HPC

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HPC

- High Performance Computer : Supercomputer
- High Performance Computing : Parallel
- BOINC is a platform for high-throughput computing "Seti@Home", "Folding@Home", (List of distributed computing projects)

Definition

HPC High Performance Computing most generally refers to the practice of aggregating computing power in a way that delivers much higher performance than one could get out of a typical desktop computer or workstation in order to solve large problems in science, engineering, or business.

Wikipedia IT

HPC Con High Performance Computing (HPC) (in italiano calcolo ad elevate prestazioni), in informatica, ci si riferisce alle tecnologie utilizzate da computer cluster per creare dei sistemi di elaborazione in grado di fornire delle prestazioni molto elevate nell'ordine dei PetaFLOPS, ricorrendo tipicamente al calcolo parallelo.

FLOPS

- FLOPS Unit https://en.wikipedia.org/wiki/Unit_prefix

Metric prefixes in everyday use -

Text	Symbol	Factor	Power	
yotta	Y	1000000000000000000000000	10E24	
zetta	Z	1000000000000000000000	10E21	
exa	E	1000000000000000000	10E18	
peta	P	1000000000000000	10E15	
tera	T	1000000000000	10E12	
giga	G	1000000000	10E9	PC (~60)
mega	M	1000000	10E6	
kilo	k	1000	10E3	
hecto	h	100	10E2	
deca	da	10	10E1	
(none)	(none)	1	10E0	

Local FLOPS using Linpak

1. Download Linpak (link)
2. Extract
3. cd .../linux/mkl/benchmarks/linpack
4. ./runme_xeon64

Es.

```
cd /home/avaresio/downloads/l_mklb_p_11.3.3.011/
cd benchmarks_11.3.3/linux/mkl/benchmarks/linpack
./runme_xeon64
```

TOP 500

+

- TOP_500 https://www.top500.org/ TOP_500
- 1-10 LIST
- 1-100

Hardware components

- Power Supply : 10MW (Medium Town)
- Space and Cooling
- Box: IBM, Cray, Fujitsu, Lenovo, HPE, Bull, Dell
- CPU: IBM, Intel, AMD, ARM, Custom
- GPU: AMD, NVIDIA
- Network
  - Mellanox Infiniband
  - Intel OmniPath
  - Ethernet $>$ 10GBit
- Shared Filesystem
  - NFS (Mostly Read)
  - pNFS
  - Lustre
  - Gluster
  - BeeGFS
  - Ceph
- A Lot of $$$

- Useful Tools to manage / use an HPC Cluster
  - Ansible
  - GIT
  - Docker, Singularity
  - Nagios, Ganglia, Zabbix
  - Job Scheduler (Slurm,PBS,Grid Engine)

Software Components

- Application Code (rewritten from Serial to Parallel)
- Libraries for IPC
- Lib to use GPU: CUDA, OpenCL
- IDE
- GUI to High Level Tools (Jupyter Notebook)

IPC - Inter Process Communication

- shared files / memory + semaphores
- pipes (named, unnamed)
- message queues unidirectional
- sockets (memory, network) bi-directional
- signals
- RPC
  - ONC/RPC, XML-RPC -> SOAP, CORBA, JSON-RPC, gRPC, ...

Approaches to message passing

PVM Parallel Virtual Machine

MPI Message Passing Interface

MPI

- OpenMP (threads)
- OpenMPI
- IntelMPI
- PlatformMPI

Compile and Run - Hello World

```
int main ( int argc, char *argv[] );
{
  printf ( "  Hello, world!\n" );

  return 0;
}
```

- mpicc -o hello hello.c
- mpirun --use-hwthread-cpus -np 4 hello
- mpirun --use-hwthread-cpus -np 4 -tag-output hello
- mpirun --use-hwthread-cpus -np 4 -report-bindings hello
- mpirun --use-hwthread-cpus -np 4 --bind-to hwthread -report-bindings hello

Compile and Run - hello_mpi

- hello_mpi.c (see on Editor)
- mpicc -o hello_mpi hello_mpi.c
- mpirun --use-hwthread-cpus -np 4 -report-bindings hello_mpi
- mpirun --use-hwthread-cpus --bind-to hwthread -np 4 hello_mpi
- mpirun --use-hwthread-cpus --bind-to hwthread -np 4 -report-bindings hello_mpi

Output of hello_mpi

```
  Process 3 says 'Hello, world!'

  Process 2 says 'Hello, world!'
  Process 1 says 'Hello, world!'
HELLO_MPI - Master process:
  C/MPI version
  An MPI example program.

  The number of processes is 4.

  Process 0 says 'Hello, world!'
  Elapsed wall clock time = 0.000342 seconds.

HELLO_MPI - Master process:
  Normal end of execution: 'Goodbye, world!'

10 May 2019 07:43:00 PM
```

