage. If this is the case, execution of the program continues. If the page does not exist in real storage, then paging takes place under supervision of the system control programming.

To speed program execution, the dynamic address translation facility contains a translation lookaside buffer, which holds the addresses of previously referenced pages located in real storage. If the real storage location of a referenced page is found in this manner, a search of segment and page tables is not required.

The system control programming and circuitry automatically monitor page usage in main storage to identify inactive pages. These are paged out, when necessary, to meet demands for main storage space. If a page has been changed during the run of a program, it is written over the former version that exists on external page storage. If a page has not been changed, no actual transfer of data need take place. This helps keep paging time to a minimum.

Monitoring of paging activity also helps prevent programs from being reduced below their optimum real storage space -- the minimum real storage they need to perform efficiently. Thus, if too much paging activity takes place, the system control program will free additional real storage space by temporarily deactivating the lowest priority program. This helps ensure that actual processing of programs is not impacted by abnormal paging rates.

Although System/370 virtual storage ranges up to 16 million bytes, DOS/VS and OS/VS users can use smaller capacities to meet individual requirements.

DOS/VS, OS/VS1 and OS/VS2 all automatically divide virtual storage into segments of 65,000 bytes each. OS/VS2, designed for larger data processing jobs, divides programs and data into pages of 4,000 bytes each. DOS/VS and OS/VS1, in order to meet requirements of smaller programs and applications, work with page sizes of 2,000 bytes each.

Improved DOS, OS Functions

In addition to their virtual storage capabilities, the new OS and DOS versions include new features designed for easier and more efficient system operation. These include:

-- Expanded multiprogramming for DOS/VS, increasing from three to five the number of application programs that can be run simultaneously

-- A new Virtual Storage Access Method (VSAM) common to all three system control programs, allowing, for example, data files created on a direct access device by DOS/VS to be used by OS/VS1 or 2

-- A Job Entry Services feature for OS/VS1 that centralizes the handling of input and output for new speed and storage efficiency

The fourth system control program announced today, Virtual Machine Facility/370, puts new function at the fingertips of terminal users sharing a central System/370. It allows each terminal to be operated as the user's "own" computer with his choice of configuration and System/370 operating system, and up to 16 million bytes of virtual storage.

This flexibility, together with VM/370's interactive capability, can offer important advantages in such diverse applications as on-line program development, conversational problem solving and complex business computations.

At a multiple computer installation, for example, programmers sharing a Model 145 can simultaneously develop applications for larger machines with operating systems ranging from DOS to OS/VS2. At a university, VM/370 can serve a variety of users, including students, administrators and professors engaged in research.

VM/370 can be run on any System/370 with at least 240,000 bytes of main storage and with the dynamic address translation facility. It is scheduled for availability in the fourth quarter of this year.

OS/VS1, available now, will run on any System/370 with the dynamic address translation facility and at least 148,000 bytes of main storage. OS/VS2, scheduled for availability in the fourth quarter of this year, can run on Models 145 to 168 with at least 384,000 bytes of main storage. DOS/VS, which can run on Models 135 to 158, is scheduled to become available in mid-1973.

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FROM: International Business Machines Corp.
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NEW HIGH-PERFORMANCE COMPUTER: The IBM System/370 Model 168, announced today, offers the virtual storage function to users of large-scale computing systems. Virtual storage, which makes it possible to work with a computer as if it had a main storage many times larger than its actual capacity, was introduced by IBM for the Model 168, the new System/370 Model 158 and the existing Models 135 and 145. Both Models 158 and 168 contain the most compact monolithic main storage circuits ever used in IBM computers. Shown here in an engineering design model is the Model 168's operator console, which includes a TV-like display and keyboard that allow the operator to communicate with the computer. In the background is the IBM 3330 series disk storage.

