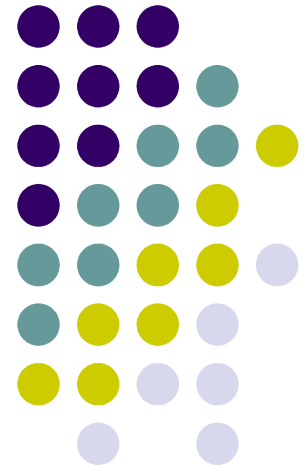
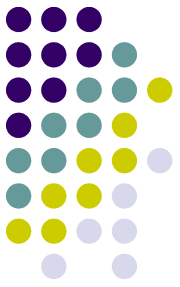


Linux clustering

Morris Law, IT Coordinator,
Science Faculty, Hong Kong
Baptist University



PII 4-node clusters started in 1999



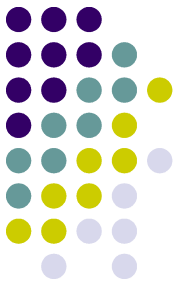


**PIII 16 node
cluster
purchased in
2001.**

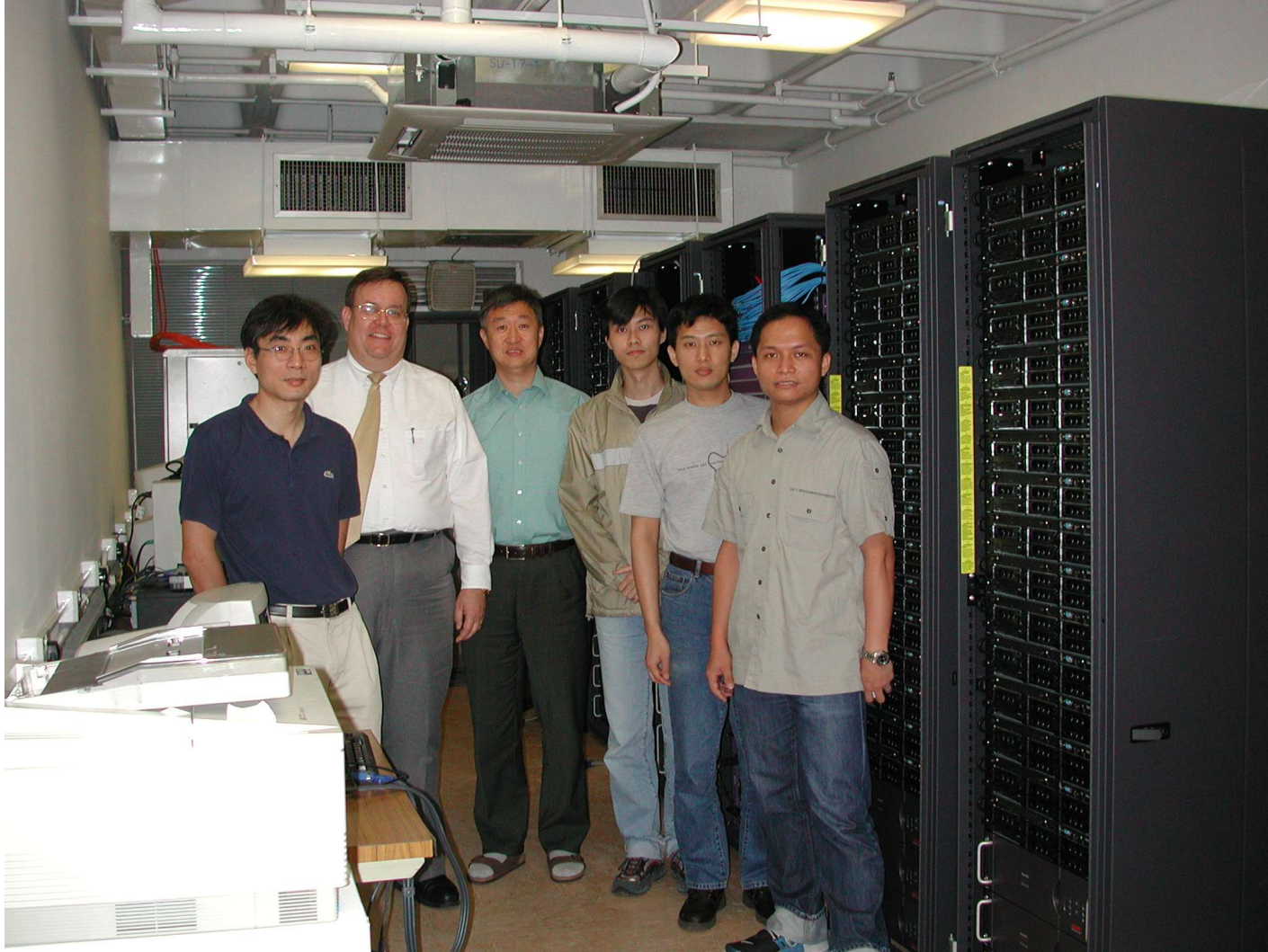
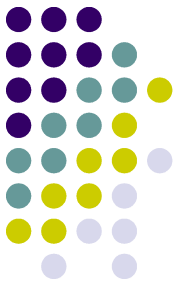


