

# Entering a New Arena in Computing

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By: Munira Hussain, December 2016 – HPC Innovation Lab

In order to build a balanced cluster ecosystem and eliminate bottle-necks, the need for powerful and dense server node configurations is essential to support parallel computing. The challenge is to provide maximum compute power with efficient I/O subsystem performance, including memory and networking. Some of the emerging technologies along with traditional computing that are needed for intense compute power are advanced parallel algorithms in the areas of research, life science and financial application.

## **Dell PowerEdge C6320p**

The introduction of the Dell EMC C6320p platform, which is one of the densest and greatest maximum core capacity platform offerings in HPC solutions, provides a leap in this direction.

The PowerEdge C6320p platform is Dell EMC's first self-bootable Intel Xeon Phi platform. The previously available versions of Intel Xeon Phi were PCIE adapters that required a host system to be plugged into. From the core perspective, it supports up to 72 processing cores, with each core supporting two vector processing units capable of AVX-512 instructions. This increases the computation of floating point operations requiring longer vector instructions unlike Intel Xeon® v4 processors that support up to AVX-2 instructions. The Intel Xeon Phi in Dell EMC C6320p also features on-package 16GB of fast MCDRAM that is stacked on the processor. The availability of MCDRAM helps out-of-order execution in applications that are sensitive to high memory bandwidth. This is in addition to the six channels of DDR4 memory hosted on the server. Being a single socket server, the C6320p provides a low power consumption compute node compared to traditional two socket nodes in HPC.



The following table shows platform differences as we compare the current Dell EMC PowerEdge C6320 and Dell EMC PowerEdge C6320p server offerings in HPC.

|                                      | <b>C6320</b>  | <b>C6320p</b>   |
|--------------------------------------|---|---|
| <b>Server Form Factor</b>            | 2U Chassis with four sleds  | 2U Chassis with four sleds  |
| <b>Processors</b>                    |   |   |
|                                      | Dual Socket   | Single Socket   |
| <b>Processor Model</b>               | Intel® Xeon   | Intel® Xeon Phi   |
| <b>Max cores in a sled</b>           | Up to 44 physical cores, 88 logical cores<br><br>(with two * Intel® Xeon E5-2699 v4, 2.2 GHz, 55MB, 22 cores, 145W) | Up to 72 physical cores, 288 logical cores<br><br>(with the Intel® Xeon Phi Processor 7290 (16GB, 1.5GHz, 72 core, 245W)) |
| <b>Theoretical DP Flops per sled</b> | 1.26 TFlops/sec   | 2.9 TFlops/sec  |
| <b>Memory</b>                        |   |   |
| <b>DIMM slots</b>                    | 16 DDR4 DIMM slots  | 6 DDR4 DIMM slots + on-die 16GB MCDRAM  |
| <b>MCDRAM BW (Memory mode)</b>       | N/A   | <a href="#">~ 475-490 GB/s</a>  |
| <b>DDR4 BW</b>                       | <a href="#">~ 135 GB/s</a>  | ~ 90GBs   |
|                                      |   |   |
| <b>Interconnects</b>                 |   |   |
| <b>Provisioning fabric</b>           | Dual port 1Gb/10GbE   | Single port 1GbE  |
| <b>High Speed</b>                    | Intel Omni-Path Fabric (100Gbps)<br><br>Mellanox Infiniband (100Gbps)   | Intel Omni-PathFabric (100Gbps)<br><br>On-board Mellanox Infiniband (100Gbps)   |
| <b>Storage</b>                       |   |   |
|                                      | Up to 24 x 2.5" or 12 x 3.5" HD   | 6 x 2.5" HD per node +<br><br>Internal 1.8" SSD option for boot   |
| <b>Management</b>                    |   |   |

|   |                             |                             |
|---|-----------------------------|-----------------------------|
| <b>Integrated Dell EMC Remote Access Controller</b> | Dedicated and shared iDRAC8 | Dedicated and shared iDRAC8 |
|---|-----------------------------|-----------------------------|

Table 1: Comparing the C6320 and C6320p offering in HPC

## Dell EMC Supported HPC Solution:

Dell EMC offers a complete, tested, verified and validated solution offering on the C6320p servers. This is based on Bright Cluster Manger 7.3 with RHEL 7.2 that includes specific highly recommended kernel and security updates. It will also provide support for the upcoming RHEL 7.3 operating system. The solution provides automated deployment, configuration, management and monitoring of the cluster. It also integrates recommended Intel performance tweaks, as well as required software drivers and other development toolkits to support the Intel Xeon Phi programming model.

The solution provides the latest networking support for both InfiniBand and Intel Omni-Path Fabric. It also includes Dell EMC-supported System Management tools that are bundled to provide customers with the ease of cluster management on Dell EMC hardware.

