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NETWORK OF EXPERTISE

ANSYS Fluent
Performance Benchmarking and Profiling

Oct 2018

Note

- **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**
  - ANSYS Fluent performance overview over AMD EPYC based platforms
  - Understanding Fluent communication patterns

- **More info on ANSYS Fluent**
  - https://www.ansys.com/products/fluids/ansys-fluent

ANSYS Fluent

- **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.

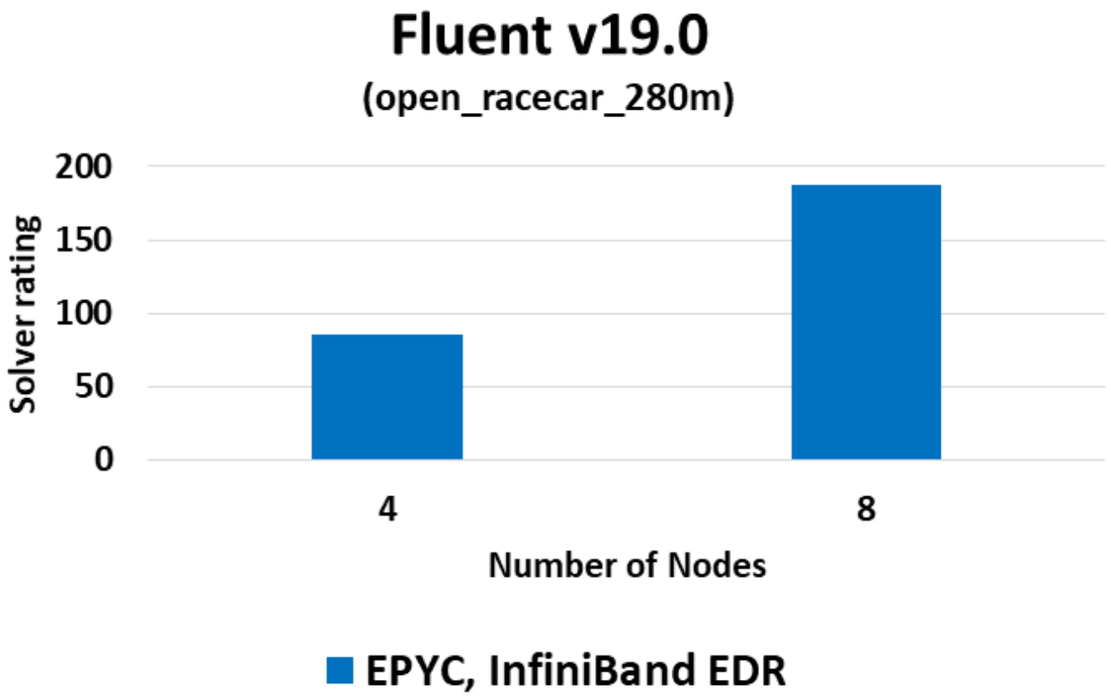
- **ANSYS FLUENT is a leading CFD application from ANSYS**
  - Widely used in almost every industry sector and manufactured product.