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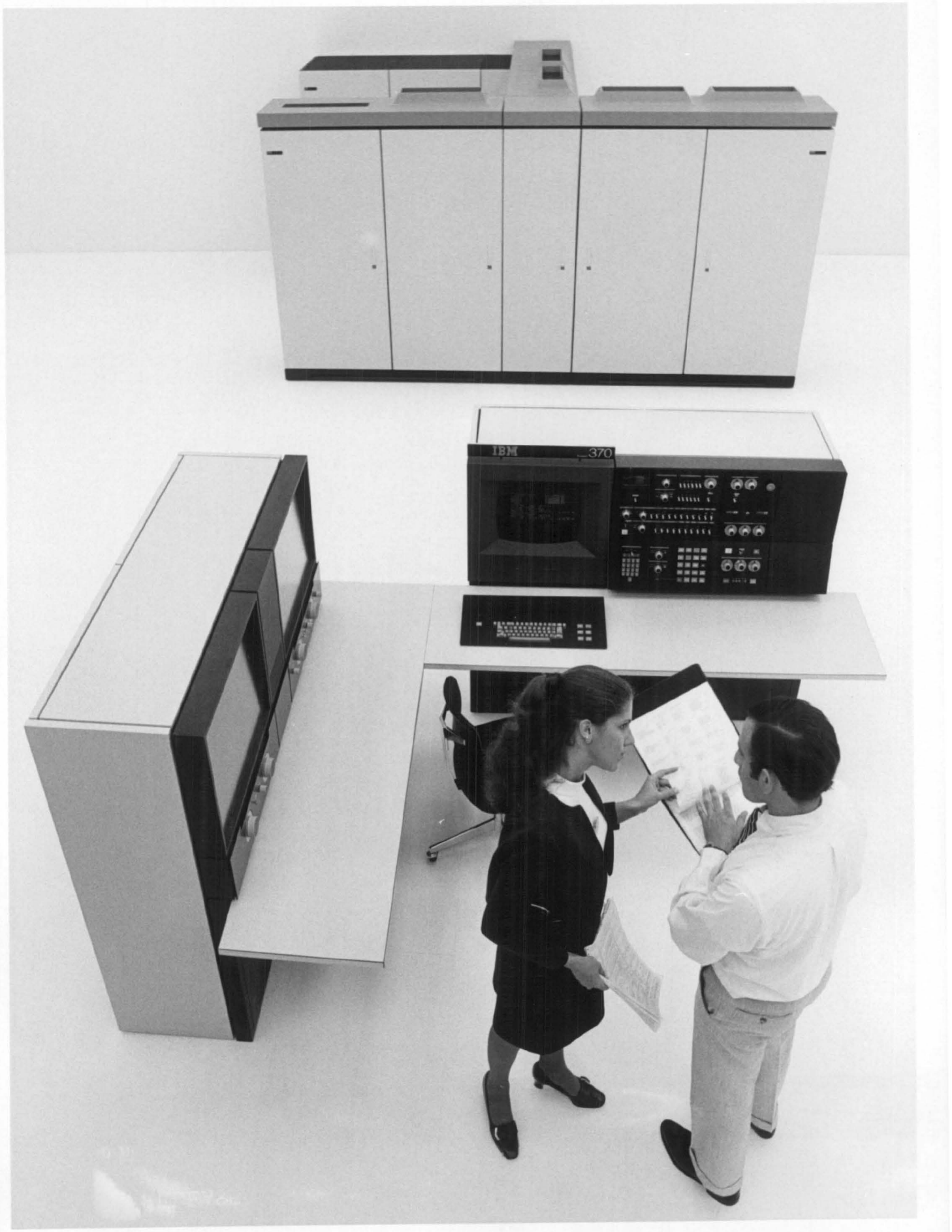
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USES MONOLITHIC MAIN STORAGE: The IBM System/370 Model 168, announced today, contains the most compact monolithic main storage circuits ever used in IBM computers. The high-performance Model 168 has a main storage capacity of up to 4-million characters and can take full advantage of virtual storage which permits use of a System/370 as if it had up to 16-million characters of main storage. IBM introduced virtual storage today for the Model 168, the new System/370 Model 158 and the existing Models 135 and 145.