*\*Note: As a continuation to this blog, there will be follow-on micro-level benchmarking and application study published on C6320p.*

| <p>OS name: <b>Linux</b></p> <p>OS version: <b>3.10.0-327.36.3.el7.x86_64</b></p> <p>OS flavor: <b>RedHat7 u2</b></p> <p>Motherboard manufacturer: <b>Dell Inc.</b></p> <p>Motherboard name: <b>0D2RR8</b></p> <p>Bios vendor: <b>Dell Inc.</b></p> <p>System manufacturer: <b>Dell Inc.</b></p> <p>System name: <b>PowerEdge C6320p</b></p> <p>Vendor tag: <b>Not Specified</b></p> <p>Bios date: <b>12/001/2016</b></p> <p>Bios version: <b>1.1.3</b></p>  |                  | <p><b>Disk Information</b></p> <table border="1"> <thead> <tr> <th>Name</th> <th>Model</th> <th>Size</th> </tr> </thead> <tbody> <tr> <td>sdb</td> <td>ST91000640NS</td> <td>931.51 GiB</td> </tr> <tr> <td>sda</td> <td>MZ8LM120HCFD00D3</td> <td>111.79 GiB</td> </tr> </tbody> </table> |          |         | Name                      | Model | Size   | sdb     | ST91000640NS | 931.51 GiB | sda   | MZ8LM120HCFD00D3          | 111.79 GiB |   |   |          |         |                         |   |   |   |          |         |                         |   |   |   |          |         |                         |   |   |   |          |         |                         |   |   |   |          |         |                         |   |   |   |          |         |                         |   |   |   |          |         |                         |   |   |   |          |         |                         |
|--|------------------|--|----------|---------|---------------------------|-------|--------|---------|--------------|------------|-------|---------------------------|------------|---|---|----------|---------|-------------------------|---|---|---|----------|---------|-------------------------|---|---|---|----------|---------|-------------------------|---|---|---|----------|---------|-------------------------|---|---|---|----------|---------|-------------------------|---|---|---|----------|---------|-------------------------|---|---|---|----------|---------|-------------------------|---|---|---|----------|---------|-------------------------|
| Name   | Model            | Size   |          |         |                           |       |        |         |              |            |       |                           |            |   |   |          |         |                         |   |   |   |          |         |                         |   |   |   |          |         |                         |   |   |   |          |         |                         |   |   |   |          |         |                         |   |   |   |          |         |                         |   |   |   |          |         |                         |   |   |   |          |         |                         |
| sdb  | ST91000640NS     | 931.51 GiB   |          |         |                           |       |        |         |              |            |       |                           |            |   |   |          |         |                         |   |   |   |          |         |                         |   |   |   |          |         |                         |   |   |   |          |         |                         |   |   |   |          |         |                         |   |   |   |          |         |                         |   |   |   |          |         |                         |   |   |   |          |         |                         |
| sda  | MZ8LM120HCFD00D3 | 111.79 GiB   |          |         |                           |       |        |         |              |            |       |                           |            |   |   |          |         |                         |   |   |   |          |         |                         |   |   |   |          |         |                         |   |   |   |          |         |                         |   |   |   |          |         |                         |   |   |   |          |         |                         |   |   |   |          |         |                         |   |   |   |          |         |                         |
| <p><b>CPU Information</b></p> <table border="1"> <thead> <tr> <th>CPU id</th> <th>Core id</th> <th>Model name</th> <th>Speed</th> <th>Cache</th> <th>Current governor (others)</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>0</td> <td>Intel(R) Xeon Phi(TM) CPU 7290F @ 1.50GHz</td> <td>1498 MHz</td> <td>1024 KB</td> <td>performance (powersave)</td> </tr> <tr> <td>0</td> <td>1</td> <td>Intel(R) Xeon Phi(TM) CPU 7290F @ 1.50GHz</td> <td>1277 MHz</td> <td>1024 KB</td> <td>performance (powersave)</td> </tr> <tr> <td>0</td> <td>2</td> <td>Intel(R) Xeon Phi(TM) CPU 7290F @ 1.50GHz</td> <td>1498 MHz</td> <td>1024 KB</td> <td>performance (powersave)</td> </tr> <tr> <td>0</td> <td>3</td> <td>Intel(R) Xeon Phi(TM) CPU 7290F @ 1.50GHz</td> <td>1504 MHz</td> <td>1024 KB</td> <td>performance (powersave)</td> </tr> <tr> <td>0</td> <td>4</td> <td>Intel(R) Xeon Phi(TM) CPU 7290F @ 1.50GHz</td> <td>1500 MHz</td> <td>1024 KB</td> <td>performance (powersave)</td> </tr> <tr> <td>0</td> <td>5</td> <td>Intel(R) Xeon Phi(TM) CPU 7290F @ 1.50GHz</td> <td>1505 MHz</td> <td>1024 KB</td> <td>performance (powersave)</td> </tr> <tr> <td>0</td> <td>6</td> <td>Intel(R) Xeon Phi(TM) CPU 7290F @ 1.50GHz</td> <td>1302 MHz</td> <td>1024 KB</td> <td>performance (powersave)</td> </tr> <tr> <td>0</td> <td>7</td> <td>Intel(R) Xeon Phi(TM) CPU 7290F @ 1.50GHz</td> <td>1506 MHz</td> <td>1024 KB</td> <td>performance (powersave)</td> </tr> </tbody> </table> |                  |  |          |         |                           |       | CPU id | Core id | Model name   | Speed      | Cache | Current governor (others) | 0          | 0 | Intel(R) Xeon Phi(TM) CPU 7290F @ 1.50GHz | 1498 MHz | 1024 KB | performance (powersave) | 0 | 1 | Intel(R) Xeon Phi(TM) CPU 7290F @ 1.50GHz | 1277 MHz | 1024 KB | performance (powersave) | 0 | 2 | Intel(R) Xeon Phi(TM) CPU 7290F @ 1.50GHz | 1498 MHz | 1024 KB | performance (powersave) | 0 | 3 | Intel(R) Xeon Phi(TM) CPU 7290F @ 1.50GHz | 1504 MHz | 1024 KB | performance (powersave) | 0 | 4 | Intel(R) Xeon Phi(TM) CPU 7290F @ 1.50GHz | 1500 MHz | 1024 KB | performance (powersave) | 0 | 5 | Intel(R) Xeon Phi(TM) CPU 7290F @ 1.50GHz | 1505 MHz | 1024 KB | performance (powersave) | 0 | 6 | Intel(R) Xeon Phi(TM) CPU 7290F @ 1.50GHz | 1302 MHz | 1024 KB | performance (powersave) | 0 | 7 | Intel(R) Xeon Phi(TM) CPU 7290F @ 1.50GHz | 1506 MHz | 1024 KB | performance (powersave) |
| CPU id   | Core id          | Model name   | Speed    | Cache   | Current governor (others) |       |        |         |              |            |       |                           |            |   |   |          |         |                         |   |   |   |          |         |                         |   |   |   |          |         |                         |   |   |   |          |         |                         |   |   |   |          |         |                         |   |   |   |          |         |                         |   |   |   |          |         |                         |   |   |   |          |         |                         |
| 0  | 0                | Intel(R) Xeon Phi(TM) CPU 7290F @ 1.50GHz  | 1498 MHz | 1024 KB | performance (powersave)   |       |        |         |              |            |       |                           |            |   |   |          |         |                         |   |   |   |          |         |                         |   |   |   |          |         |                         |   |   |   |          |         |                         |   |   |   |          |         |                         |   |   |   |          |         |                         |   |   |   |          |         |                         |   |   |   |          |         |                         |
| 0  | 1                | Intel(R) Xeon Phi(TM) CPU 7290F @ 1.50GHz  | 1277 MHz | 1024 KB | performance (powersave)   |       |        |         |              |            |       |                           |            |   |   |          |         |                         |   |   |   |          |         |                         |   |   |   |          |         |                         |   |   |   |          |         |                         |   |   |   |          |         |                         |   |   |   |          |         |                         |   |   |   |          |         |                         |   |   |   |          |         |                         |
| 0  | 2                | Intel(R) Xeon Phi(TM) CPU 7290F @ 1.50GHz  | 1498 MHz | 1024 KB | performance (powersave)   |       |        |         |              |            |       |                           |            |   |   |          |         |                         |   |   |   |          |         |                         |   |   |   |          |         |                         |   |   |   |          |         |                         |   |   |   |          |         |                         |   |   |   |          |         |                         |   |   |   |          |         |                         |   |   |   |          |         |                         |
| 0  | 3                | Intel(R) Xeon Phi(TM) CPU 7290F @ 1.50GHz  | 1504 MHz | 1024 KB | performance (powersave)   |       |        |         |              |            |       |                           |            |   |   |          |         |                         |   |   |   |          |         |                         |   |   |   |          |         |                         |   |   |   |          |         |                         |   |   |   |          |         |                         |   |   |   |          |         |                         |   |   |   |          |         |                         |   |   |   |          |         |                         |
| 0  | 4                | Intel(R) Xeon Phi(TM) CPU 7290F @ 1.50GHz  | 1500 MHz | 1024 KB | performance (powersave)   |       |        |         |              |            |       |                           |            |   |   |          |         |                         |   |   |   |          |         |                         |   |   |   |          |         |                         |   |   |   |          |         |                         |   |   |   |          |         |                         |   |   |   |          |         |                         |   |   |   |          |         |                         |   |   |   |          |         |                         |
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**References:**

- 1) [http://www.dell.com/us/business/p/poweredge-c6320p/pd?ref=PD\\_OC](http://www.dell.com/us/business/p/poweredge-c6320p/pd?ref=PD_OC)
- 2) [http://en.community.dell.com/techcenter/high-performance-computing/b/general\\_hpc/archive/2016/11/11/cryo-em-in-hpc-with-knl](http://en.community.dell.com/techcenter/high-performance-computing/b/general_hpc/archive/2016/11/11/cryo-em-in-hpc-with-knl)