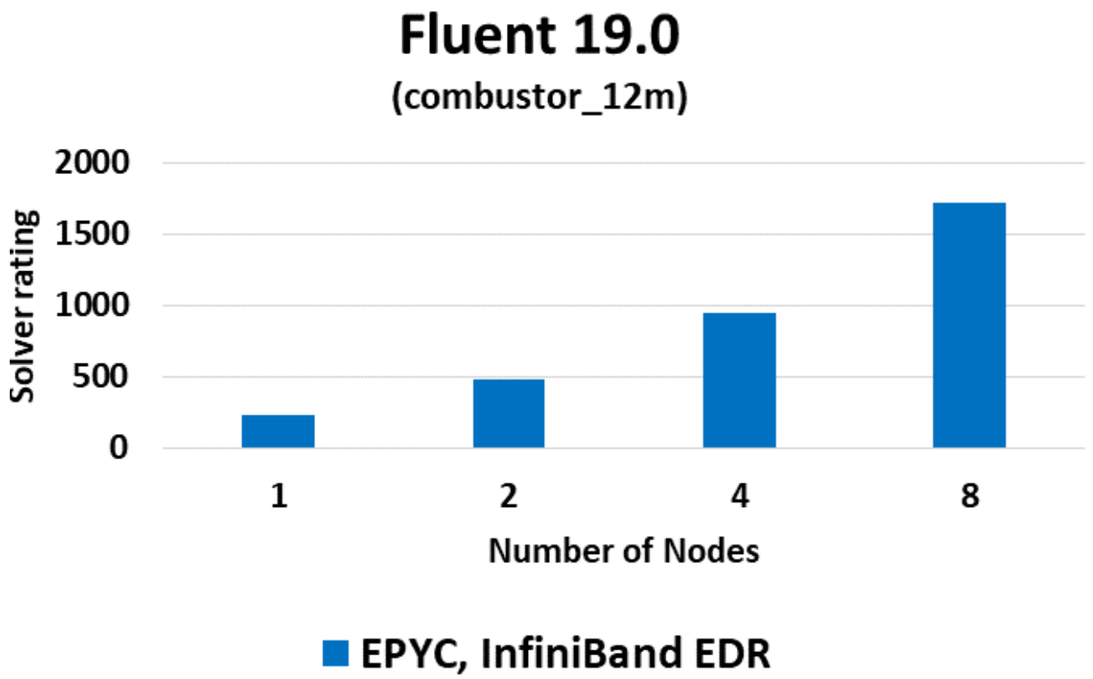
Cluster Configuration

- **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
  - ANSYS Fluent v19.0

Fluent Performance





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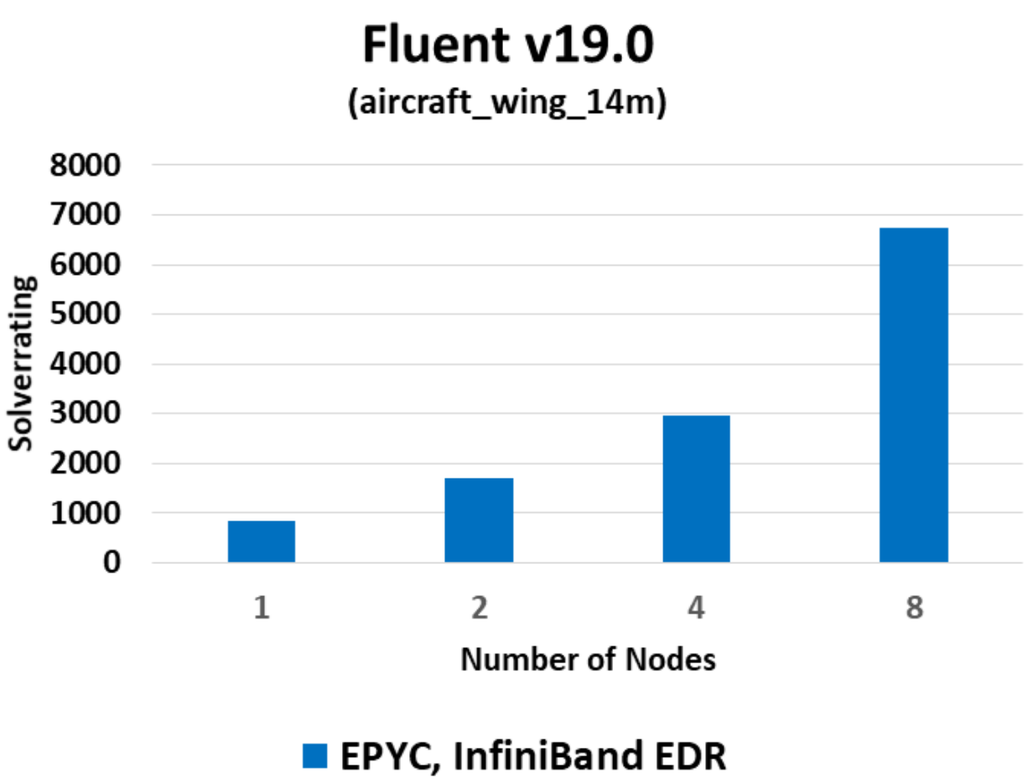
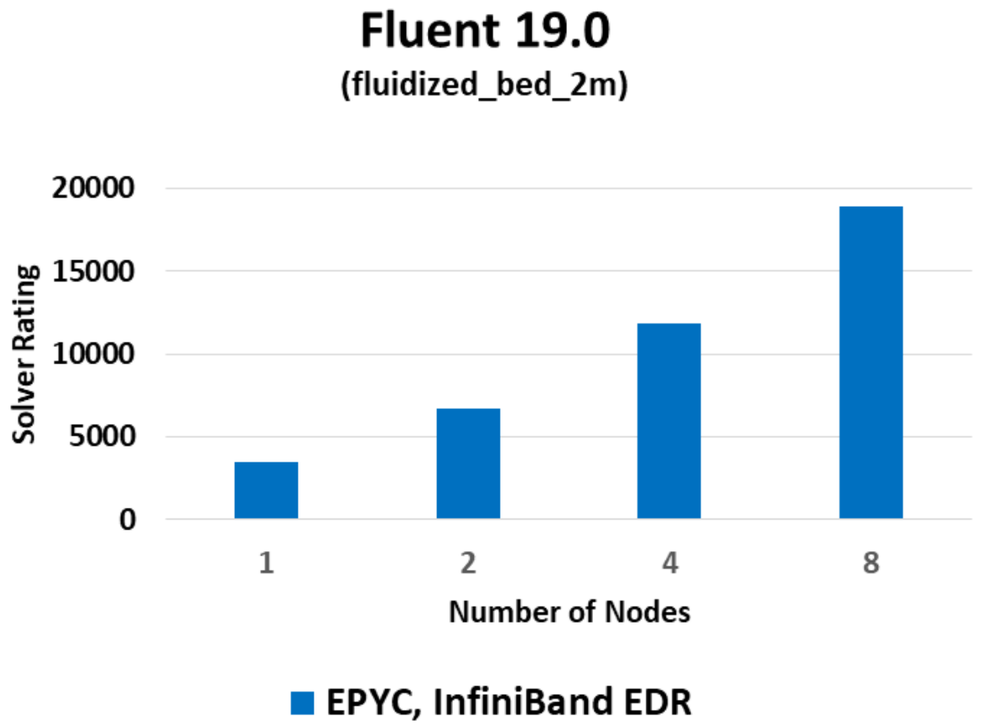
Fluent Performance





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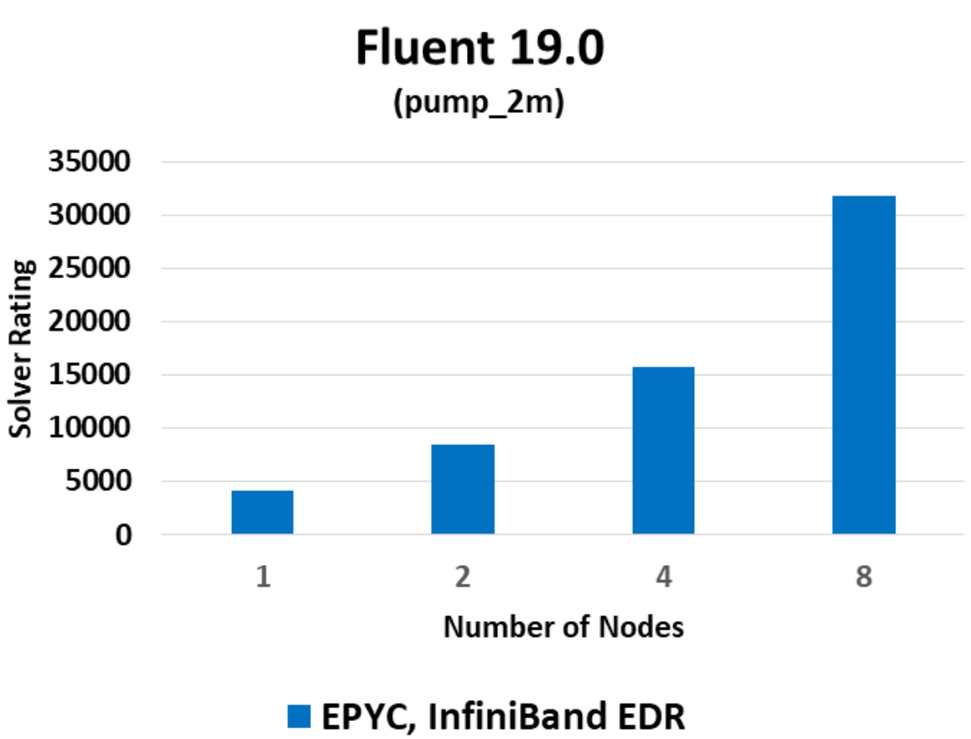