Plan for grid
For test base

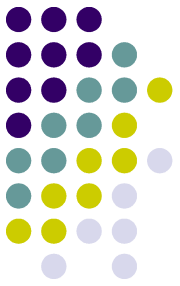
HKBU - 64-nodes P4-Xeon cluster at #300 of top500



The cluster management team



OUTLINE



What is PC cluster?

Different kinds of PC cluster

Beowulf cluster example

SSI cluster example

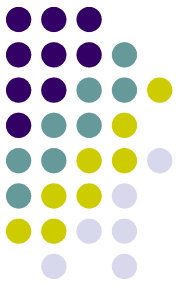
HPCC Cluster and parallel computing applications

What is a PC cluster?



An ensemble of networked, stand-alone common-off-the-shelf computers used together to solve a given problem.

Different kinds of PC cluster

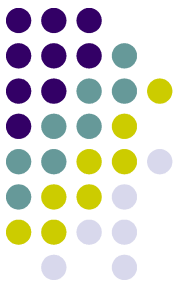


High Performance Computing Cluster

Load Balancing

High Availability

High Performance Computing Cluster (Beowulf)



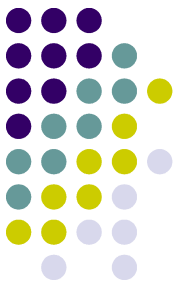
Start from 1994

Donald Becker of NASA assemble the world's first cluster with 16 sets of DX4 PCs and 10 Mb/s ethernet

Also called Beowulf cluster

Built from commodity off-the-shelf hardware

Applications like data mining, simulations, parallel processing, weather modelling, computer graphical rendering, etc.



