The Evolution of IBM Mainframes and VM

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9140 The Evolution of IBM Mainframes and VM

- Many sites using or exploring Linux on zSeries are new to IBM mainframes or new to VM.
- This session will provide an overview of the evolution of IBM mainframes that has brought us to today's zSeries family.
- We will also review the history and evolution of VM from CP/67 to z/VM Version 4.
In the Beginning…
The family tree – 1952 to 1964

- Several mainframe families announced, designed for different applications
- Every family had a different, incompatible architecture
- Within families, moving from one generation to the next was a migration
  - Common compilers made migration easier – COBOL and FORTRAN
IBM 701 – 1952

1st generation

- The first IBM large-scale electronic computer manufactured in quantity
- IBM's first commercially available scientific computer
- The first IBM machine in which programs were stored in an internal, addressable, electronic memory
- The first of the pioneering line of IBM 700 series computers, including the 702, 704, 705 and 709

701
IBM 305 RAMAC – 1956

1st generation

- The first computer to include a disk drive (named the IBM 350 Disk File)
- Prior to this magnetic computer storage had consisted of core memory, tape, and drums
- The 350 Disk File consisted of a stack of fifty 24” discs
- The capacity of the entire disk file was 5 million 7-bit characters, which works out to about 4.4 MB in modern parlance
IBM 1401 – 1959

2nd generation

- The all-transistorized IBM 1401 Data Processing System placed the features found in electronic data processing systems at the disposal of smaller businesses, previously limited to the use of conventional punched card equipment.

- These features included: high speed card punching and reading, magnetic tape input and output, high speed printing, stored program, and arithmetic and logical ability.
IBM 1440 – 1962
2nd generation

- Low-cost system specifically designed to solve the increasing data handling problems of smaller volume businesses
- The 1440 met the need for a complete accounting system and offered the benefits of a business information system
- With a variety of models and special features available for the 1440, a system could be tailored to meet immediate data processing requirements and expanded to absorb increased demands
IBM 7094 – 1962

2nd generation

- Built for large-scale scientific computing
- Compatible with the IBM 7090, the advanced solid-state IBM 7094 offered substantial increases in internal operating speeds and functional capacities
- New expanded functions provided with the IBM 7094 were: double-precision floating-point operations and seven index registers
The April 1964 Revolution – 
3rd generation
During the 1950s, Data Processing came of age

- Data Processing machines existed – sorters, collators, tabulators
- "Computers" were devoted almost entirely to the processing of computationally intensive tasks
- Demand for computers, as data processing machines, boomed and new machines were built to meet this demand
- IBM decided to implement a wholly new architecture specifically designed both for data processing and to be compatible across a wide range of performance levels
- System/360 was designed with easily-managed overlapping of I/O and Central Processing, along with the ability to allow concurrent "multi-programming" of independent units of work
- Huge amounts of extra capacity were built into the architecture, such as the ability to address up to 16 Megabytes of main storage, and allowing for as many as seven data channels
System/360 – Announced April 7, 1964

- Customers were getting very frustrated with migration costs that came with processor upgrades
- IBM invested $1B to develop a family of processors with the same architecture
  - Architecture published in the S/360 Principles of Operation
  - 24-bit addressing (32-bit architecture)
- Solid logic circuit cards
- Common set of peripheral devices
- Family of operating systems
  - Operating System/360 (OS/360)
  - Disk Operating System/360 (DOS/360)
  - TOS, BPS, …
System/360 – a child is born

- One main storage, maximum size is 16MB
- One or two Central Processing Units (CPUs)
- One to seven Channels
  - Selector or Byte Multiplexor
  - Block Multiplexor
- Control Units (which connect to Channels)
- Devices (which connect to Control Units)
# S/360 family

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System/360 Model 67

- **First IBM system with virtual storage capabilities**
  - S/360 Model 65 with addition of the Dynamic Address Translation facility

- **Operating systems**
  - Time Sharing System
    - The “official” operating system from IBM Data Systems Division
  - Control Program/67 with the Cambridge Monitor System
    - The “unofficial” operating system from the IBM Cambridge Scientific Center

S/360-67

“DAT box”