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NEW SYSTEM WITH VIRTUAL STORAGE: The IBM System/370 Model 158, announced today, offers the virtual storage function to users of intermediate and large-scale computers. Virtual storage makes it possible to work with a System/370 as if it had up to 16 million characters of main storage, a maximum many times larger than its actual capacity. IBM introduced virtual storage for the Model 158, the new System/370 Model 168 and the existing Models 135 and 145. Models 158 and 168 contain the most compact monolithic main storage circuits ever used in IBM computers. In addition, as shown in this engineering design model, the Model 158 features a TV-like display with an "electronic pen" the operator can use to communicate with the system. In the background is the IBM 3330 series disk storage.

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COMPACT COMPUTER DESIGN: The IBM System/370 Model 158, announced today, contains the most compact monolithic main storage circuits ever used in IBM computers. The system can provide up to 2 million characters of main storage as well as up to 16 million characters of virtual storage. Virtual storage, introduced for System/370 by IBM today, makes it possible to work with a computer as if it had a main storage many times larger than its actual capacity. Virtual storage also was announced for the new System/370 Model 168 and the existing Models 135 and 145.

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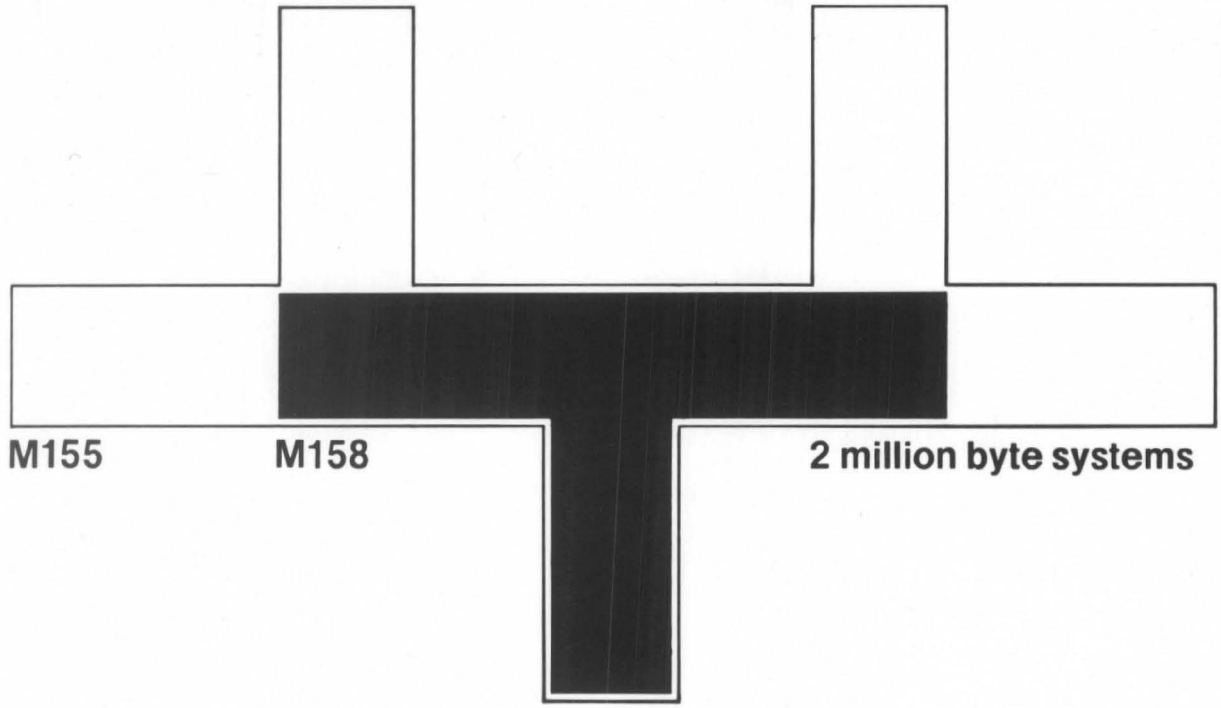
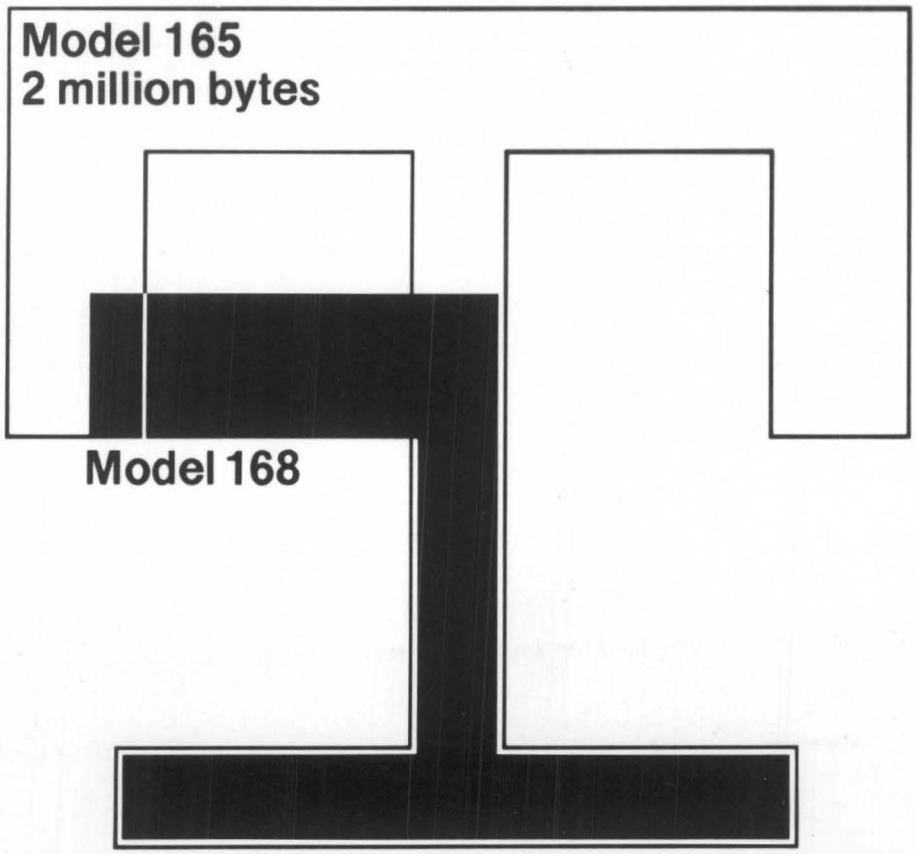