Examples of Beowulf cluster

Scyld Cluster O.S. by Donald Becker

<http://www.scyld.com>

ROCKS from NPACI

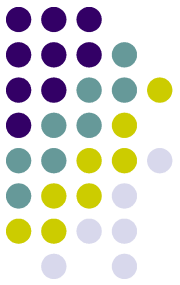
<http://www.rocksclusters.org>

OSCAR from open cluster group

<http://oscar.sourceforge.net>

OpenSCE from Thailand

<http://www.opensce.org>



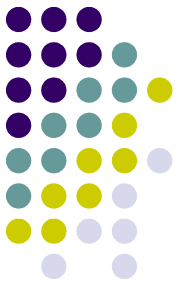
Load Balancing Cluster

PC cluster deliver load balancing performance

Commonly used with busy ftp and web servers with large client base

Large number of nodes to share load

High Availability Cluster



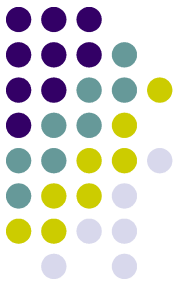
Avoid downtime of services

Avoid single point of failure

Always with redundancy

Almost all load balancing cluster are with HA capability

Examples of Load Balancing and High Availability Cluster



RedHat HA cluster

<http://ha.redhat.com>

Turbolinux Cluster Server

<http://www.turbolinux.com/products/tcs>

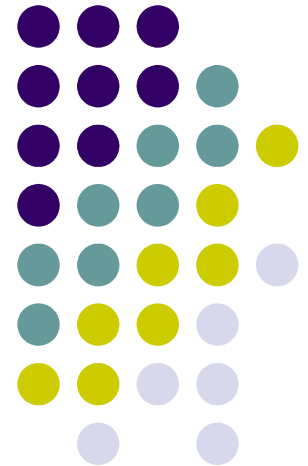
Linux Virtual Server Project

<http://www.linuxvirtualserver.org/>

Snapshots 1

An example of Beowulf Cluster:
ROCKS

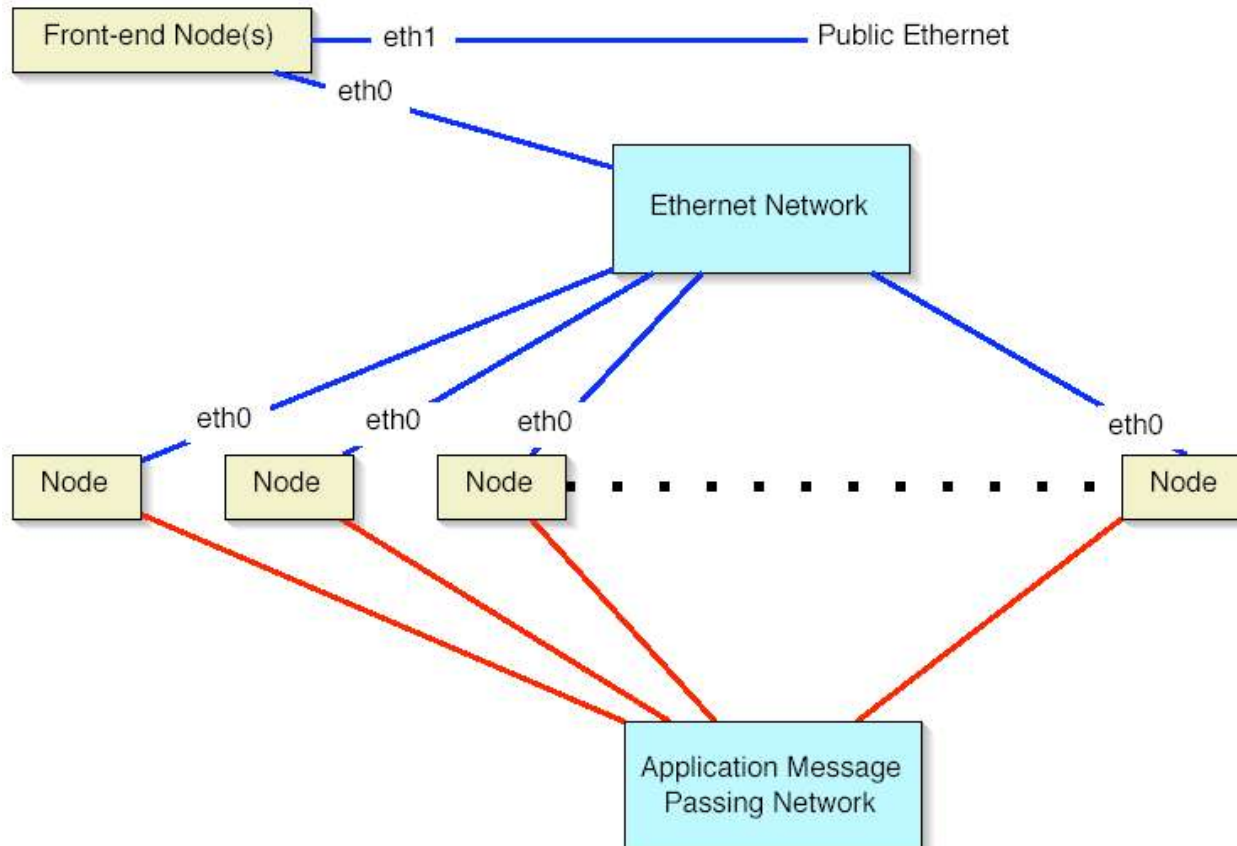
(<http://www.rockclusters.org>)