University of Newcastle Upon Tyne
CP-67

- CP/CMS conceived in 1964 as a 2nd generation time-sharing system for S/360
- Influenced by Compatible Time-Sharing System (CTSS) from MIT on a modified 7094
- Key concept was that resource management (CP) and user support (CMS) were split
- Internal as CP-40 on a modified S/360-40 in 1966
- External as CP-67 on the S/360-67 later in 1966
  - “Type III” product – no charge
System/370 with Virtual Storage

- Compatible upgrade from S/360 with virtual storage
- First system designed using integrated circuits
- First multiprocessor models (158MP, 168MP)
- New peripherals
  - 3330/3340/3350 disk
  - 3211 printer
- Family of operating systems
  - OS/360 ➤ OS/VS
  - DOS/360 ➤ DOS/VS
  - CP/67 ➤ VM/370
S/370 – the architecture matures

- **Virtual storage**
  - 2KB or 4KB pages of memory
  - 64KB or 1MB segment sizes
  - Translation of virtual addresses to real addresses using Dynamic Address Translation (DAT) logic
  - Segment tables point to page locations

- **Channel architecture**
  - 256 channels

- **CPU changes**
  - Extended MP support via CPU address
# S/370 family

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Virtual storage capable models
VM/370

- Announced August 2, 1972 to assist customers in migration from OS/360 to OS/VS
  - System Control Programming (no-charge product)
  - Six releases through 1979
- Basic System Extensions (BSEPP) and System Extensions (SEPP) products available for VM/370 R5 and R6
  - Major functional enhancements were now chargeable
Data Processing Division
Program Announcement

VM/370 PROVIDES VIRTUAL MACHINE, VIRTUAL STORAGE, AND TIME SHARING SUPPORT FOR SIX SYSTEM/370 MODELS

SCP 0749-010


Its major functions are:

- Multiple concurrent virtual machines with virtual storage support.
- Time sharing support provided by a conversational subsystem.

Role of Function Announcements

VM/370 is complementary to OS/VS1, OS/VS2, and OS/VS3, offering our customers extended capabilities and additional virtual storage-based functions.

Ordered to the online environment, VM/370 can be a significant aid in the development and installation of new applications, and can help justify additional equipment through serviceable systems, additional storage and I/O, and CPU upgrade. It is used to help move customers from the mainframe system, and to help them when they get there.

VM/370 Highlights

- Virtual machine, virtual storage, and time sharing support.
- An environment of multiple concurrent operating systems, including DOS, DOS/VS1, OS/VS1, OS/VS2, and OS/VS3.
- Virtual storage facilities for operating systems which do not support Dynamic Address Translation, such as OS/VS1.
- A general purpose time sharing system suitable for use in high-ratio program development, available to customers beginning with a 2584.
- Capability of running many types of batch problem-solving applications from a remote terminal.
- Capability of performing system management, maintenance, and system testing concurrently with other work.

A high degree of security, isolation, and integrity of user systems.
- The ability for many users to test privileged code in their own virtual machines.
- An end to manual tasks requiring one operating system to communicate with another operating system.
- Device address independence for all supported operating systems.
- Multiple forms of disk protection, e.g., preventing users from writing the addresses of other specific areas.
- Ability to use virtual machines to provide backup for other systems.
- Option to improve the performance of selected virtual machines.
- Ability to run many System/370 emulators in virtual machines.

Customers who should consider VM/370

- Large, multi-system users; satellite systems for virtual machine applications and online program developments.
- Customers not yet large enough to utilize TSO and ISPF, but interested in utilizing program development and/or interactive application programs.
- Universities, colleges, and schools; time sharing applications for students, faculty, research, and administration.
- Users of non-IBM systems: VM/370 is a strong new IBM entry with many advanced functional capabilities.
- Customers considering conversion from DOS to OS/VS1. VM/370 can assist through its virtual machine function, and can supplement the DOS environment available with DOS systems.
- Mixed systems or mixed release installations, including those using FSL4 or modified back-up systems.

The capability of running multiple virtual machines should assist the customer in scheduling multiple operating systems and various mixes of production jobs, tests, program maintenance, and FE diagnostics. It can aid in systems development, reduce the problems of converting from one operating system to another, and provide more economical backup and test operating systems.

Time Sharing

The Conversational Monitor System (CMS) component of the VM/370 environment provides a general purpose time sharing facility that is independent of the operating system and program development, and can serve as a basis for interactive applications.

