Virtualization Leadership born from 40 years of Experience

Throughout the history of z/VM, IBM's ground-breaking virtualization software for System z, key design principles formed the backbone or DNA of the family of z/VM products. The high level capabilities of z/VM are grounded in these original key design principles which include:

- A virtualization hypervisor, also called the Control Program, that would create virtual machines that replicate the IBM System z architecture (z/Architecture).
- Interfaces for virtual machines to interact with the hypervisor,
- Comprehensive management of virtual machines through various system services such as accounting, performance monitoring, and security management.
- Ability to run 1000s of virtual machines with diverse or disparate workloads within a single hardware footprint.
- Over commitment of real resources compared to total virtual resources.

These design principles continue to impact the nature of the workload on System z, where 36% of System z customers have at least one IFL (Integrated Facility for Linux) engine dedicated to Linux and z/VM workloads. In a System z environment z/VM 6.2 can support the rapid deployment of more Linux virtual servers than any other platform in a single footprint.

The adaptability of z/VM over its 40 year history has demonstrated IBM's commitment to provide innovative approaches that have in a nutshell, continually helped customers do more with less. On this 40th anniversary of z/VM, we trace the heritage with a light hearted twist and appreciate the origins of virtualization and the roots of IBM's virtualization leadership. Previous generations of z/VM went by various names. In this article, we'll refer to the virtualization offering by the current name "z/VM" when talking about the general z/VM family.

z/VM 40 year Lineage

The 1960s

z/VM can be traced back to IBM's Cambridge Scientific Center, a research and development lab that pioneered virtualization with CP/CMS. CP, Control Program, was the original hypervisor component which created multiple independent virtual machines (VMs), each a full virtualization of the underlying hardware, and CMS was a light-weight single-user operating system. CMS at the time stood for Cambridge Monitor System. Later renamed Conversational Monitor System,

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CMS continues to be a component in the z/VM today. CP/CMS would develop into various versions during the late 1960s and into the early 1970s: CP-40/CMS, CP-67/CMS, and CP-370/CMS. These developments parallel the introduction of IBM's System 360 and System 370 predecessors to the System z server family. Many people associate z/VM with the CP-67 which was tied to the S/360 Model 67 and introduced virtual memory in May 1966, the same year the Monkees released I'm a Believer.

The 1970s

While earlier CP/CMS software was made available as source informally to customers, the first official release of the technology was VM/370 in August 2, 1972, a month after Neil Diamond's Song Sung Blue hit number 1 on the charts. This was done in conjunction with the first S/370 servers with virtual memory. IBM continued to provide source to customers and a community of users and their modifications was born. The ability to run several operating systems at the same time while providing the system stability that came from isolating users from each other (a bug in one user's system could not cause another user's system to also crash) was key to VM/370 acceptance and adoption in the market.

The 1980s

The next decade brought many enhancements and changes for new hardware support. The use of z/VM for more than just virtualization increased as various applications were created for it. Some customers started to use z/VM for a development and deployment platform; z/VM is not only a hypervisor, but also an operating system. This was also the decade where middleware products such as databases became prevalent for z/VM when used as an operating system. It was the 1980's when Olivia Newton John topped the chart for 10 weeks with Physical and when one of the most influential changes was the z/VM-inspired logical partitions (PR/SM for LPAR) which effectively provided two levels of virtualization. Customers could now share the same set of CPUs, I/O adapters, devices and networking cards across z/VM systems running in different LPARs, allowing capacity to shift from one z/VM system to another – enabling the IT organization to provide consistent performance for their end users while handling spikes in workload. To address widening demographics of customer environments, the z/VM family multiplied to three separate products being available at the end of decade:

- VM/SP – various releases of this multi-purpose virtualization operating system were created. It would tend to run on the smaller System z servers
- VM/SP HPO – for larger System z servers, a High Performance Option (HPO) was introduced

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- VM/XA – this flavor of the product supported the S/370 Extended Architecture, hence the XA

The 1990s

The three members of the z/VM family converged in the early 1990s into a single product, VM/ESA. This new system also supported the new Enterprise Systems Architecture (ESA). The late 1980s and early 1990s saw the rise of applications in the CMS environment on VM/ESA creating a very diverse workload environment. Millions of OfficeVision seats, IBM's premier product for email, calendaring, and document management were deployed on small CMS virtual machines and run alongside other guest operating systems such as TPF, MVS, and VSE which had much different resource demands. It was the end of the 1990s however that profoundly changed the demographics of guests on VM. The fundamental "share everything, host anything" design of VM/ESA made it a natural landing pad for Linux applications, the same year (1999) as Santana featuring Rob Thomas had the monster hit Smooth.

The 2000s

The wave of enthusiasm for Linux on System z that came with the ability to consolidate thousands of distributed servers led to heightened interest in VM/ESA in the beginning of the new millennium. As competitors chased so-called mainframe-like technology IBM announced z/Architecture in October 2000 providing 64-bit addressing for new System z servers shortly after 'N Sync's hit It's Gonna Be Me. On the heels of that announcement z/Architecture support was added to VM/ESA and it was renamed z/VM. The first 64-bit based z/VM was generally available in February of 2001. As of 2012, there have been 10 releases of z/VM with the most current being z/VM 6.2 made available on December 2, 2011 while many people were listening to Colbie Caillat sing Brighter than the Sun.