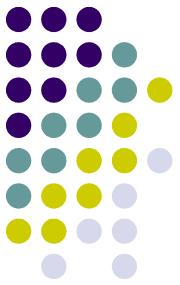


ROCKS SNAPSHOTS



The schematic diagram of a rocks cluster





ROCKS SNAPSHOTS

Installation of a compute node

```
Terminal — bash (tty2) — 80x24  
Insert Ethernet Addresses -- version 3.0.0
```

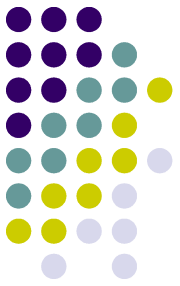
Inserted Appliances	
00:07:e9:03:e4:07	compute-0-0

```
Press <F1> to quit
```

```
Terminal — bash (tty2) — 80x24  
Derived from Red Hat Linux, (C) 2002 Red Hat, Inc.  
Rocks V3.0.0 (Lhotse) -- www.rockclusters.org
```

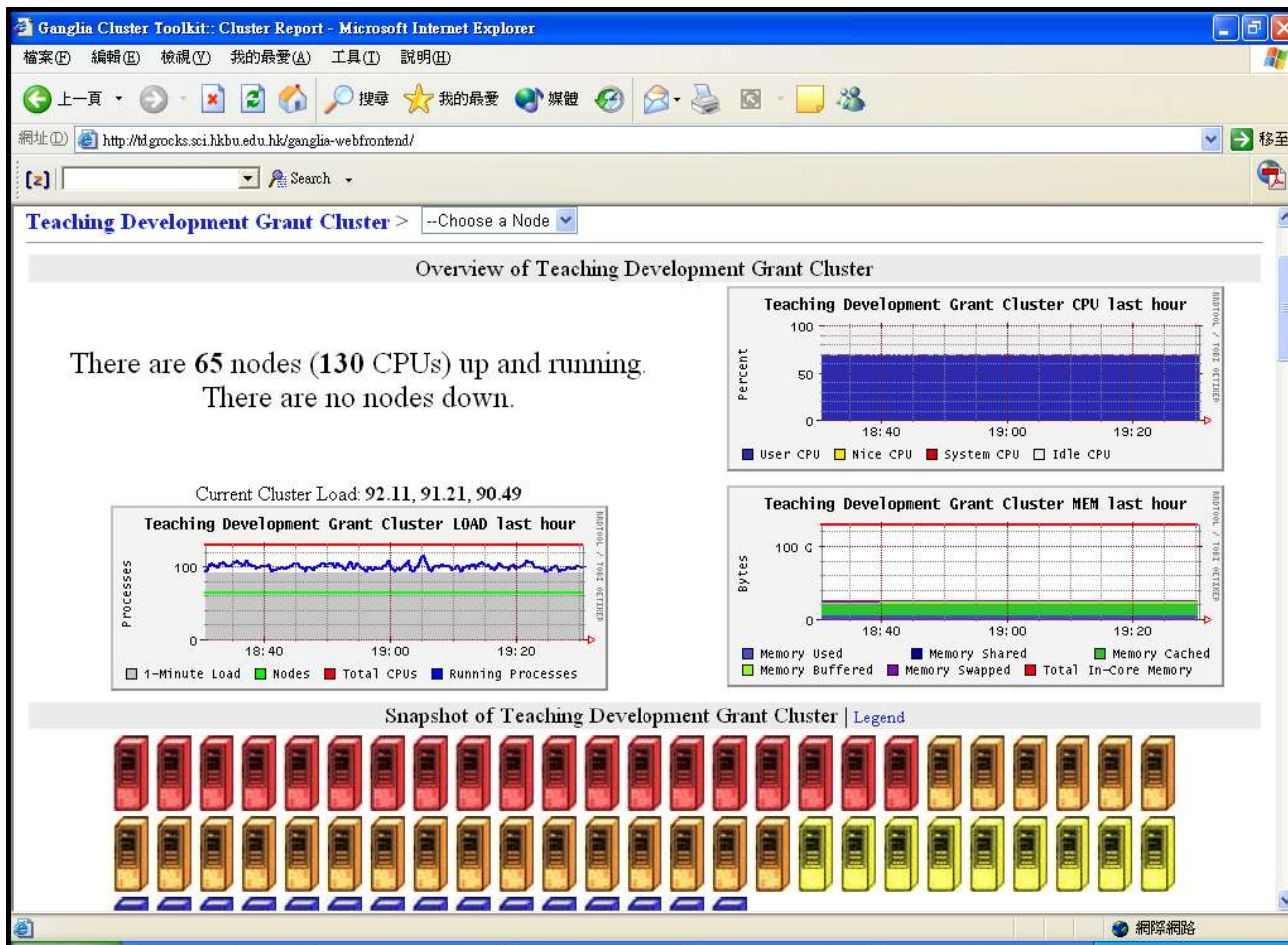
Package Installation			
Name :	rocks-boot-3.0.0-1		
Size :	8520k		
Summary: Rocks kickstart boot images			
<div style="background-color: red; width: 10%; height: 10px;"></div>			
	Packages	Bytes	Time
Total :	544	1514M	0:01:43
Completed:	128	285M	0:00:19
Remaining:	416	1229M	0:01:24
<div style="background-color: red; width: 20%; height: 10px;"></div>			

```
<Tab>/<Alt-Tab> between elements | <Space> selects | <F12> next screen
```