Compile and Run - ring

- mpicc -o ring_c ring_c.c
- mpirun --use-hwthread-cpus --bind-to hwthread -np 4 -report-bindings ring_c

Compile and Run - Search Serial

- gcc -Ofast -o search_serial_mklb_p_2018.3.011l search_serial.c
- ./search_serial
- Elapsed CPU time is 23.3898

Compile and Run - Search MPI

- mpicc -Ofast -o search_mpi search_mpi.c
- mpirun --bind-to hwthread -np 3 search_mpi
- Elapsed wallclock time is 12.3633
- use nmon to see CPU load

HPC HOWTO

- http://www.admin-magazine.com/HPC/Articles/Building-an-HPC-Cluster
- http://hpc.fs.uni-lj.si/sites/default/files/HPC_for_dummies.pdf
- https://openhpc.community/downloads/
- https://opensource.com/article/18/1/how-build-hpc-system-raspberry-pi-and-openhpc
- http://bccd.net/
- https://www.rocksclusters.org/
- https://pelicanhpc.org/

Pelican HPC

https://www.pelicanhpc.org/index.html -

PelicanHPC over Virtualbox

First Steps ... sudo mkdir /cdrom sudo mount -oro /dev/sr1 /cdrom sudo /cdrom/VBoxLinuxAdditions.run

sudo ln -sf /home/etc/apt/sources.list /etc/apt/sources.list sudo apt update sudo apt install libatlas3-base sudo apt install gpm

cd hpl-2.0 sh SetupForPelican cd bin/Pelican HPC orterun --hostfile /home/usr/tmp/bhosts -np 4 xhpl

PelicanHPC over KVM

URLS

- HPC@Polito
- https://openhpc.community

https://github.com/jupyter/jupyter/wiki/A-gallery-of-interesting-Jupyter-Notebooks

= JupyterLab -

Tensorflow docker run -it --rm -p 8888:8888 --mount type=bind,source=/home/avaresio/GIT/Polito-HPC/Jupyter,destination=/home/jovyan/work jupyter/tensorflow-notebook start.sh jupyter lab

DataScience docker run -it --rm -p 8888:8888 --mount type=bind,source=/home/avaresio/GIT/Polito-HPC/Jupyter,destination=/home/jovyan/work jupyter/datascience-notebook start.sh jupyter lab

Questions

Sponsor

- DoIT http://www.doit-systems.it
- DoIT - Work With US

Extra Slides

Commands & Aliases

```
alias S='/home/avaresio/GIT/txt2tags/txt2tags -t txt2t Slid
pandoc -s -t beamer -V theme:Copenhagen -V colortheme:wolve
sed -i "/^ *:$/d" Slides.tex
sed -i "/^ *-$/d" Slides.tex
pdflatex Slides.tex > Slides.plog
rm Slides{.out,.vrb,.toc,.snm,.nav,.aux,.log,.plog}'

alias I='impressive --noquit -f -d 1:30:00 -M -g 1280x1024
 --page-progress --time-display --tracking \
 Slides.pdf'
```

Presentation Tools

TXT2TAGS + LaTEX Beamer

```
/home/avaresio/GIT/txt2tags/txt2tags -t txt2t Slides.t2t
pandoc -s -t beamer -f t2t -o Slides.tex Slides.txt2t
sed -i '/^ *:$/d' Slides.tex
sed -i '/^ *-$/d' Slides.tex
pdflatex Slides.tex > Slides.plog
rm Slides{.out,.vrb,.toc,.snm,.nav,.aux,.log,.plog}
bl-file-manager Slides.pdf
```

TXT2TAGS + LaTEX Beamer (alternative method)

```
/home/avaresio/GIT/txt2tags/txt2tags -vv \
-C /home/avaresio/GIT/txt2tags/templates/beamer.conf.t2t \
-T /home/avaresio/GIT/txt2tags/templates/beamer.tex \
-t tex Slides.t2t
```

Presentation Tool

```
impressive -f -d 1:30:00 -M -g 1024x768 \
```

Skip

Further IDEAS

- Q commands
- Queuing system

TXT2TAGS - ASCII Art Presentation

```
/home/avaresio/GIT/txt2tags/txt2tags -t aapp --slides Slide
enscript -l -r -p file.ps Slides.aapp
ps2pdf file.ps Slides.pdf
```

Skip

~~map-by hwthread~~ rank-by hwthread ~~bind-to hwthread~~ use-hwthread-cpus

mpirun --map-by node : balanced - rrobin mpirun -nolocal

mpirun --use-hwthread-cpus --bind-to hwthread -np 1 search_mpi Elapsed wallclock time is 59.731 mpirun --use-hwthread-cpus --bind-to hwthread -np 2 search_mpi Elapsed wallclock time is 44.0702 mpirun --use-hwthread-cpus --bind-to hwthread -np 3 search_mpi Elapsed wallclock time is 31.4417 -