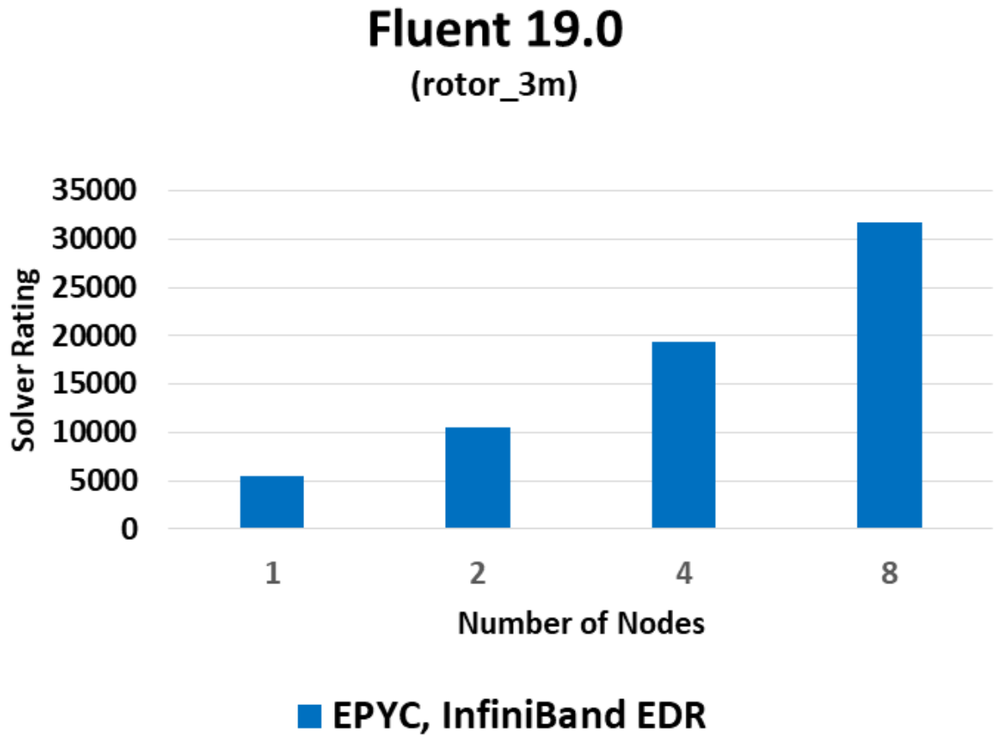

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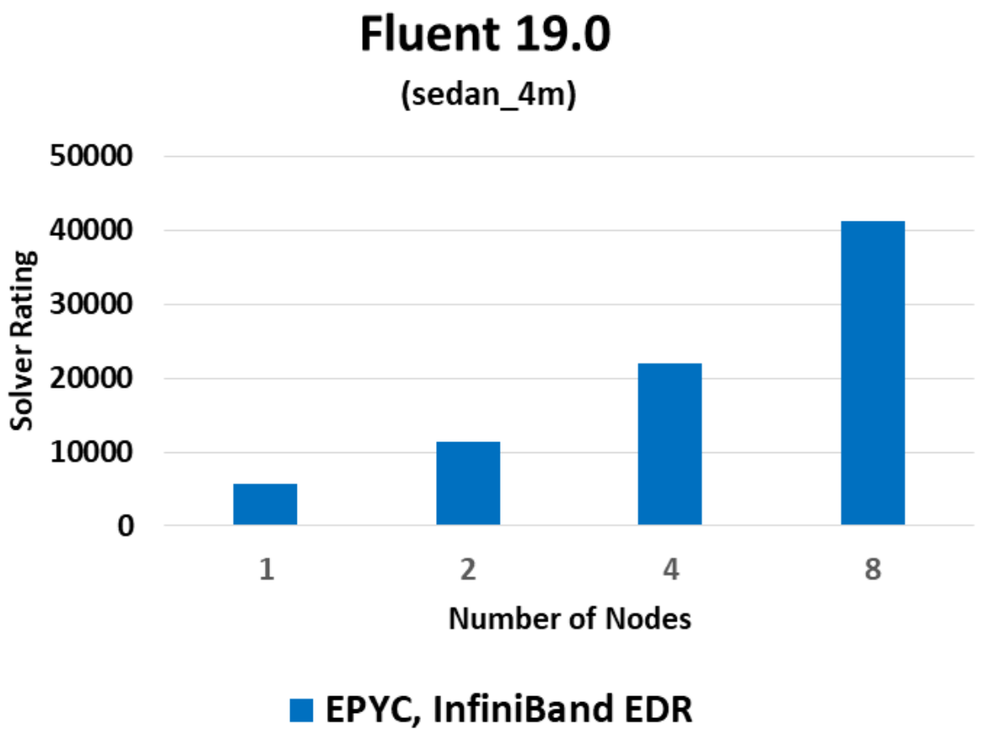