M155
M158
2 million byte systems


Model 165
2 million bytes
Model 168

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SIZE REDUCTION: Use of monolithic field-effect transistor main storage circuits instead of conventional ferrite cores in the newly-announced IBM System/370 Models 158 and 168, can result in significantly reduced floor space requirements from previous systems of the same class. For example, the top illustration represents a Model 158 central processor (shaded black) with 2 million bytes of monolithic main storage superimposed against a System/370 Model 155 with 2 million bytes of core storage. Below, a Model 168 with 2 million bytes of monolithic storage is compared with a Model 165 with 2 million bytes of core storage. The main storage circuits in Models 158 and 168 are the most compact ever used in IBM computers. The new systems can take full advantage of the virtual storage function announced today for System/370.

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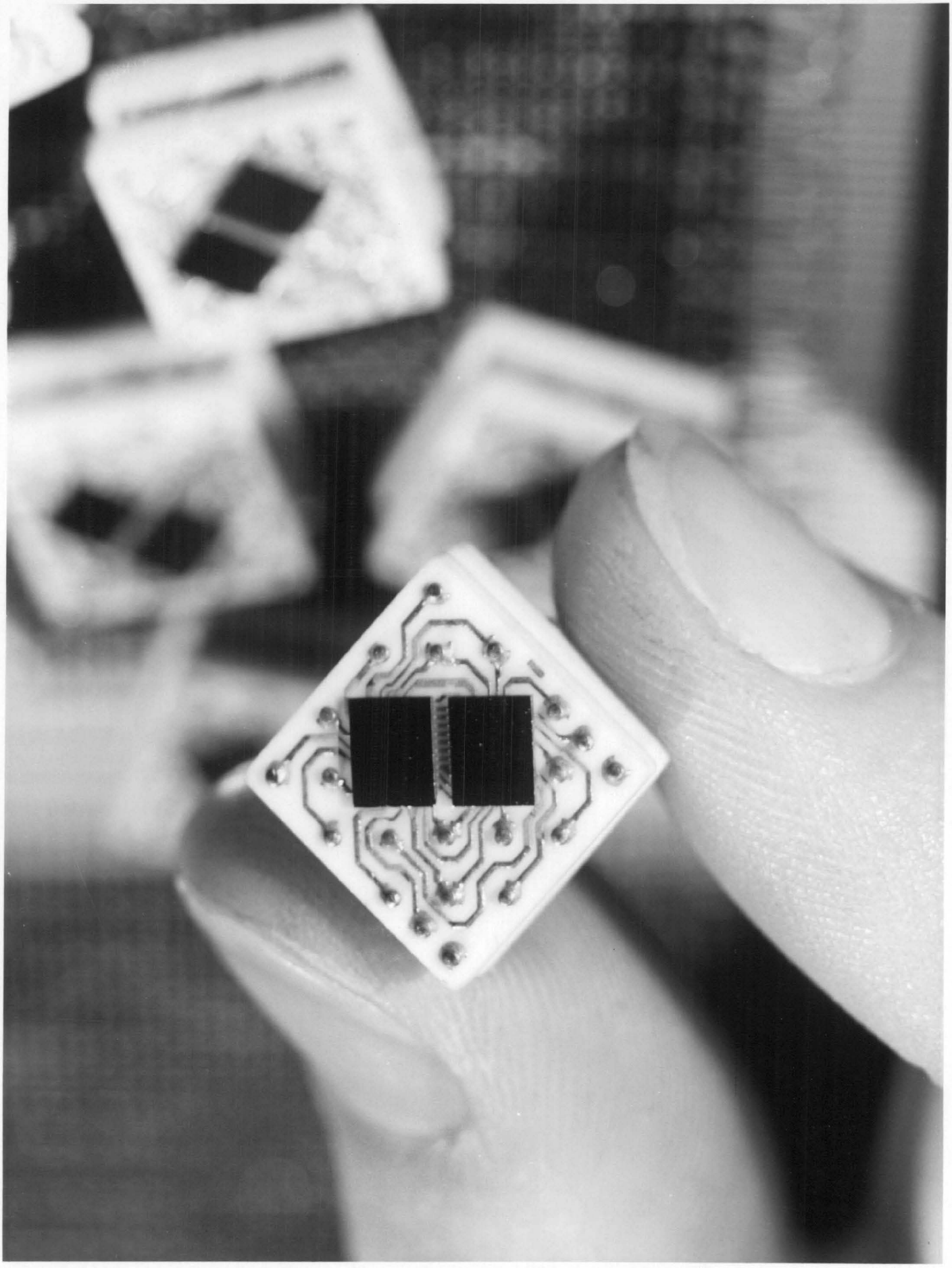

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TINY DATA STORAGE CIRCUITS: Silicon chips, each about one-eighth-inch square, contain 1,024 microscopically small monolithic data storage circuits for use in the newly announced IBM System/370 Models 158 and 168. These are the most compact main storage circuits ever used in IBM computers, and are fabricated with advanced metal oxide semiconductor field-effect transistor (MOSFET) technology. Two of the chips are shown here mounted on a ceramic base, which is assembled into a tiny four-chip storage module containing 4,096 circuits. Because of this highly dense circuit technology, Models 158 and 168 have a faster instruction execution rate and require significantly less floor space than computers of similar data capacity that use conventional ferrite cores for main storage. The new computers also can take advantage of virtual storage, an advanced technique announced today for System/370 that makes it possible to work with a computer as if it had a main storage many times its actual capacity.

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