The following research was performed under the HPC Advisory Council activities

- Special thanks for: HP, Mellanox

For more information on the supporting vendors solutions please refer to:


For more information on the application:

- http://www.mscsoftware.com/
MSC Nastran Application

- MSC Nastran is a widely used Finite Element Analysis (FEA) solver
- Used for simulating stress, dynamics, or vibration of real-world, complex systems
- Nearly every spacecraft, aircraft, and vehicle designed in the last 40 years has been analyzed using MSC Nastran
Objectives

• The presented research was done to provide best practices
  – MSC Nastran performance benchmarking
  – Interconnect performance comparisons
  – MPI performance comparison
  – Understanding MSC Nastran communication patterns

• The presented results will demonstrate
  – The scalability of the compute environment to provide nearly linear application scalability
Test Cluster Configuration

- **HP ProLiant SL230s Gen8 4-node “Athena” cluster**
  - Processors: Dual Eight-Core Intel Xeon E5-2680 @ 2.7 GHz
  - Memory: 32GB per node, 1600MHz DDR3 DIMMs
  - OS: RHEL 6 Update 2, OFED 1.5.3 InfiniBand SW stack

- **Mellanox ConnectX-3 VPI InfiniBand adapters**

- **Mellanox SwitchX SX6036 56Gb/s InfiniBand and 40Gb/s Ethernet Switch**

- **MPI: Platform MPI 8.1, Intel MPI 4.0.3**

- **Application: MSC Nastran 2012.1**

- **Benchmark Workload:**

  - **Input dataset:**
  - xl0tdf1: Power Train (Ndof: 529,257, SOL108, Direct Freq)
  - md0mdf1: Half Sphere (Ndof: 42,066 SOL 108, Direct Freq w/ Umfpack)
# About HP ProLiant SL230s Gen8

<table>
<thead>
<tr>
<th>Item</th>
<th>SL230 Gen8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Processor</td>
<td>Two Intel® Xeon® E5-2600 Series, 4/6/8 Cores,</td>
</tr>
<tr>
<td>Chipset</td>
<td>Intel® Sandy Bridge EP Socket-R</td>
</tr>
<tr>
<td>Memory</td>
<td>(512 GB), 16 sockets, DDR3 up to 1600MHz, ECC</td>
</tr>
<tr>
<td>Max Memory</td>
<td>512 GB</td>
</tr>
<tr>
<td>Internal Storage</td>
<td>Two LFF non-hot plug SAS, SATA bays or Four SFF non-hot plug SAS, SATA, SSD bays Two Hot Plug SFF Drives (Option)</td>
</tr>
<tr>
<td>Max Internal Storage</td>
<td>8TB</td>
</tr>
<tr>
<td>Networking</td>
<td>Dual port 1GbE NIC/ Single 10G Nic</td>
</tr>
<tr>
<td>I/O Slots</td>
<td>One PCIe Gen3 x16 LP slot 1Gb and 10Gb Ethernet, IB, and FlexF abric options</td>
</tr>
<tr>
<td>Ports</td>
<td>Front: (1) Management, (2) 1GbE, (1) Serial, (1) S.U.V port, (2) PCIe, and Internal Micro SD card &amp; Active Health</td>
</tr>
<tr>
<td>Power Supplies</td>
<td>750, 1200W (92% or 94%), high power chassis</td>
</tr>
</tbody>
</table>
| Integrated Management | iLO4  
hardware-based power capping via SL Advanced Power Manager            |
| Additional Features   | Shared Power & Cooling and up to 8 nodes per 4U chassis, single GPU support, Fusion I/O support |
| Form Factor           | 16P/8GPUs/4U chassis                                                      |
MSC Nastran Result (xl0tdf1)

- **Input dataset: xl0tdf1**
  - Car Body (Ndof 529,257, SOL111, Direct Frequency Response)
  - Memory: 520MB, SCR Disk: 5GB, Total I/O 190GB

- **Time reduced as more nodes are being utilized for computation**
  - Up to 74% in time saved by running on a 4 DMPs cluster versus 1 DMP

![MSC Nastran Profiling (xl0tdf1)](chart)

*Lower is better*
MSC Nastran Result (md0mdf1)

- **Input dataset: md0mdf1**
  - Half Sphere (Ndof 42,066, SOL108, Direct Freq w/ Umfpack)
  - Memory: 1GB, Total I/O 0.1GB

- **Time reduced as more nodes are being utilized for computation**
  - Up to 91% in time saved by running on a 16 DMPs versus 1 DMP

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**MSC Nastran Profiling**

(md0mdf1)

*Lower is better*
**MSC Nastran Result – Comparison (md0dmf1)**

- **Intel E5-2600 Series cluster delivers higher performance**
  - Up to 46% in higher performance than best published result* at 8 DMPs

- **Reference hardware configuration:**
  - Dual Intel Westmere X5682 @ 3.47GHz, Linux RHEL 6.1, 96GB 1333MHz DDR3 DIMMs

*Higher is better

*SMP=1

*http://www.mscsoftware.com/support/prod_support/nastran/performance/msc20121_par.cfm
**MSC Nastran Benchmark – Comparison (xl0tdf1)**

- **Intel E5-2600 Series cluster delivers higher performance**
  - Up to 39% in higher performance than best published result* at 4 DMPs

- **Reference hardware configuration:**
  - Dual Intel Westmere X5682 @ 3.47GHz, Linux RHEL 6.1, 96GB 1333MHz DDR3 DIMMs

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*Higher is better*
• Both Platform MPI and Intel MPI performs about the same
  – Intel MPI delivers slightly better performance
MSC Nastran Profiling – MPI Functions

- **Mostly used MPI functions**
  - `MPI_Recv` (50%) and `MPI_Ssend` (50%)

- **Mostly time consuming MPI functions**
  - `MPI_Recv` (61%) follows by `MPI_Ssend` (15%)
MSC Nastran Profiling – Message Size

- Majority of MPI messages are small messages
  - In the range of 0-64 bytes

![MSC Nastran Profiling](chart.png)
MSC Nastran Profiling – Disk IO

- Heavy disk write access is seen throughout the test run
  - Not much access for disk IO reads
  - Tests show that Nastran could benefit from better disk IO
MSC Nastran Summary

- **MSC Nastran Performance**
  - ProLiant G7 servers provide 46% higher performance than best published results
  - Test illustrates Using more DMPs allow Nastran to scale
  - Time reduced as more nodes are being utilized for computation
  - Both Platform MPI and Intel MPI performs about the same

- **MSC Nastran Profiling**
  - Frequent used message sizes
    - Small message are used the most frequently
  - Frequent used MPI functions
    - MPI_Recv and MPI_Ssend
  - Heavy disk write access is seen throughout the test run
  - Tests shows that Nastran could benefit from better disk IO
Thank You
HPC Advisory Council