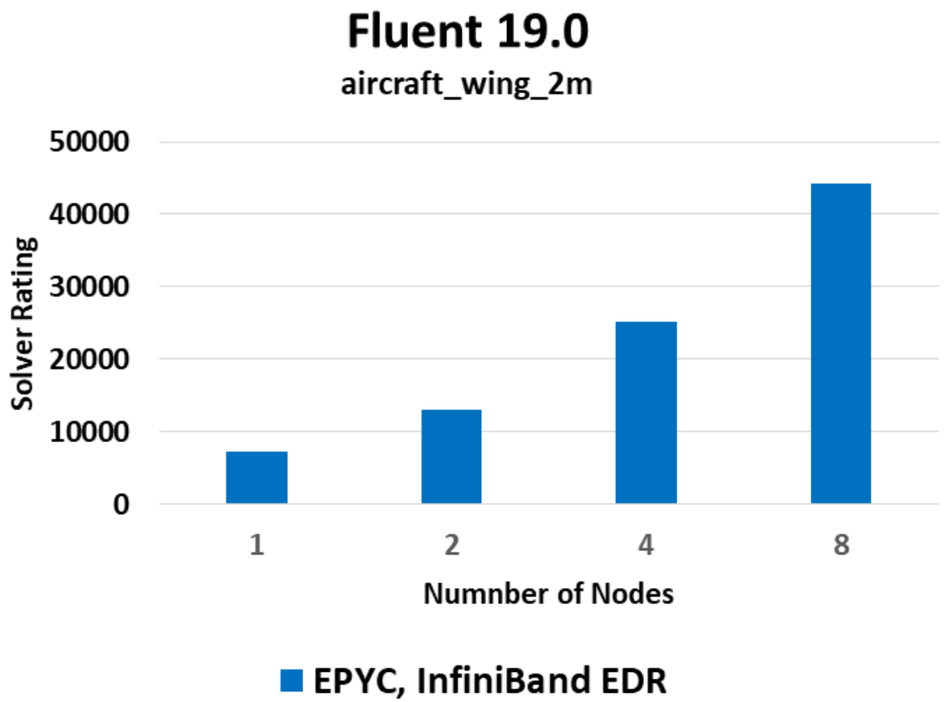

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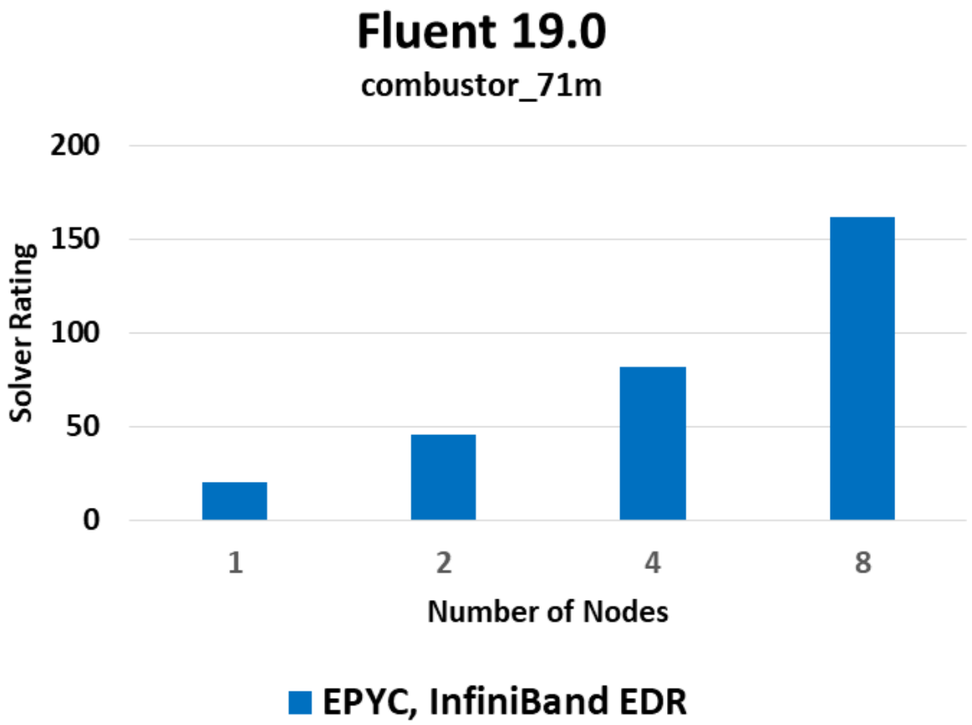