CMS, specifically designed to run under VM/370, provides broad functional capability with minimal installation requirements.

CMS can help programmers become more productive and efficient by requiring independent work. CMS allows non-programmers such as scientists, management, managers, and secretaries to become more productive with less training and access to computing facilities. CMS gives the user a wide range of interactive facilities, which are maintained and supported by a network of programs for each operating system. VM/370 allows CMS basic computing and networking many types of OS programs directly under CMS, writing up complete DOS or OS/VS programs, linked and executed job streams for running to DOS or OS virtual machines; and transferring the resultant output from those virtual machines back to CMS for selective analysis and correction from the user's remote terminal.

Language Support for CMS

A VM/370 System Assembler is distributed as a part of the system and is required for installation and maintenance. All necessary libraries are provided in CMS libraries.

The following is distributed with VM/370 as a convenience to the customer but is not part of the IC.

A BASIC language facility consisting of the CALL, OS BASIC (Ch. 11) Compiler and Execution Package related for use with CMS. This facility will replace Class A maintenance for the VM/370 Control Program System.

The following program products may also be ordered for use with CMS.

OS Full American National Standard
COBOL, V4 Grammar and Library
$734-C08

COBOL V4 Library
$734-LW7

FORTRAN IV FS1
$734-FS1

FORTRAN IV Library Mod I
$734-LR1

Ctalk and FORTRAN
$734-P01

FORTRAN IV Extended Mod I
$734-DL0

FORTRAN IV Library Mod II
$734-DL1

FORTRAN IV Library Mod III
$734-DL2

FORTRAN IV Library Mod IV
$734-DL3

PL/I Optimizing Compiler
$734-PFL1

PL/I Resident Library
$734-LRM

PL/I TRANS Library
$734-LRM

PL/I Optimizing Compiler
$734-PFL3


Availability

VM/370 has a planned availability of December 30, 1972, replacing the Dynamic Address Translation Facility, System/370 Models 135 and 166. Planned support for certain advanced VM/370 features, other System/370 machines, and additional I/O devices will be via Independent Component Releases on the dates shown below.

IC1, planned for April 1973, will support the System/370 Models 155 II, the 166, the integrated

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SHARE 102 - Session 9140
2003-02-24
Fire Alarm Features (4850) for 3230 Model 1 and 3230 Model 2, and the following additional VM/370 facilities:

- The Virtual-Real and Dedicated Channel performance enhancements.
- The virtual and real Channel-Connected Adapter.
- Support of C/C++ in a VM/370 environment.
- Support of OSA/390 in a VM/370 environment.
- The 3811 Control Unit and the 3211 Printer.

ICRU, planned for August 1972, will support the CMS Batch Facility, the Model 185, and the Integrated Storage Control (ISC) for the 185 and 190.

ICRU, planned for December 1972, will support the 185 II.

See the respective program product announcement letters for planned availability of the program product units for CMS.

Note: VM/370 requires the system paging facilities (i.e., the Disk Compressor and the CPU Timer).

Maintenance

Maintenance for VM/370 Release 1 will be provided by the VM/370 Central Programming Service until nine months after the next release of VM/370.

Education

See Education Announcement Letter E70-14 for details of VM/370 introduction, training, and additional educational plans.

Publications

IBM Virtual Machine Facility/370: Introduction (SC20-1800), available from Mechanicsburg. Other manuals to be available at a later date include:

- Introduction to the System/370
- Introduction to the System/370 Hardware
- Introduction to the System/370 Console Operations
- Introduction to the System/370 Command Language
- Introduction to the System/370 Terminal User
- Introduction to the System/370 Programmer's Guide
- Table of tool numbers will be announced in a future Publications Release Letter (PRL).

Reliability, Availability, and Serviceability (RAS)

VM/370 provides facilities which supplement the reliability, availability, and serviceability (RAS) characteristics of the System/370 architecture. See the sales manual or the introduction manual for details.

MVS/370

VM/370 planning information is available in the MVS/370 manual Library as an aid to setting and installing System/370.

No RAS will be accepted at this time.

