HPC

Introducing HPC VM images—pre-tuned for optimal performance

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building a VM image that includes these best practices requires systems expertise and knowledge of Google Cloud. Starting with an HPC-optimized image can make it easier to maintain an image.

The HPC VM image makes it easy and quick to instantiate VMs that are tuned to achieve optimal CPU and network performance on Google Cloud. The HPC VM image is available at no additional cost via the Google Cloud Marketplace.

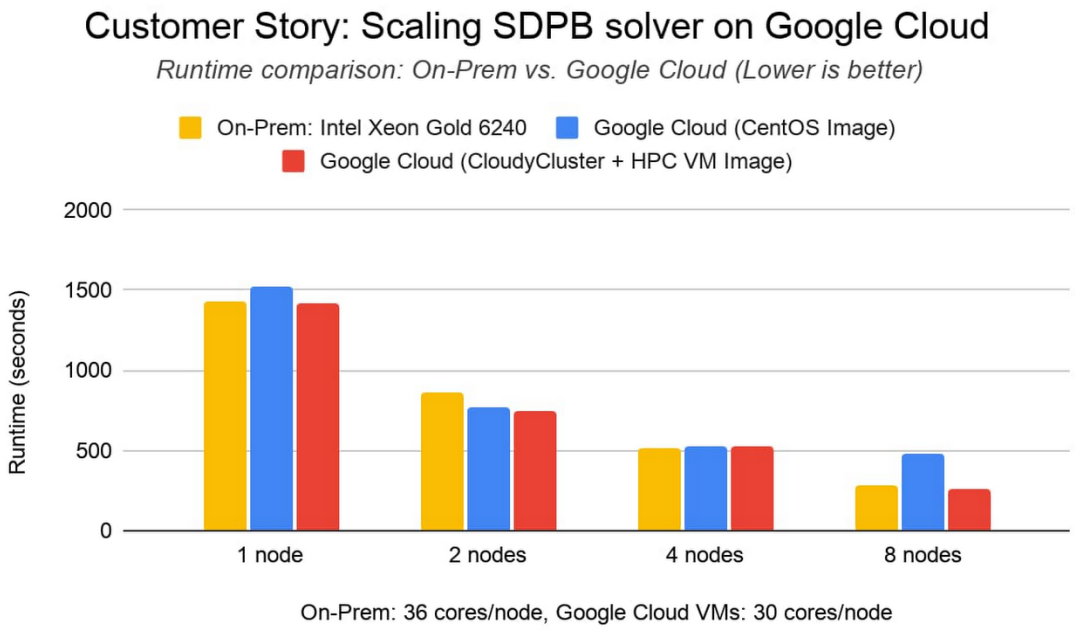
Continue reading below for details about the HPC VM image and its benefits, or skip ahead to our documentation and quickstart guide to start creating instances using the HPC VM image today!

Benefits of using the HPC VM image

The HPC VM image is pre-configured and regularly maintained, providing the following advantages to HPC customers on Google Cloud:

1. **Easily create HPC-ready VMs out-of the-box** that incorporate our best practices for tightly-coupled HPC applications. You can quickly create HPC-ready VMs and always stay up-to-date with the latest tunings.
2. **Networking optimizations for tightly-coupled workloads** help reduce latency for small messages, and benefit applications that are heavily dependent on point-to-point and collective communications.

leveraging the HPC VM image, Landry achieved comparable performance and scaling to an on-premises cluster at Yale, based on Intel Xeon Gold 6240 processors and Infiniband FDR.



Google Cloud's C2-Standard-60 instance type is based on the second-generation Intel Xeon Scalable Processor. The C2 family of instances can utilize placement policies to reduce inter-node latency, ideal for tightly-coupled MPI workloads. CloudyCluster

can decrease execution time for some HPC jobs.

- MPI collective tunings: The choice of MPI collective algorithms can have a significant impact on MPI application performance. HPC VM image includes recommended Intel MPI collective algorithms to use in the most common MPI job configurations.
- Increase tcp_*mem settings: C2 machines can support up to 32 Gbps bandwidth, and they benefit from larger TCP memory than Linux defaults.
- Enable busy polling: Busy polling can help reduce latency in the network receive path by allowing socket-layer code to poll the receive queue of a network device and by disabling network interrupts.
- Raise user limits: Default limits on system resources—like open files and numbers of processes that any one user can use—are typically unnecessary for HPC jobs where compute nodes in a cluster aren't shared between users.
- Disable Linux firewalls, Disable SELinux: For Google Cloud CentOS Linux images, SELinux and firewall is turned on by default. HPC VM image disables Linux firewalls and SELinux to improve MPI performance.
- Disable CPUIdle: C2 machines support CPU C-states to enter low-power mode and save energy. Disabling CPUIdle can help reduce jitter and provide consistent low latency.

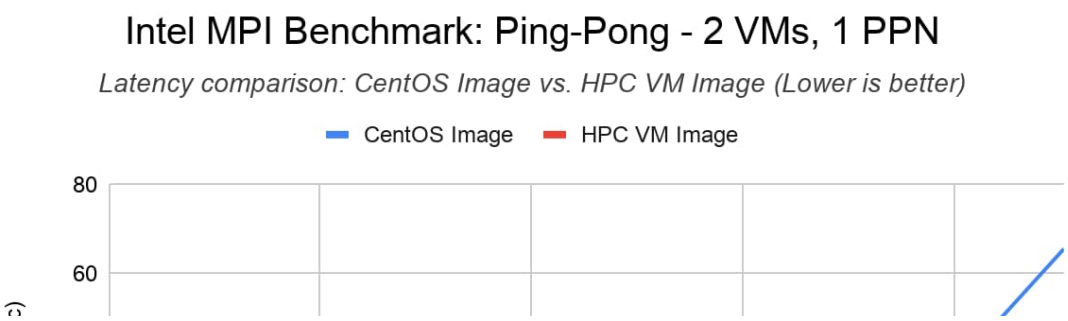
Intel MPI Benchmark (IMB) Ping-Pong

IMB Ping-Pong measures the ping-pong latency of transferring a fix-sized message between two ranks over a pair of VMs. On average, we saw that the HPC VM image reduces inter-node ping-pong latency by up to 50% compared to the default CentOS 7 Image (baseline).