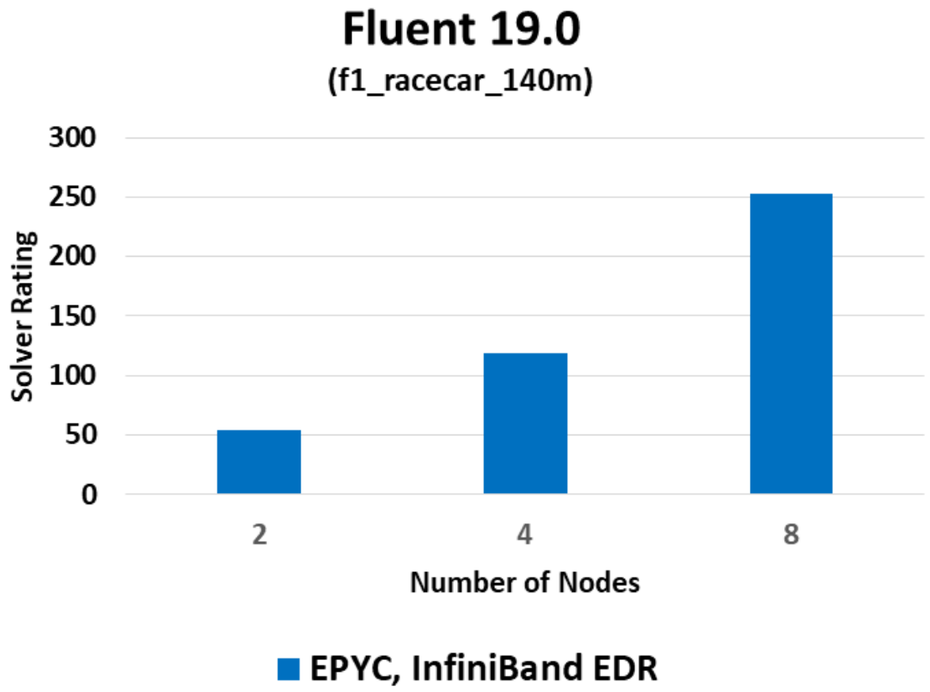

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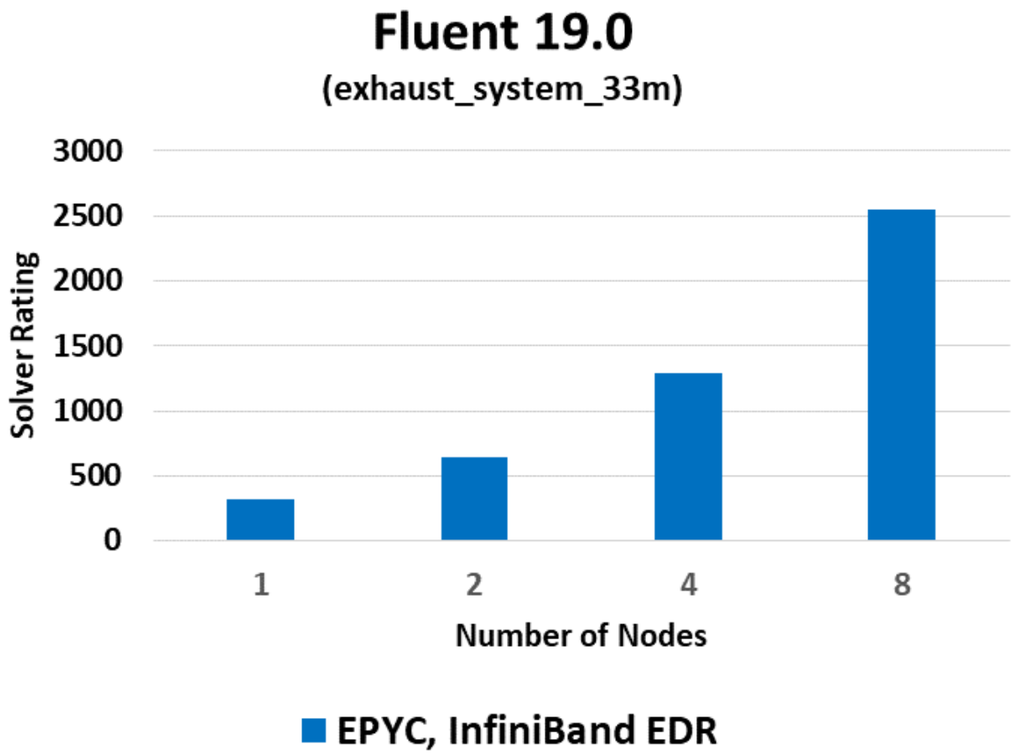

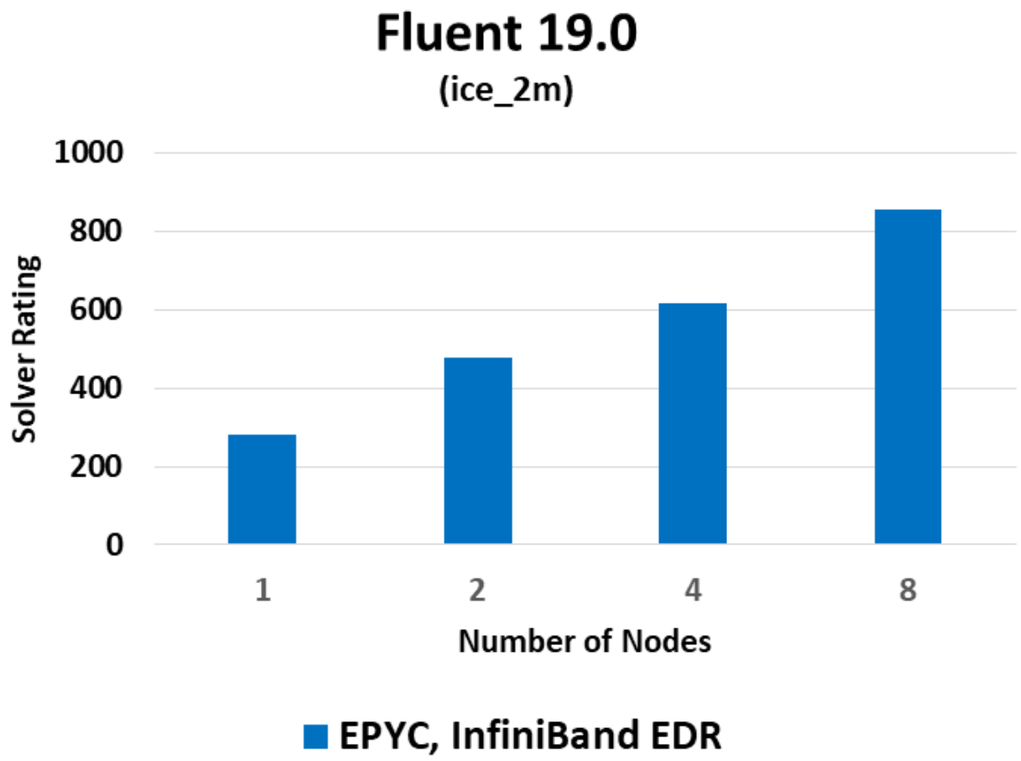

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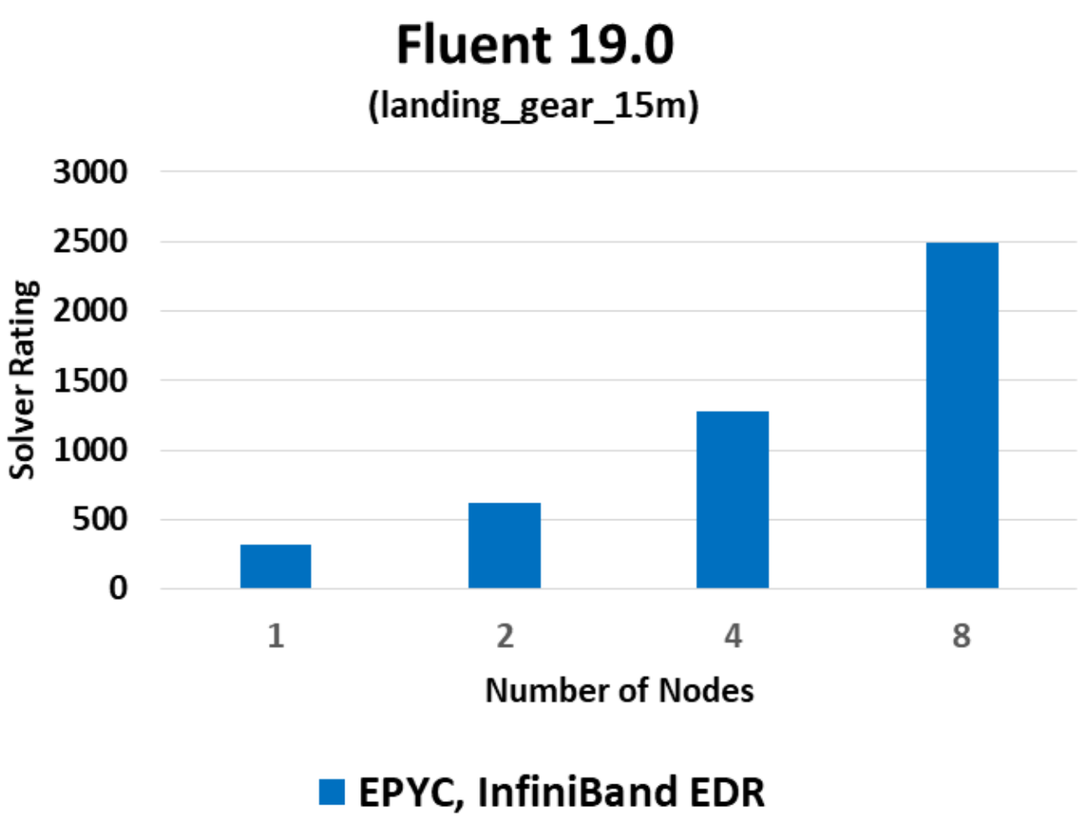