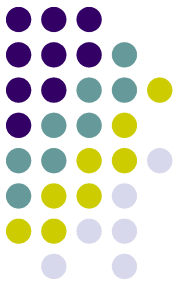



ROCKS SNAPSHOTS

Ganglia Monitoring tools



HPCC Cluster and parallel computing applications



Message Passing Interface

MPICH (<http://www-unix.mcs.anl.gov/mpi/mpich/>)

LAM/MPI (<http://lam-mpi.org>)

Mathematical

fftw (fast fourier transform)

pblas (parallel basic linear algebra software)

atlas (a collections of mathematical library)

[sprng](#) (scalable parallel random number generator)

[MPITB](#) -- MPI toolbox for MATLAB

Quantum Chemistry software

gaussian, [qchem](#)

Molecular Dynamic solver

[NAMD](#), [gromacs](#), [gamess](#)

Weather modelling

MM5 (<http://www.mmm.ucar.edu/mm5/mm5-home.html>)

NAMD2 – Software for Quantum Chemistry



The screenshot displays the VMD 1.8 software interface. The main window shows a 3D molecular model of alanine (alanin.pdb) with 66 atoms and 3 frames. The interface includes a menu bar (File, Molecule, Graphics, Display, Mouse, Extensions, Help), a toolbar, and a control panel with the following sections:

