MetaComp ICFD++
Performance Benchmarking and Profiling

Oct 2018
The following research was performed under the HPC Advisory Council activities
- Compute resource - HPC Advisory Council Cluster Center

The following was done to provide best practices
- MetaComp ICFD++ performance overview over AMD EPYC based platforms
- Understanding MetaComp ICFD++ communication patterns

More info on MetaComp ICFD++ Application
MetaComp ICFD++

- **Computational Fluid Dynamics (CFD)**
  - Enables the study of the dynamics of things that flow
  - Enable better understanding of qualitative and quantitative physical phenomena in the flow which is used to improve engineering design

- **CFD brings together a number of different disciplines**
  - Fluid dynamics, mathematical theory of partial differential systems, computational geometry, numerical analysis, Computer science

- **MetaComp ICFD++ is a part of MetaComp’s CFD software suite**
  - ICFD++ can be used to simulate compressible and incompressible fluids and flows, unsteady and steady flows, large range of speed regimes including low speeds through subsonic, transonic, supersonic and hypersonic speeds, laminar and turbulent flows, various equations of state
Cluster Configuration

• **Venus cluster**
  - Supermicro AS-2023US-TR4 8-node cluster
  - Dual Socket AMD EPYC 7551 32-Core Processor @ 2.00GHz
  - Mellanox ConnectX-5 EDR 100Gb/s InfiniBand
  - Mellanox Switch-IB 2 SB7800 36-Port 100Gb/s EDR InfiniBand switch
  - Memory: 256GB DDR4 2677MHz RDIMMs per node
  - 240GB 7.2K RPM SSD 2.5" hard drive per node

• **Software**
  - OS: RHEL 7.5, MLNX_OFED 4.4
  - MPI: HPC-X 2.2
  - MetaComp ICFD++ 18.1
MetaComp ICFD++ Performance

METACOMP CFD++ 18.1
(3D_CHANNEL)

Steps/Min

<table>
<thead>
<tr>
<th>Number of Nodes</th>
<th>2</th>
<th>4</th>
<th>8</th>
</tr>
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<tbody>
<tr>
<td>Steps/Min</td>
<td>100</td>
<td>200</td>
<td>350</td>
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EPYC, EDR InfiniBand

Higher is better
MetaComp CDF++ Application Profile (8 nodes AMD EYPC)

- 16.14% MPI and WallClock of 765 seconds
### Communication pattern

<table>
<thead>
<tr>
<th>Communication Event Statistics (% detail, --- error)</th>
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<tbody>
<tr>
<td><strong>Comm Size</strong></td>
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<tr>
<td>----------------</td>
</tr>
<tr>
<td>MPI_BARRIER</td>
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<td>MPI_RECV</td>
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MetaComp CDF++ Application Profile (8 nodes AMD EYPC)

- Memory usage: ~10GB per node
MetaComp ICFD++ Application Profile (8 nodes AMD EYPC)

- Communication is done mainly between near ranks
• MetaComp performance testing over AMD EYPC based platform
  – An average of 63% scaling was achieved from 4 to 8 nodes

• MetaComp profiling on “3D_CHANNEL”
  – MPI communication accounts for 16.14% of overall wall clock time at 8 nodes
  – MPI_Recv is 66% of MPI, MPI_Barrier is 28% of MPI and MPI_Allreduce is 6% of MPI
  – Most communication is done between ranks that are close to each other
Thank You