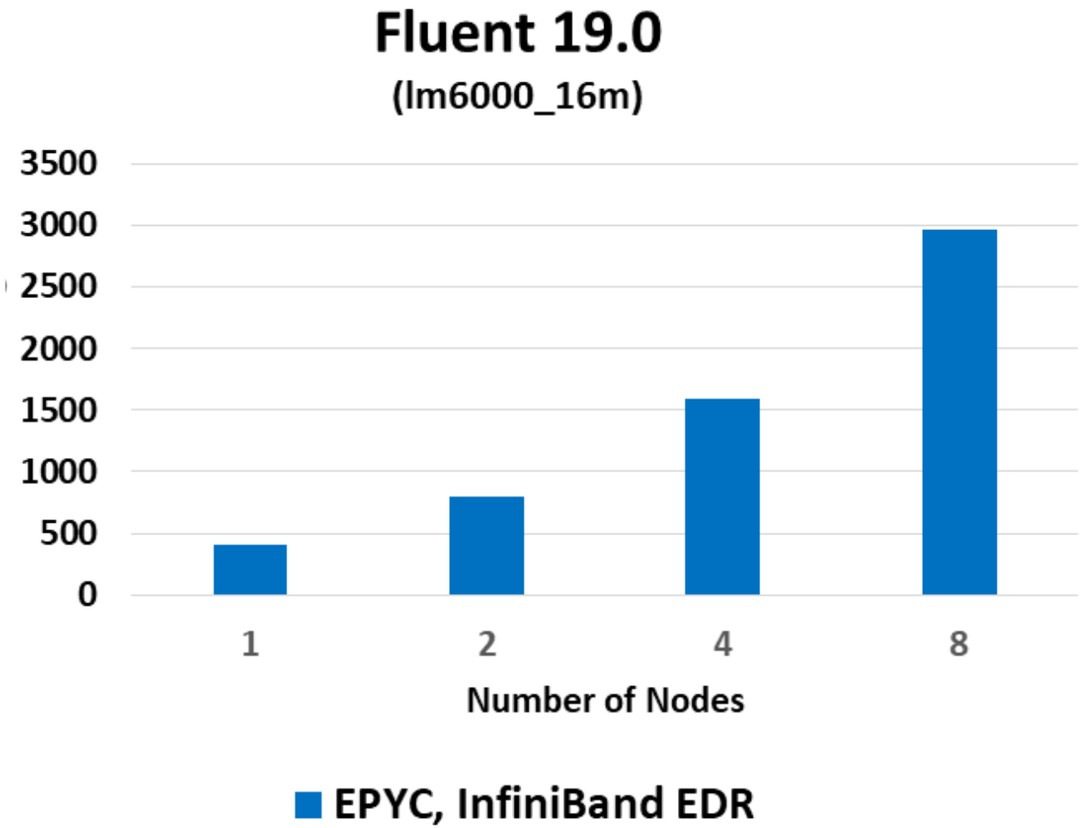

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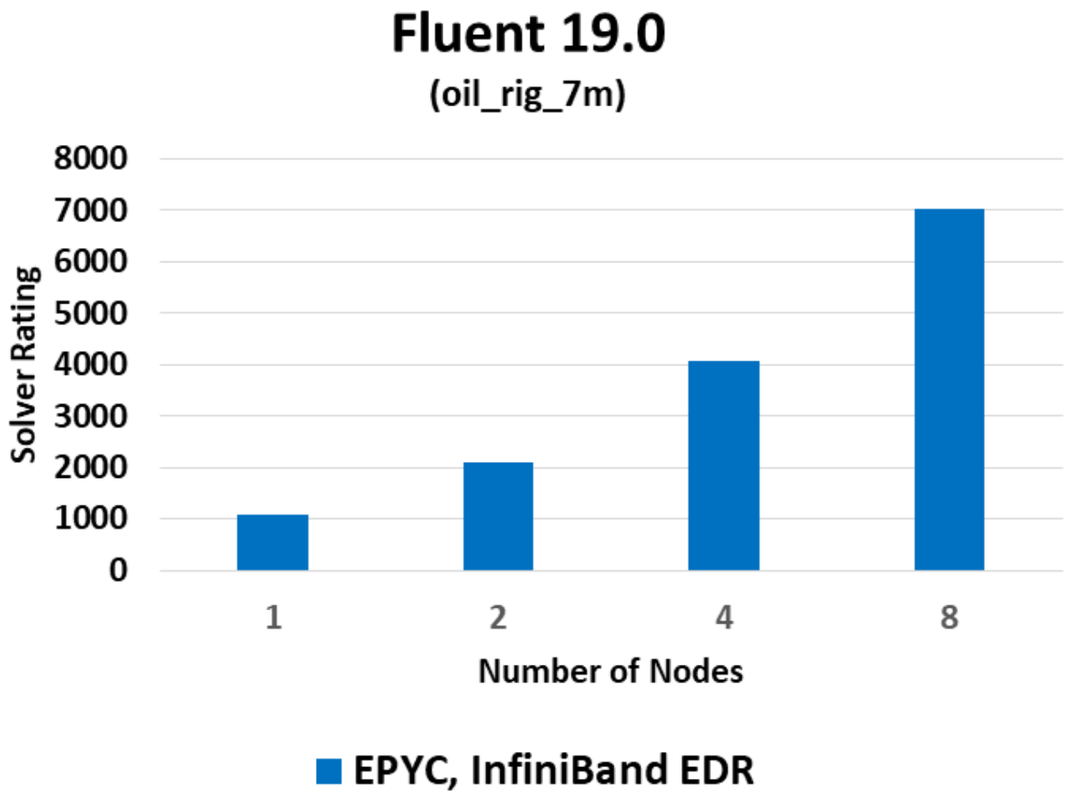

