Enabling High Performance Computing (HPC) in the Cloud

High performance computing (HPC) is one of the fastest growing segments in the computing industry. Scientists, engineers, designers, developers, and business users across a wide range of fields have found that the power of HPC can accelerate their research and development efforts, enabling new innovation and insight.

Many organizations are using HPC to do what they would otherwise do through physical experimentation, only faster and at lower cost. Others, in fields ranging from astrophysics to financial services, are using HPC to explore issues that defy physical experimentation altogether. In recent years, the demand for HPC has been growing even faster, as businesses have begun aggregating multiple servers into clusters to speed application performance for simulation, modeling, analytics, data visualization, machine learning, and more.

“Intel has deep relationships with the HPC and cloud communities, and is working with both to help solve the challenges that slow the adoption of cloud-based HPC.”

– Mauri Whalen, Intel Corporation Vice President, Director, Open Source Technology Center, Core System Software
Unfortunately, the cost and complexity of deploying a dedicated physical cluster remains a roadblock for many organizations. Cloud computing offers a potential solution by allowing people to create and access computing resources on demand. Yet meeting the complex software demands of an HPC application can be quite challenging in a cloud environment. In addition, running HPC workloads on virtualized infrastructure may result in unacceptable performance penalties for some workloads. Because of these issues, relatively few organizations have run production HPC workloads in either private or public clouds.

Breaking Down the Barriers
Intel engineers are working to simplify the delivery of HPC solutions across multiple cloud environments. A recent prototype demonstrated the viability of provisioning a complete HPC environment on bare metal servers in a private OpenStack cloud.

Solving the Software Challenge
An essential step in automating cluster provisioning is the creation of a reliable software stack that supports efficient parallel execution across multiple servers. This can be a significant challenge, requiring dozens of components to be obtained, integrated, and tested in conjunction with the desired end-user application.

Intel® HPC Orchestrator is designed to simplify this process by providing a pre-integrated software platform based on the OpenHPC community software stack. Intel HPC Orchestrator includes 60+ modular software components that are integrated, tested, and validated on Intel® architecture and with the Intel® Scalable System Framework. (See the sidebar, Transforming HPC at Every Level.) With this approach, system administrators can quickly create customized HPC software images for on-premise and cloud deployments, while maintaining a consistent application interface for end-user applications.

HPC Provisioning in an OpenStack Cloud
As performed by the Intel engineering team, the basic steps for setting up the HPC initialization package for an OpenStack cloud are as follows:

- **Setup an OpenStack bare metal cloud** environment using OpenStack core components Nova, Neutron, Glance, Keystone, and Ironic.
- **Setup a flat provider network** in the cloud using OpenStack Neutron to assign IP addresses to the bare metal nodes.
- **Build an HPC-enabled OS image** that is compatible with Intel HPC Orchestrator using the OpenStack Diskimage-builder utility and store the image in OpenStack glance.
- **Prepare a cloud-init recipe** for post-boot HPC configuration.
- **Boot the bare metal nodes** with HPC cloud-init. Register the physical machine into the resource pool of the OpenStack bare metal cloud using Ironic, then boot a bare metal instance using nova with the HPC cloud-init recipe.
- **Register the bare-metal instance with SLURM**, a workload manager in Intel® HPC Orchestrator.

After completion, the cloud resources appear as another hardware resource to the SLURM workload manager, and HPC workloads can be scheduled on the OpenStack cloud.
Transforming HPC at Every Level

Intel is working to accelerate the growth of HPC by breaking down the barriers to exascale performance, while simultaneously making it easier for organizations to purchase, deploy, and use HPC solutions.

A key element of this transformation is the Intel® Scalable System Framework (Intel® SSF), which provides optimized blueprints for balanced, high-performing clusters that are designed to help organizations get more value from every dollar they spend on HPC.

The Road Ahead

This prototype demonstrates that an OpenStack cloud can be used to provide HPC cluster resources on demand. It represents a useful step toward the more ambitious goal of enabling HPC solutions across private, public, and hybrid cloud environments. It is also part of a larger Intel effort to make HPC simpler and more cost-effective at every level, from small deskside clusters to exascale supercomputers.
Learn More

Intel in HPC

HPC at Every Level

Intel® HPC Orchestrator

Intel® Scalable System Framework

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