Detailed information on the VM/370 system is in the manual page.
System/370 with Extended Architecture

- Evolution of S/370
- New peripherals
  - 3800 printer
  - 3370/3380 disk
  - 3480 tape
- Family of operating systems
  - OS/VS ➤ MVS/XA
  - DOS/VS ➤ VSE/SP
  - VM/370 ➤ VM/SP, VM/SP HPO, VM/XA (MA/SF, SP)
370-XA – radical surgery for the architecture

- **Extended storage addressing**
  - 24-bit or 31-bit addressing
  - 4KB pages in 1MB segments

- **Interpretive execution facility**
  - Start Interpretive Execution (SIE) instruction
  - SIE runs until interception condition raised
  - Used by PR/SM LPAR and VM/XA (and later)

- **370-XA channel design**
  - CHPIDs
  - Subchannels
VM/SP

- **VM/SP R1**
  - Announced 1980/02/11, GA 1980/12/12
  - MP, enhanced AP, CCS, EXEC2, SCIF, IUCV
  - 3278-5, 3279, 3380 data streaming, 3800

- **VM/SP R2**
  - Announced 1981/10/21, GA 1982/09/02
  - Programmable Operator (PROP)
  - SENDFILE, RECEIVE, RDRLIST, FILELIST, EXECIO

- **VM/SP R3**
  - Announced 1983/03/17, GA 1983/11/18
  - REXX, XEDIT, *BLOCKIO, PER, CMSIUCV
SHARE, VM, and the teddy bear

- The MVS Group had the turkey as their mascot
  - Changed in the early 1980s to the eagle

- At SHARE 60 in 1983 the VM Group decided to identify newcomers with yellow stickers and old timers with blue stickers, but no one could remember which was which

- Carol Jobusch bought a few hundred teddy bear stickers to identify the “warm, cuddly” old timers, and a mascot was born!
VM/SP

- **VM/SP R4**
  - Announced 1984/08/22, GA 1985/11/06
  - SNA

- **VM/SP R5**
  - Announced 1985/10/07, GA 1987/06/17
  - APPC/VM, TSAF, CMS Session Services, AFP

- **VM/SP R6**
  - Announced 1987/10/20, GA 1988/12/31
  - Shared File System (SFS), Callable Services Library (CSL)
VM/SP High Performance Option

- **VM/SP HPO R1**
  - VM/SP R1 base, Announced 1981/10/21, GA 1982/03/27
  - Performance enhancements for 3081-D16

- **VM/SP HPO R2**
  - VM/SP R1 base, Announced 1981/10/21, GA 1982/08/18
  - SPMODE support for MVS/SP V=R guests

- **VM/SP HPO R3**
  - VM/SP R2 base, Announced 1981/10/21, GA 1982/05/31
  - 32MB support, 3880-11 paging subsystem
VM/SP High Performance Option

- **VM/SP HPO R3.4**
  - VM/SP R3 base, Announced 1983/09/15, GA 1984/02/23
  - High performance paging subsystem

- **VM/SP HPO R4.2**
  - VM/SP R4 base, Announced 1985/02/12, GA 1986/02/28
  - SNA, Vector

- **VM/SP HPO R5**
  - VM/SP R5 base, Announced 1997/01/26, GA 1987/09/30
  - SPOOL file limit relief, performance enhancements
VM/XA Migration Aid and Systems Facility

- **VM/XA Migration Aid**
  - Tool to assist in migration from MVS/370 to MVS/XA
  - First use of Start Interpretive Execution (SIE)
  - R1 announced 1981-10-21, GA 1984-02-06
  - R2 announced 1984-02-15, GA 1984-10-31

- **VM/XA Systems Facility**
  - Support of CMS and production guest environments
  - Exploitation of SIE Assist for I/O performance
  - R1 announced 1985-02-12, GA 1985-09-30
  - R2 announced 1986-02-11, GA 1987-06-11
VM/XA SP

- **R1 announced 1987-06-11, GA 1988-02-15**
  - Large scale, bimodal CMS (24 and 31-bit)
- **R2 announced 1987-06-11, GA 1988-04-19**
  - SNA, US DoD C2 security evaluation
- **R2.1 announced 1989-10-24, GA 1989-12-29**
  - Support for production use in an LPAR
System/370 with Enterprise Systems Architecture