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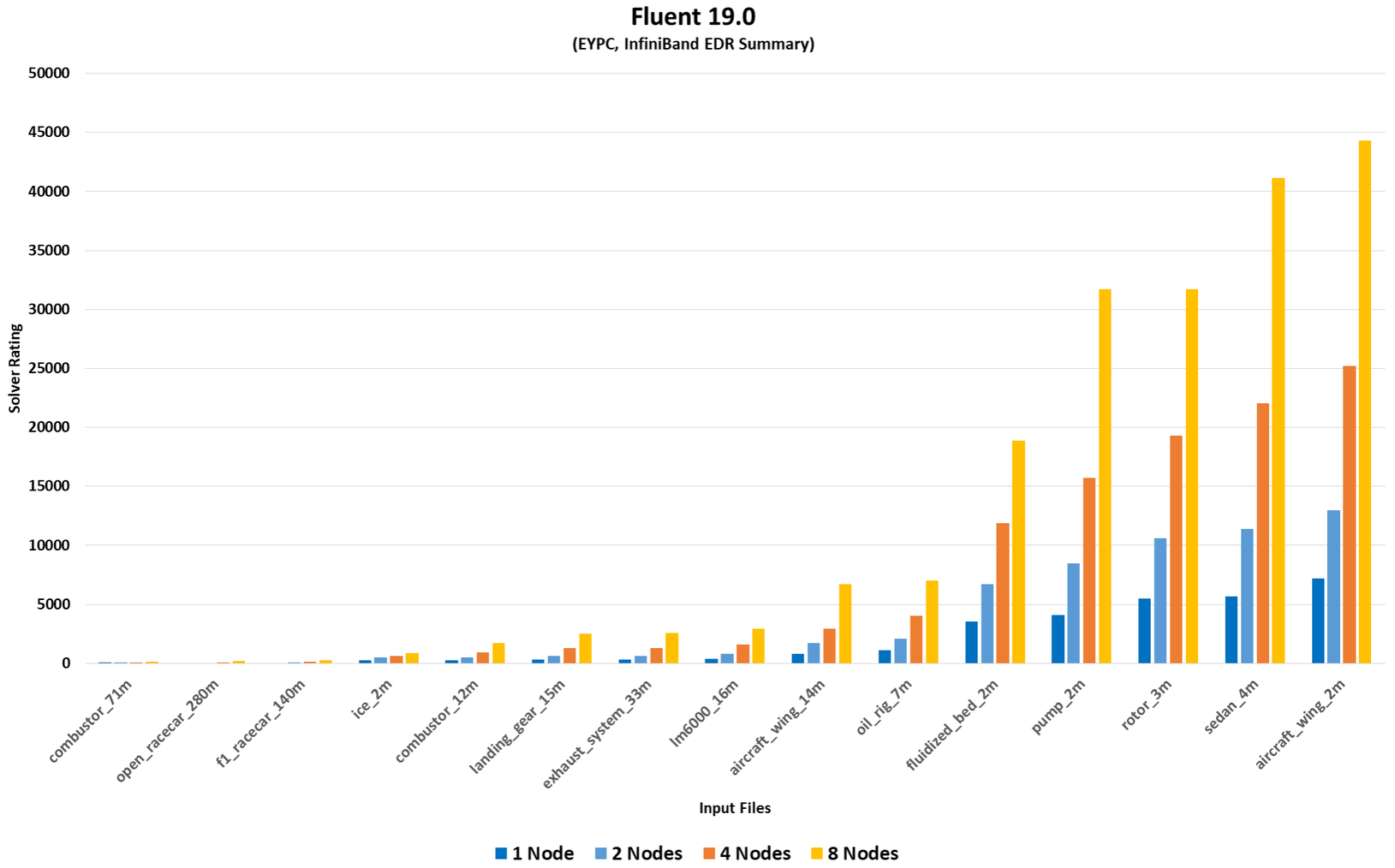
Fluent Performance – Summary



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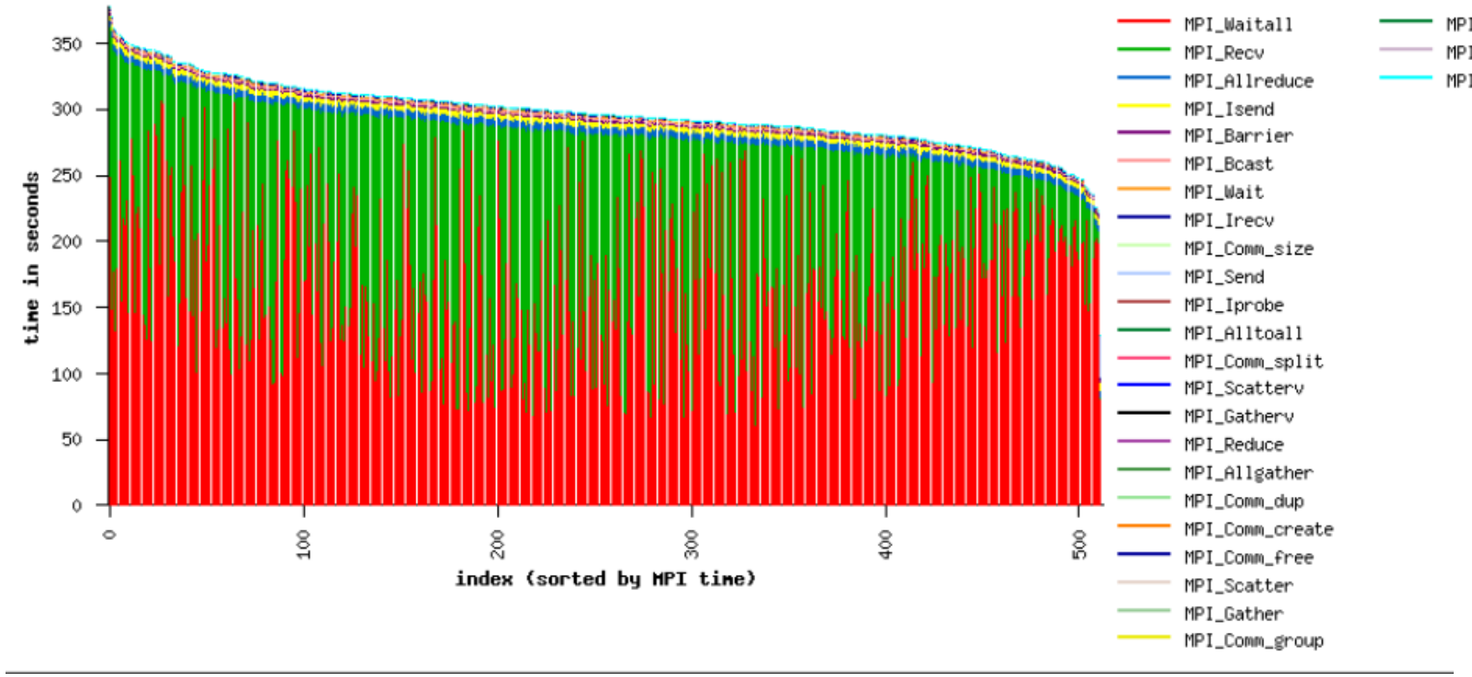
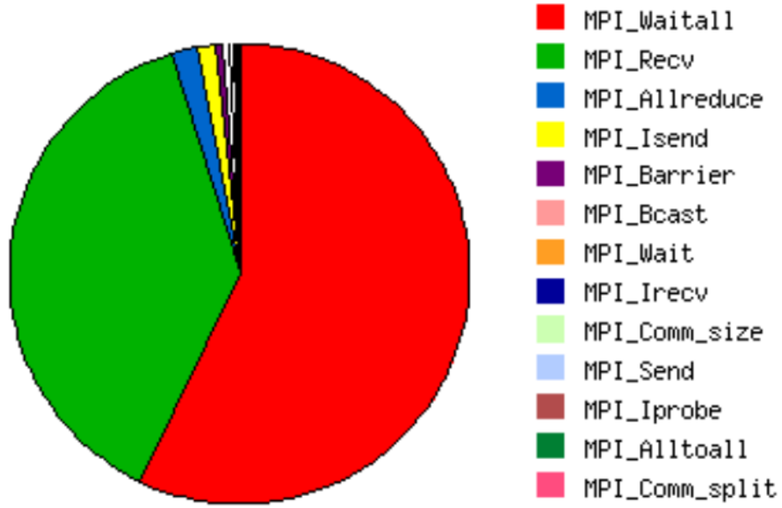
ANSYS Fluent Application Profile on “Combustor 71m”