The 2010s

Last year's release of z/VM 6.2 introduced support for multi-system virtualization and virtual system mobility, which allows up to four z/VM system instances on other LPARs or other System z servers to be clustered and serviced as a single system image cluster. This simplifies the life cycle management of the z/VM hypervisors and the virtual servers. Live guest relocation allows customers to move running Linux virtual servers without disruption to the business to help clients avoid planned outages when performing maintenance and also provides enhanced workload balancing with the added ability to move work to available resource in addition to long standing capability to move system resources to work.

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In the previous decade, z/VM advanced technology with the introduction of Virtual Switches and virtualization of FCP SCSI devices. z/VM continues to embrace the new and enhance the old. Technology to connect the previous HiperSockets connectivity (firmware-based high-speed communication) and Virtual Switches via a bridge was added to z/VM in April of 2012, again showing the advantage of software and hardware teams working together to benefit customers.

Faithful Replication of Architecture

z/VM duplicates an exact model of the architecture in a virtual machine. The design principle that a virtual machine operates according to all the rules of a real machine has been part of z/VM for over four decades. By "eating our own cooking" and using z/VM to develop and test software for new architecture and hardware, z/VM has earned the reputation of trusted virtualization. ISVs with over 3000 applications for Linux on System z have a greater confidence that it will run in a virtual machine.

The Original Cloud

While the phrase "Cloud Computing" wasn't in vogue in z/VM's early days when The Rolling Stones sang Get Off of My Cloud in 1966, the benefits of it were realized by z/VM customers over the decades and took many forms. Within IBM, developers of other System z operating systems and software gained great advantage by having their own virtual machines running on hardware maintained and managed by others. Many customers used this same approach as well for both development of their own applications or testing of solutions provided by IBM and ISVs. Other companies acted as service bureaus to provide early clouds to different customers, again having a group maintain and manage the systems outside of their corporations. Another form of cloud is the z/VM based disaster recovery solutions. These could be either internal or external to a company. Today, the fundamental strength of z/VM to not only share all system resources with very high levels of resource utilization but also manage those resources as a single pool provides a more manageable infrastructure for cloud computing. The framework of Infrastructure as a Service is augmented by a number of IBM Tivoli products, which add significant value to a reliable cloud solution.

The z/VM Community

The community of developers and users of z/VM is one of its greatest strengths. It brings a heritage of all its own. As z/VM changed over the decades, so did the way in which the

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community interacted and helped one another. Early in the life of z/VM user groups provided and shared modifications to the product. Customers would satisfy their own requirements by making enhancements. The z/VM community has also been a large influence in guiding IBM for what changes in the product would be most beneficial. The same year KC and Sunshine Band sang (Shake Shake Shake) Shake Your Booty, the z/VM community became electronically 'social' when the VMSHARE electronic conference was started in 1976. That eventually became an internet listserver and today you'll find z/VM groups on all the social media outlets. The community continues to be a rich resource of expertise and help for customers and IBMers alike. The same community exists within IBM, where there are developers on the current product that are third generation IBMers. This sharing of information, and at time code modifications, pre-dated the Open Source movements of the current generation.

Adapting to Varying Workloads

One of the things you may have noticed in this historical look back is how the workloads differ from decade to decade. z/VM and the products before it adapted easily to handle homogeneous workloads of 25,000 or more relatively small virtual machines running CMS with OfficeVision in a single z/VM system to a much smaller number of larger disparate Linux systems with large database or WebSphere applications. An investment focus spanning six decades has resulted in the flexibility that z/VM affords there it is very common to have diverse workloads in terms of the size and resource requirements of the guests.

Conclusion

By remaining true to a set of design principles, z/VM has been able to bring value to customers for decades, resulting in virtualization leadership and brand loyalty that is second to none.

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Sidebar from Bob Rogers, IBM Distinguished Engineer

In 1970, I was a computer operator at the IBM Poughkeepsie Programming Center where OS/360 was developed. That year, a IBM S/360 Model 67 showed up on the floor. We had over a dozen machines on the floor but the Model 67 made itself conspicuous. It had a bell that would ring whenever any operator action was required. At the time, I was operating a Model 50 right next to the Model 67 and the bell drove me crazy - but not as crazy as it made me when I was assigned to operate the Model 67 and the bell was mine to respond to. Needless to say, learning that it was a thing called CP67 that caused the bell to ring did not in the least endear it to me and our relationship started on shaky ground. But, as I became more familiar with CP67 (and learned how to turn off the bell) I really came to love it. With two operators, it would do the work that used to be done on four Model 50s. Its ability to virtualize DASD made it so that one bank of 2314s could be shared by as many as three copies of OS/360. I could see that with the proper infrastructure, this CP67 could provide a way for the programmers to run their own test shots instead of having to come down to the machine room and bother me. And this did come to pass. Within a few years, we were running as many virtual machines as we had terminals in the terminal room. By then it was a S/370 Model 168 running the progeny of CP67 called VM/370. Productivity skyrocketed. I doubt that the software team in Poughkeepsie could have evolved z/OS to anything near what it is today if the testing had to be done by going down to the machine room and bothering someone like me. Much of the strength of z/OS as the operating system that runs Western Civilization is owed to the capabilities of z/VM. Without z/VM there would be no z/OS as we know it.

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