VM in a 64-bit World

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Abstract:

There's a lot of talk in the industry about 64-bit systems. And, there's some confusion because 64-bit can mean many different things, including: large real memory, 64-bit binary arithmetic, large files, and 16 exabyte virtual spaces. The speaker will cover these facets of 64-bit-ness, explaining what they really mean, and what they are good for. He will also discuss how VM/ESA already delivers many of the values of 64-bit by other means and provide a sketch of how VM might support a 64-bit architecture.

What are people calling 64-bit?

Many things :

- 64-bit internal busses
- 64-bit I/O adapters
- 64-bit offsets for large files
- large real storage
- 64-bit integer arithmetic
- 16 exabyte (2^{64}) virtual spaces
- UNIX ’98

Who’s got it?

Most alternate platforms have something

- AS/400 - "64-bits, no buts"
- RS/6000 - h/w and s/w available
- Compaq/Alpha - h/w and s/w available
- HP - h/w and s/w available
- SUN - h/w and s/w available
- NT on Merced - 2000 ??

64-bit : What's it good for?

Increased processor memory

- CPU speeds and memory densities are increasing
- An attractive way of improving system performance is to increase the memory size
- The RISC and Intel servers hit a wall at 2 GB (2^{31}) or 4 GB (2^{32}) of memory
- Therefore, an architecture that removes the storage size limitation is of paramount importance to these platforms

64-bit : What's it good for?

64-bit integer arithmetic

- Some programs need to manipulate large integers
- 64-bit arithmetic can be 'emulated' on a 32-bit machine, but at 3-10x overhead for the actual operations
- Value is a function of the intensity of 64-bit integer arithmetic
  - Limited value for commercial workloads
  - 10 times almost nothing is still almost nothing

64-bit: What's it good for?

Virtually unlimited virtual

- Applications and middleware access real memory 'through' virtual
- Large virtual spaces enable the use of large real memory
- But, again, most platforms hit a wall at 2 GB or 4 GB of virtual memory per address space
- So, a 64-bit architecture is essential to these platforms

What about VM/ESA today?

Large processor memory

- Expanded Storage was introduced in the 1980s
- Current maximum physical processor memory size for IBM processors is 32 GB (CMOS G6)
- Expanded Storage is managed to provide system benefits transparently to guests
- Expanded Storage can be incrementally given to guests for their exclusive use
- Today, VM/ESA supports images much larger than 2 GB or 4 GB with superb response time for real customer workloads

What about VM/ESA today?

64-bit arithmetic

- Fortran has long supported a 64-bit integer data type for scientific computation

Large virtual memory

- VM is a hypervisor (its virtual memory is guest real) VM/ESA supports the full ESA/390 architecture for its guests

Addressing Architecture Constraint

RISC-UNIX, WINTEL
31- and 32-bit systems

Addressing Architecture Constraint

VM/ESA
with Enhanced 31-bit

What about the Future?

- IBM is developing a 64-bit architecture for S/390
- A 64-bit architecture includes:
  - Large real storage support - up to 16 exabytes which is 16 million trillion
  - Large virtual address spaces - also up to 16 exabytes
  - 64-bit integer arithmetic
  - Interpretive execution of the architecture for virtualization by VM/ESA

What about the Future?

- New terminology
  - Gigabyte - 2^{30}
  - Terabyte - 2^{40}
  - Petabyte - 2^{50}
  - Exabyte - 2^{60}

What might VM do for 64-bit?

- Objectives of VM 64-bit support
  - Facilitate IBM and ISV development and test of 64-bit code for OS/390 and other 64-bit Operating Systems
  - Facilitate customer migration and test
  - Support larger VM and guest images
  - Improve performance

What might VM do for 64-bit?

- 64-bit architecture would be used to:
  - Allow 64-bit-architecture guests, including guests with more than 2 GB of guest-real (host-virtual) storage
  - Continue to support ESA/390 guests
  - Exploit large real for hypervisor paging and Minidisk Cache (MDC)
- Don't expect to initially see:
  - 64-bit application support under CMS
  - V=R or V=F guests with more than 2GB

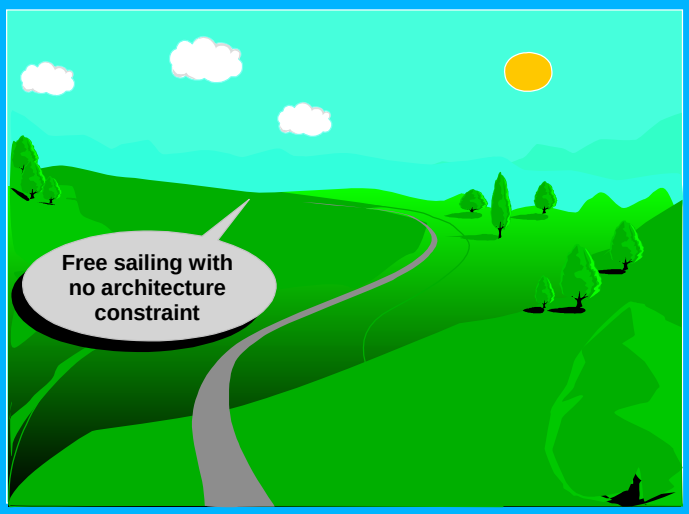
Compatability and Migration

- A single product operates on either ESA/390 or 64-bit systems
- On 64-bit systems, the installation chooses which architecture to use
- On 64-bit systems, guests can run under the ESA/390, ESA/XC, or 64-bit architectures
- The 64-bit VM can participate in a mixed CSE environment

Large Real Memory Use

- Processor memory configurable as Central+Expanded, or as all Central
- Expanded storage can still be incrementally assigned to guests
- Initial uses of real above 2GB
  - Pageable pages
  - Minidisk Cache (MDC)

Addressing Architecture Constraint



VM/ESA
with 64-bit support

How Can You Prepare?

- Since this is an opportunity to drop some deprecated CP functions, reorganize things internally, and generally clean up CP, requirements or guidance along these lines would be timely now
- User modifications and other CP-dependent code might experience more than the usual amount of upheaval when this support arrives
  - One way to limit that is to exploit the CP Exits facility to isolate user changes
- ***DO NOT*** depend upon a delay in the delivery of VM support after availability of hardware and OS/390 support

Summary

- **Alternate platforms are implementing 64-bit right now**
  - **They need to !!**
- **Expanded Storage and ESA solved the same problems years ago**
- **As memories get larger, a 64-bit architecture will be needed to re-balance the system**
- **Few application programs can take direct advantage of 64-bit virtual. Most will continue to be 31-bit**
- **IBM S/390 is committed to implementing the hardware and software technologies for S/390 to support larger and more diverse workloads**

When we provide 64-bit support, it will be a smooth migration that protects your investment