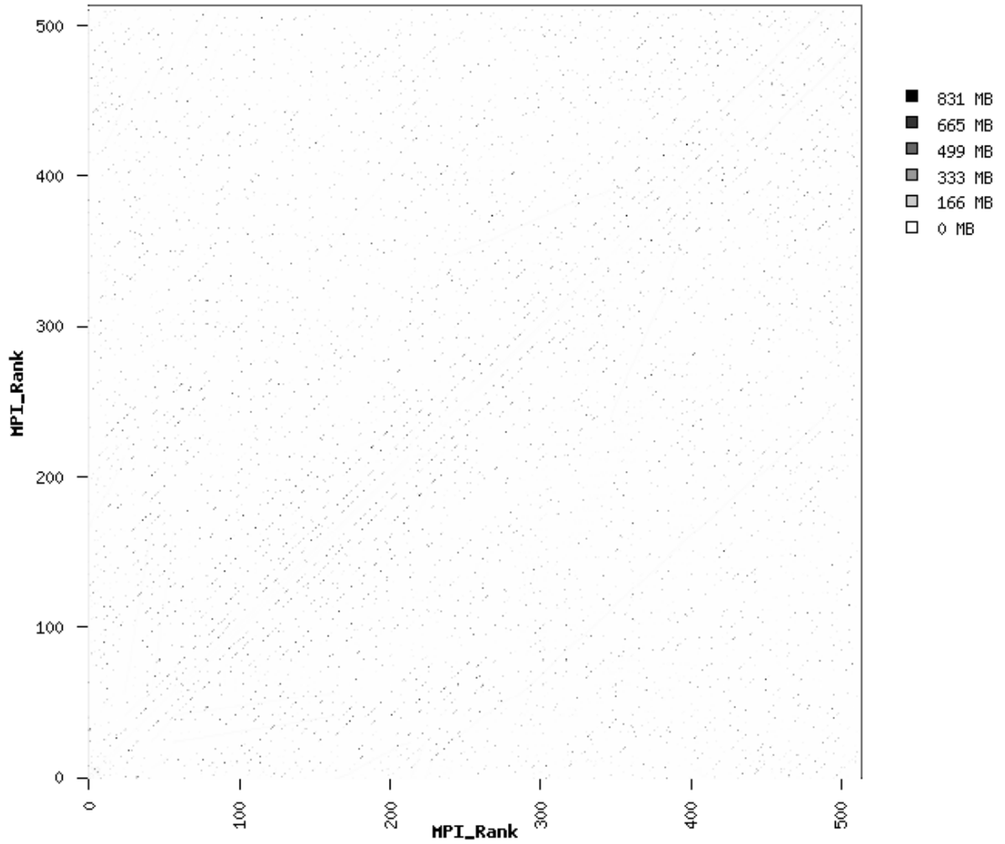
- **27.64% MPI and WallClock of 1074 seconds**





ANSYS Fluent Application Profile

- **Sparse Communication between the ranks**



ANSYS Fluent Summary

- **Fluent performance testing over AMD EYPC based platform**
  - An average of 88% scaling was achieved from 4 to 8 nodes among all 15 different input files

- **Fluent MPI profiling on “combustor 71m”**
  - MPI communication accounts for 27.64% of overall wall clock time at 8 nodes
  - MPI_Waitall is 57% of MPI, MPI_Recv is 38% of MPI and MPI_Allreduce is 2% of MPI
  - Most communication is sparse, among all nodes

MPI Launch command

- **ANSYS Fluent**

mpirun -report-bindings -display-map -x UCX_NET_DEVICES=mlx5_0:1 -x HCOLL_ALLREDUCE_ZCOPY_TUNE=off -mca btl_openib_if_include mlx5_0:1 -bind-to core -map-by node -mca ras_base_launch_orted_on_hn true --prefix /global/software/centos-7/modules/AOCC/1.2.1/hpcx/2.2.0/ompi --x LD_LIBRARY_PATH -x KMP_AFFINITY=disabled -x FLUENT_PROD_DIR=/global/software/centos-7/modules/apps/cfd/ansys_inc/v190/fluent//fluent19.0.0 -np $nproc --hostfile /tmp/fluent-appfile.gerardo.15302 /global/software/centos-7/modules/apps/cfd/ansys_inc/v190/fluent//fluent19.0.0/lnamd64/3d_node/fluent_mpi.19.0.0 node -mpiw openmpi -pic infiniband -mport 192.168.4.1:192.168.4.1:33449:0

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Thank You