



## Monash Central High Performance Computing (HPC) Facility



### Monash Campus Cluster (MCC)

The Monash Campus Cluster (MCC) is Monash University's central production-class High-Performance and High-Throughput Computing (HPC/HTC) and Data Storage facility. First established in 2005 with 32 nodes, it has since expanded annually to currently over 200 nodes with ~1,700 cores, funded from central Monash operational and capital development funds and

partnerships with various research groups. The MCC supports a wide variety of Monash researchers spread across most faculties, with 80% continuous utilisation of the HPC service, and 1.3 petabytes of data storage (LaRDS).

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## 2011 Configuration

The Monash Campus Cluster is a major component of the Monash Campus Grid (MCG). The 2011 MCG HPC/HTC configuration provides eight classes of 'compute node' capabilities:

### 1 General purpose:

130 nodes (1,040 CPU cores), each node with 16-24 GB RAM, plus dual 80~146 GB hard drives per node. Hardware: Sun x6250 blades, each with two quad core intel L5420 CPUs.

### 2 High-RAM:

30 nodes (120 CPU cores), each node with 24-40 GB RAM, plus dual 80~146 GB hard drives per node. Hardware: Sun x6220 blades, each with two dual-core AMD 2218 CPUs.

### 3 Tightly-coupled:

three nodes (96 CPU cores), each node with 96 GB RAM. Hardware: Sun x4600 servers, each with 32-core on eight quad-core AMD 8356 CPUs.

### 4 nVidia Tesla C1060 GPUs:

ten nodes (80 CPU cores), with two Tesla C1060 GPU cards each; eight nodes with 48 GB RAM and two with 96 GB RAM for visualisation, and GPU applications.

### 5 Tightly-coupled partnership nodes:

five nodes (240 CPU cores), each node with 128 GB RAM and over 1 TB of local disk. Hardware: Dell R815 servers, each with four 12-core AMD 6174 CPUs.

### 6 Very-Large Memory:

two nodes (64 CPU cores with hyperthreading enabled), each node with 1,024 GB RAM and over 3 TB of local disk. Hardware: Dell R910 servers, each with four 8-core Intel X7560 CPUs.

### 7 Distributed CONDOR Pool:

from 500-1,000 cores spanning several campuses, including eSolution labs. Participating faculties include: Medicine, Science and Information Technology. The Monash SPONGE uses Condor to execute Java, C/C++, Fortran-77 [via CYGWIN] and Globus jobs. This Condor pool soaks up spare CPU cycles that would otherwise be wasted within operating desktop computers around the Monash campuses.

## 8 Interactive:

For interactive login, visualization, animation and real-time results processing. One of the Tesla nodes is deployed as a visualisation node, providing eight CPU-cores for interactive GPU-intensive tasks.

## Common Features

- Head/Administrative-nodes: Dual Sun x4600 each with 16 cores (expandable) at ~4 GB/core and dual 146 GB hard drives per node, running VMware. Supports a variety of virtual machines to provide the following functions: login node; visualization node; Globus/Nimrod front node; interactive front-end; SGE job dispatch; license server; system boot; Condor headnode; and various system management functions.
- Linux operating system.
- Dual hard-drives: These are configured in a RAID1 (mirrored) configuration to allow system continuation in the even of disk failure – important for HPC jobs, which are typically long-running.
- Dual PSUs: High availability for long-running jobs.
- Dual gigabit ethernet connections to Monash network for: inter-node (MPI) communication; communication with head node machines; & communication with (LaRDS) storage system.

### • Summary:

MCG computing capability:

over 1,700 dedicated cores; over 6 TB RAM; approx. 12.5 Tflop/s CPU and ~18.6 Tflop/s GPU; ~47 kW + 500-1000 Condor non-dedicated cores.

## Data Storage System

Each execute node, as well as the head nodes, of the Monash Sun Grid has direct gigabit ethernet NFS access to Monash's central research data store (LaRDS).

The central LaRDS data store comprises dual SGI Altix A450 multi-CPU servers; 400 TB of disk; and dual IBM 3500 tape libraries having a current capacity of 1.7 PB (expandable as required). Servers and storage capacity are distributed equally across Monash's two main data-centres via Cisco MDS 9500 fibre-channel SAN. Storage capacity is managed using SGI's Data Migration Facility (DMF) hierarchical storage management (HSM) environment.

## Partial Software List on MSG

- **Molecular Dynamics code:**  
NAMD, GROMACS, AMBER 10/11, LAMMPS, VASP
- **Computational Chemistry**  
Gaussian 03/09, GaussView 4/5  
GAMESS, Molden
- **Computational Biology:**  
BLAST, ClustalW, LifeScope, CAVAVA
- **Other Applications:**  
OpenFOAM, Fluent, CFX – Computational fluid dynamics (licensed to Engineering)  
Gauss, R, Stata – Statistical packages  
Ox – Object-oriented matrix programming language  
FSL – Comprehensive library for analysis of FMRI, MRI and DTI brain imaging data  
CircuitScape – Open-source code for landscape genetics research and conservation planning using circuit theory  
ENVIMET – Micro climate model  
ENVI/IDL – Image processing system for environmental / geography research (running on front node)  
WRF – Weather model
- **Software Development tools, libraries, and parallel environments:**  
OpenMPI, MPICH2  
Java, Python – scipy, numpy, etc.  
NetCDF, HDF5  
PETSc, FFTW, BLAS, LAPACK  
Intel Fortran and C/C++ 2011  
Intel Maths Kernel Library 2011  
CUDA. OpenCL and CULA

## Contact MeRC

MeRC support staff are available to discuss all your research needs.

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