

# Fluent on HPCx

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## Background

Ansys / Fluent is the world's largest provider of commercial CFD software and consulting services. The software is used for simulation, visualization, and analysis of fluid flow, heat and mass transfer, and chemical reactions.

From the Fluent website: 'The broad physical modelling capabilities of FLUENT have been applied to industrial applications ranging from air flow over an aircraft wing to combustion in a furnace, from bubble columns to glass production, from blood flow to semiconductor manufacturing, from clean room design to wastewater treatment plants. The ability of the software to model in-cylinder engines, aeroacoustics, turbomachinery, and multiphase systems has served to broaden its reach.'

Fluent is currently being used on HPCx to model applied aerodynamics. A brochure describing Fluent's use in aerospace applications can be found at

<http://www.fluent.com/solutions/aerospace/index.htm>

Fluent usage is restricted on HPCx. Any users interested in using Fluent should send a query into the Helpdesk. The current version of Fluent on HPCx is v6.2.16. A new beta release of Fluent (v6.3.17) with potentially much improved I/O performance is also available.

## Fluent Benchmarks

Fluent provide a series of datasets in order to allow users to benchmark Fluent performance. The largest dataset provided is FL5L3 which computes turbulent flow through a transition duct, consisting of around 10 million cells. However in order to benchmark representative problems of interest to UK Applied Aerodynamic Consortium members, datasets of around 100 million cells are required. To this end Fluent provided a new dataset with around 125 million cells for benchmarking on high-end machines such as HPCx.

The model is a constant cross section half pipe section with turbulent air running through. The Spallart-Allmaras Turbulence model is used with second order discretisation schemes for pressure momentum and turbulence.

	<b>Half pipe Model</b>
<b>Number of cells</b>	124,999,074
<b>Number of faces</b>	247,869,818
<b>Number of nodes</b>	43,002,348
<b>Cell type</b>	Tetrahedral
<b>Mesh type</b>	Unstructured
<b>Models</b>	Spallart-Allmaras Turbulence
<b>Solver</b>	segregated implicit

Table 1. Benchmark dataset characteristics

## HPCx Hardware Details

HPCx is the UK's Flagship High Performance Computing Service. The machine consists of a large IBM eServer 575 cluster whose configuration is specifically designed for high-availability capability computing. HPCx is a joint venture between the Daresbury Laboratory of the Council for the Central Laboratories of the Research Councils (CCLRC) and Edinburgh Parallel Computing Centre (EPCC) at the University of Edinburgh. The current phase of HPCx has 160 IBM eServer 575 nodes for computation. Each eServer node houses 16 processors and 32 Gbytes of shared main memory, giving a total of 2560 processors and 1.60 TB of memory on HPCx. The nodes on HPCx are connected via IBM's High Performance Switch (HPS) for message passing. Further details of the HPCx hardware can be found at the HPCx website: <http://www.hpcx.ac.uk>.

## Running Fluent benchmarks on HPCx

Use of Fluent is restricted on HPCx to research groups with a special agreement with the Fluent providers.

In order to run Fluent on HPCx the following Loadleveler submission script is used.

```
#!/bin/ksh
#
#@ job_type = parallel
#@ job_name = fluent_128
#
#@ cpus = 128
#
#@ node_usage = not_shared
#
#@ wall_clock_limit = 01:00:00
#@ account_no = c01-hec
#
#@ output = fluent.128.${jobid}.jout
#@ error = fluent.128.${jobid}.jerr
#@ notification = never
#@ queue

export MP_EAGER_LIMIT=65536
export MP_POLLING_INTERVAL=2000000000
export MP_SHARED_MEMORY=yes
export MP_SINGLE_THREAD=yes
export MP_USE_BULK_XFER=yes
export MEMORY_AFFINITY=MCM
export FLUENT_ARCH=aix51_64
export LM_LICENSE_FILE=/usr/local/packages/fluent/Fluent.Inc/license/license.dat
```

```
/usr/local/packages/fluent/new/Fluent.Inc/bin/fluent 3d -g -64 -t128 -pvmpi -i input.txt
```

## Fluent HPCx Performance

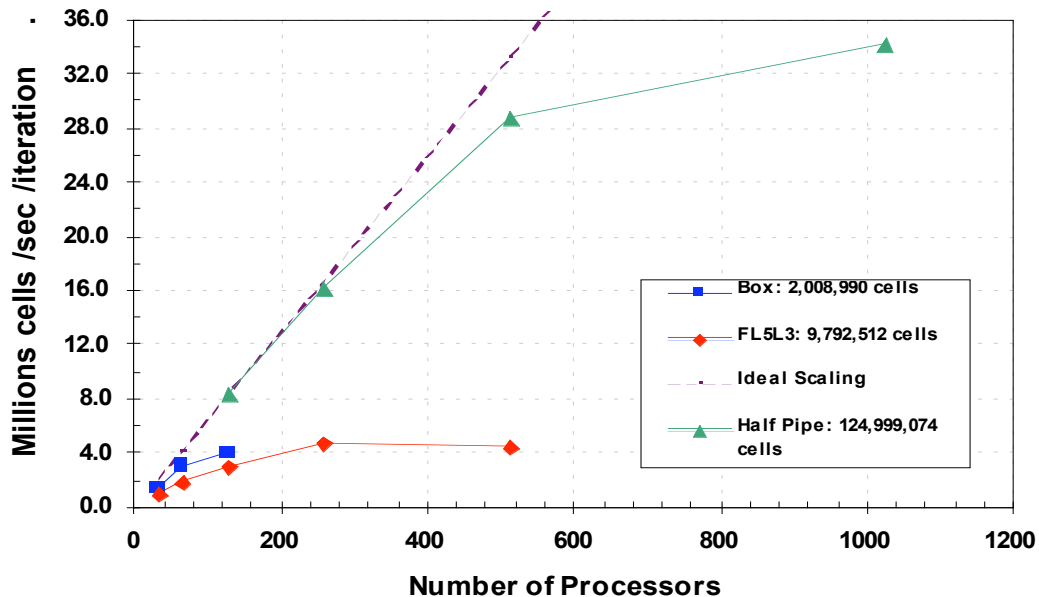


Figure 2. Parallel Performance of Fluent Solver on HPCx

## HPCx Capability Incentive Award

Codes that perform well on HPCx are reviewed by the science support staff, and awarded "Seals of Approval" at three different levels, authorising them for different levels of discount. An important criterion in deciding the level for a code is its ability to scale satisfactorily on different numbers of processors. In order to achieve the scaling requirements a doubling of processor numbers must result in a speed up of at least **1.7** (based on wallclock time).

- Bronze award: code must run at least 1.7 times faster on 256 processors (16 nodes) than on 128 processors (8 nodes), i.e.  $T_{128} / T_{256} \geq 1.7$ .
- Silver Award:  $T_{256} / T_{512} \geq 1.7$ .
- Gold Award:  $T_{512} / T_{1024} \geq 1.7$ .

Level	Number of Processors	Discount
Bronze	256	5%
Silver	512	15%
Gold	1024	30%

Time for fluent per iteration on 256 processors ( $T_{256}$ ) = 7.664 secs

Time for fluent per iteration on 512 processors ( $T_{512}$ ) = 4.351 secs

$$T_{256} / T_{512} = 7.664 / 4.351 = \mathbf{1.761}.$$

Based on the timing results from the 125M cell dataset, Fluent therefore qualifies for a **Silver** capability award on HPCx.