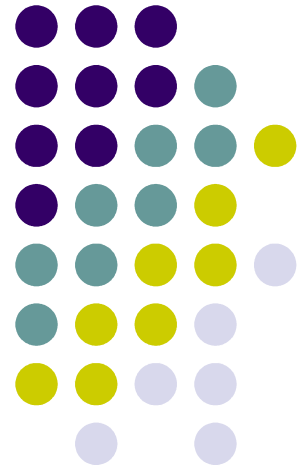
- Simulation Control:** Hostname (tdgrocks.sci.hkbu.edu), Port (2030), Parameter to Modify (Transfer rate 1, Save frame rate 0), and Simulation Status (Timestep: 20205, Temp: 294.414948, Total E: -120.145622, KE: 57.920815, PE: -178.066437, Bond E: 16.051596, vdW E: -26.936316, Coul E: -204.250809).
- Terminal:** Shows the command prompt for morris@frontend-0 ~~/alanin, displaying simulation output including energy values and coordinates.
- OpenGL Display:** A 3D visualization of the alanine molecule with a coordinate system (x, y, z).

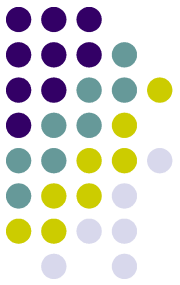
The terminal output shows the following data:

```
00 0.0000 52.3841 -117.3767
ENERGY: 21015 19.8789 24.8260 3.
00 0.0000 55.9391 -117.5447
ENERGY: 21012 17.1495 24.4234 3.
00 0.0000 56.5684 -117.6100
ENERGY: 21013 17.7925 24.7517 3.
00 0.0000 54.5654 -117.9580
ENERGY: 21014 19.5592 24.8567 3.
00 0.0000 52.3841 -117.3767
ENERGY: 21015 19.8789 24.8260 3.
00 0.0000 50.4466 -118.0870
ENERGY: 21016 18.5591 24.5394 3.
00 0.0000 49.3798 -119.7961
ENERGY: 21017 17.4141 23.9492 3.
00 0.0000 49.6641 -120.4699
ENERGY: 21018 17.5347 23.2537 3.
00 0.0000 50.6710 -119.5054
ENERGY: 21019 18.2601 22.4596 3.
00 0.0000 51.2423 -118.8710
ETITLE: TS BOND ANGLE
NDARY MISC KINETIC TOTAL
ENERGY: 21020 17.5766 21.5512 3.
00 0.0000 52.9459 -119.0895
```

Single System Image (SSI) Cluster

MOSIX
openMosix



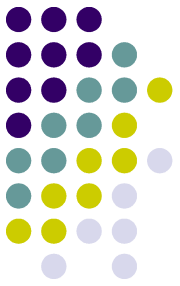


MOSIX and openMosix

MOSIX: MOSIX is a software package that enhances the Linux kernel with cluster capabilities. The enhanced kernel supports any size cluster of X86/Pentium based boxes. MOSIX allows for the automatic and transparent migration of processes to other nodes in the cluster, while standard Linux process control utilities, such as 'ps' will show all processes as if they are running on the node the process originated from.

openMosix: openMosix is a spin off of the original Mosix. The first version of openMosix is fully compatible with the last version of Mosix, but is going to go in its own direction.

OpenMosix installation



Install Linux in each nodes

Download and install

[openmosix-kernel-2.4.22-openmosix1.i686.rpm](#)

[openmosix-tools-0.3.4-1-RH80.i386.rpm](#)