- **Extension of 370-XA**
  - Multiple 31-bit address spaces

- **Common set of peripheral devices**
  - 3390 disk
  - 3490 tape

- **Family of operating systems**
  - MVS/XA ➔ MVS/ESA
  - VSE/SP ➔ VSE/ESA
  - VM/XA SP ➔ VM/ESA
VM/ESA Version 1

- **V1.1 announced 1990-09-05, GA 1991-03-29**
  - Converged VM/SP, VM/SP HPO, VM/XA SP
- **V1.1.1 announced 1990-09-05, GA 1991-12-27**
  - CMS Pipelines
- **V1.2 announced 1992-06-16, GA 1992-12-18**
  - System configuration
- **V1.2.1 announced 1993-05-20, GA 1993-07-09**
  - Virtual disks
- **V1.2.2 announced 1994-04-06, GA 1994-06-10**
  - SPXTAPE, Minidisk cache, VMLINK, LOGON BY
VM/ESA Version 2

- **V2.1 announced 1994/09/13, GA 1995/10/27**
  - OpenEdition, CMS GUI
- **V2.2 announced 1996/09/10, GA 1996/12/20**
  - Year 2000, OSA/SF
- **V2.3 announced 1998/03/24, GA 1998/03/27**
  - TCP/IP, Java/NetRexx, LE (in base)
- **V2.4 announced 1999/05/24, GA 1999/07/23**
  - Dynamic CP exits
System/390 with Enterprise Systems Architecture

- Evolution of ESA/370
- Common set of peripheral devices
  - RAMAC, Shark disk
  - 3590 Magstar tape
- Family of operating systems
  - MVS/ESA ➤ OS/390
  - VSE/ESA
  - VM/ESA
### S/370 to ES/9000

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zSeries with z/Architecture

- **Evolution of ESA-390**
  - 24-bit, 31-bit, and 64-bit addressing supported concurrently

- **Family of operating systems**
  - OS/390 ➤ z/OS
  - VSE/ESA
  - VM/ESA ➤ z/VM
  - Linux
9672 to zSeries

G1 – 9672-Rn1, 9672-Enn, 9672-Pnn

G2 – 9672-Rn2, 9672-Rn3


G4 – 9672-Rn5

G5 – 9672-nn6 ———► 7060-nnn (MP3000)

G6 – 9672-nn7

zSeries – 2064 (z900) —► 2066 (z800)

zSeries – 2084 (z990)
z/VM

- **V3.1 announced 2000-10-03, GA 2001-02-23**
  - Enabling 64-bit guest operating systems
  - Real storage constraint relief
  - Native FlashCopy support for Enterprise Storage Server
  - Connectivity enhancements for TCP/IP

- **V4.1 announced 2001-05-29, GA 2001-07-20**
  - New pricing structure
  - Support for the IBM Integrated Facility for Linux
  - Improved performance for Linux guests
z/VM

- **V4.2 announced 2001-10-04, GA 2001-10-26**
  - HiperSockets high-speed internal TCP/IP network
  - Guest support for FICON CTCA communications
  - Guest LAN support
  - Ease-of-use functions for managing Linux images

- **V4.3 announced 2002-04-30, GA 2002-05-31**
  - Fibre Channel Protocol support
  - Simulation of a QDIO network adapter
  - TCP/IP stack security, performance and configurability
  - z/VM self-management to achieve guest performance goals
  - Better utilization of large real storage
z/VM

- **V4.4 announced 2003-05-13, GA 2003-08-15**
  - High-performance virtual FICON channel-to-channel adapters
  - Virtual LANs (VLANs)
  - External IP connectivity for Guest LANs through virtual switching
  - Improved logical-partitioning scalability due to logical channel subsystems
  - Twice the number of logical partitions (LPARs)
  - Better control, definition and dynamic reconfiguration of hardware I/O
  - Support for the new C/C++ for z/VM compiler
Summary

- From System/360 in 1964 to today’s z/Architecture, we have seen an evolution that has preserved customer investments in a unique way.
- From CP/67 as a research project and VM/370 as a migration tool, VM has evolved to today’s z/VM as the core of IBM’s virtualization strategy.
- Virtualization is now considered “standard” in the industry and all virtualization solutions owe much to the VM family.

“Legacy systems are systems that work!”
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