Benchmark setup

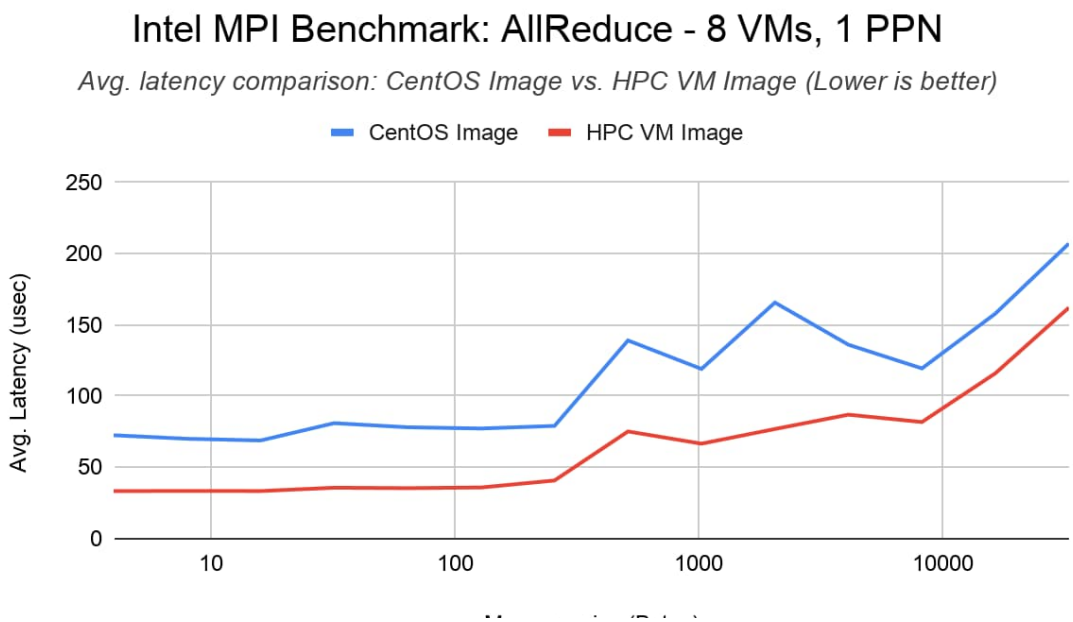
- 2x C2-standard-60 VMs with compact placement policy
- **MPI Library**: Intel MPI Library 2018 update 4
- **Command line**: mpirun -genv I_MPI_PIN=1 -genv I_MPI_PIN_PROCESSOR_LIST=0 -hostfile <hostfile> -np 2 -ppn 1 IMB-MPI1 Pingpong -iter 50000

Results



- 8x C2-standard-60 VMs with compact placement policy
- **MPI Library**: Intel MPI Library 2018 update 4
- **Command line**: mpirun -tune -genv I_MPI_PIN=1 -genv I_MPI_FABRICS ‘shm:tcp’ -hostfile <hostfile> -np <#vm*ppn> -ppn <ppn> IMB-MPI1 AllReduce -iter 50000 -npmin <#vm*ppn>

Results



HPC application benchmarks: LS-DYNA, Fluent and WRF

At an application level, the HPC VM image yielded up to a 25% performance improvement to the ANSYS LS-DYNA “3 cars” vehicle collision simulation benchmark when running on 240 MPI ranks across 8 Intel Xeon processor based C2 instances. With ANSYS Fluent and WRF, we observed up to 6% performance improvement using the HPC VM image in comparison with the default CentOS Image.

Benchmark setup

- **ANSYS LS-DYNA (“3-cars” model)**: 8 C2-standard-60 VMs with compact placement policy, using the LS-DYNA MPP binary compiled with AVX-2
- **ANSYS Fluent (“aircraft_wing_14m” model)**: 12 C2-standard-60 VMs with compact placement policy
- **WRF V3 Parallel Benchmark (12 KM CONUS)**: 16 C2-standard-60 VMs with compact placement policy
- **MPI Library**: Intel MPI Library 2018 update 4

Results

HPC Application Benchmarks: LS-DYNA, Fluent and WRF

Runtime comparison: CentOS Image vs. HPC VM Image (Lower is better)

be able to start HPC-ready clusters that make use of the HPC VM image by default (preview version is available here).

For customers who are looking for HPC Enterprise Linux options and support, SUSE is working with Google on a SUSE Enterprise HPC VM image that has been optimized for Google Cloud. If you're interested in learning more about SUSE Enterprise HPC VM image, or have a requirement for additional integrations or Linux distributions, please contact us.

Get started today!

The HPC VM image is available in Preview for all customers through the Google Cloud Marketplace today. Check out our documentation and quickstart guide for more details on creating instances using the HPC VM image.

Special thanks to Jiuxing Liu, Tanner Love, Jian Yang, Hongbo Lu and Pallavi Phene for their contributions.

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