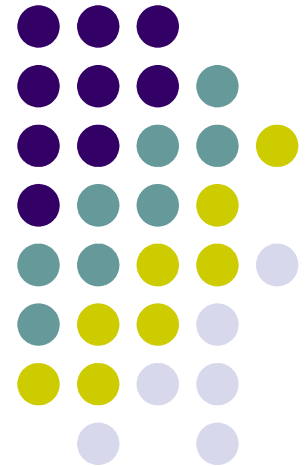
and related packages like thoses in

www.openmosixview.com

Reboot with openmosix kernel

Screenshots 2

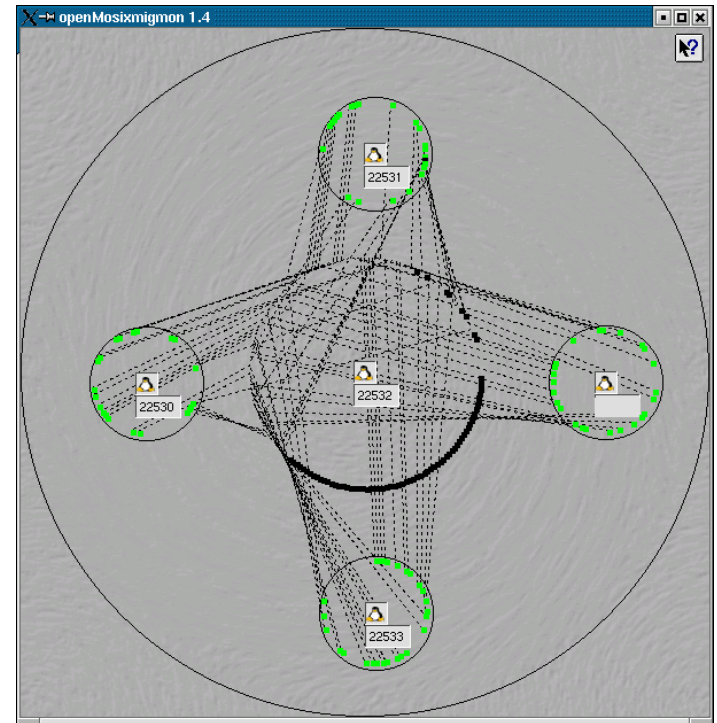
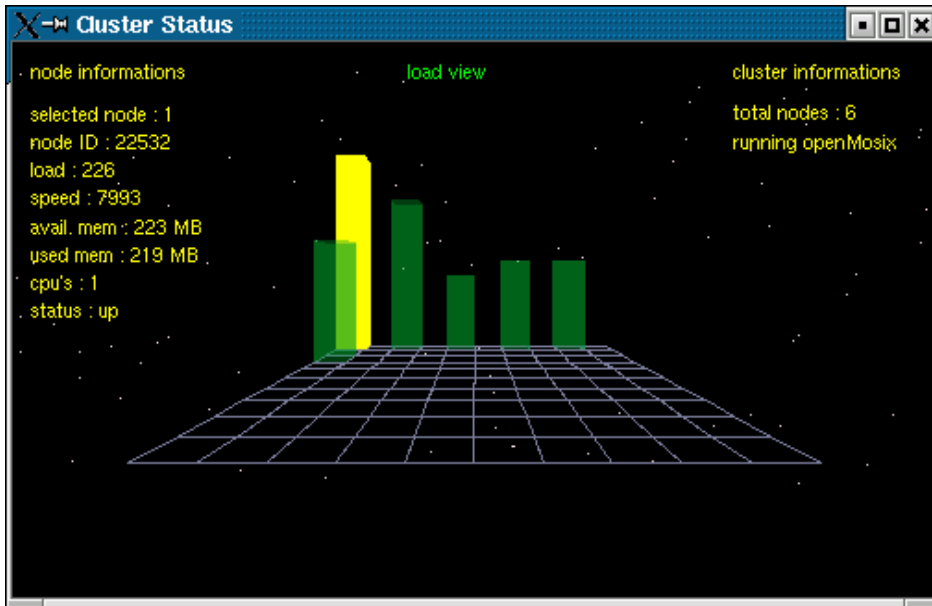
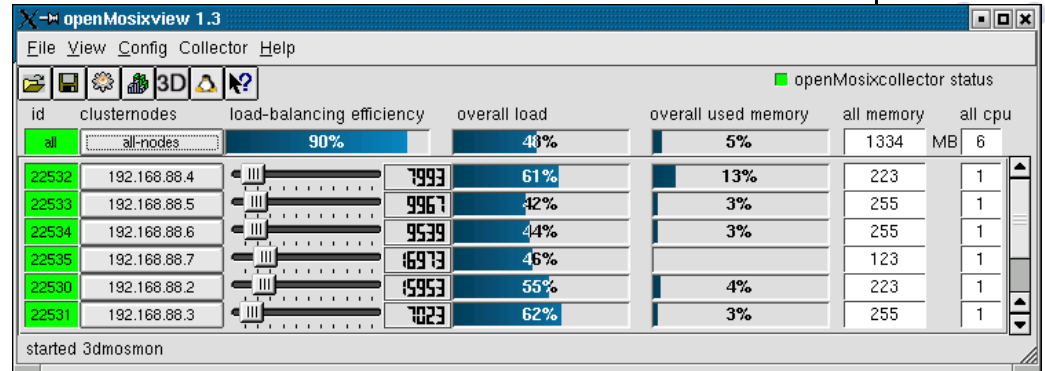
OpenMosix cluster management

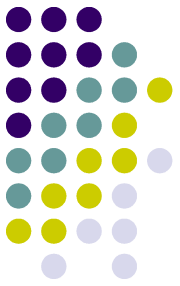


openMosix cluster management tools



openMosixView
openMosixmigmon
3dmosmon





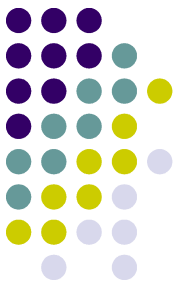
Advantage of SSI cluster

Not need to parallelize code

Automatic process migration, i.e. load balancing

Add / delete nodes at any time

Well aware of hardware and system resources



Reference URLs

Clustering and HA

Beowulf , parallel Linux cluster.

ROCKS from NPACI

OPENMOSIX , scalable cluster computing
with process migration

HKBU Science Faculty Cluster

High Performance Cluster Computing Centre &

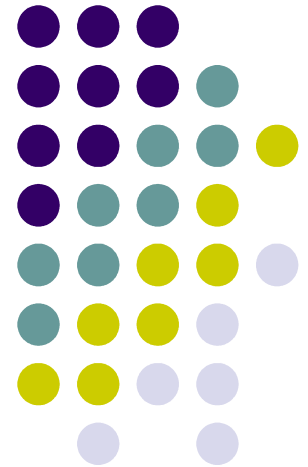
Linux Cluster Information Center

Thank you!

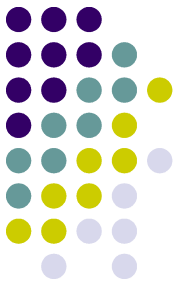
Welcome to visit HPCCC, HKBU

<http://www.hkbu.edu.hk/hpccc/>

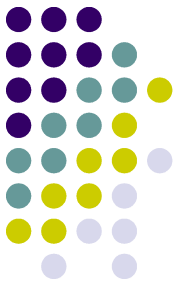
<http://www.hkbu.edu.hk/tdgc/>

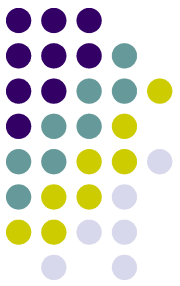


The Scientific Computing Lab.



Opening of the High Performance Cluster Computing Centre Supported by Dell and Intel





TDG cluster configuration

Master node:

DELL PE2650 P4 Xeon
2.8GHz x 2
4GB ECC DDR RAM
36GB x 2 internal HD
running RAID 1 (mirror)
73GB x 10 HD array
running RAID 5 with hot
spare

Compute nodes x 64 each with

DELL PE2650 P4 Xeon
2.8GHz x 2
2GB ECC DDR RAM
36GB internal HD





Interconnect configuration



Extreme
BlackDiamond
6816 Gigabit
ethernet switch