NATIONAL SUPERCOMPUTING MISSION

ParaDE

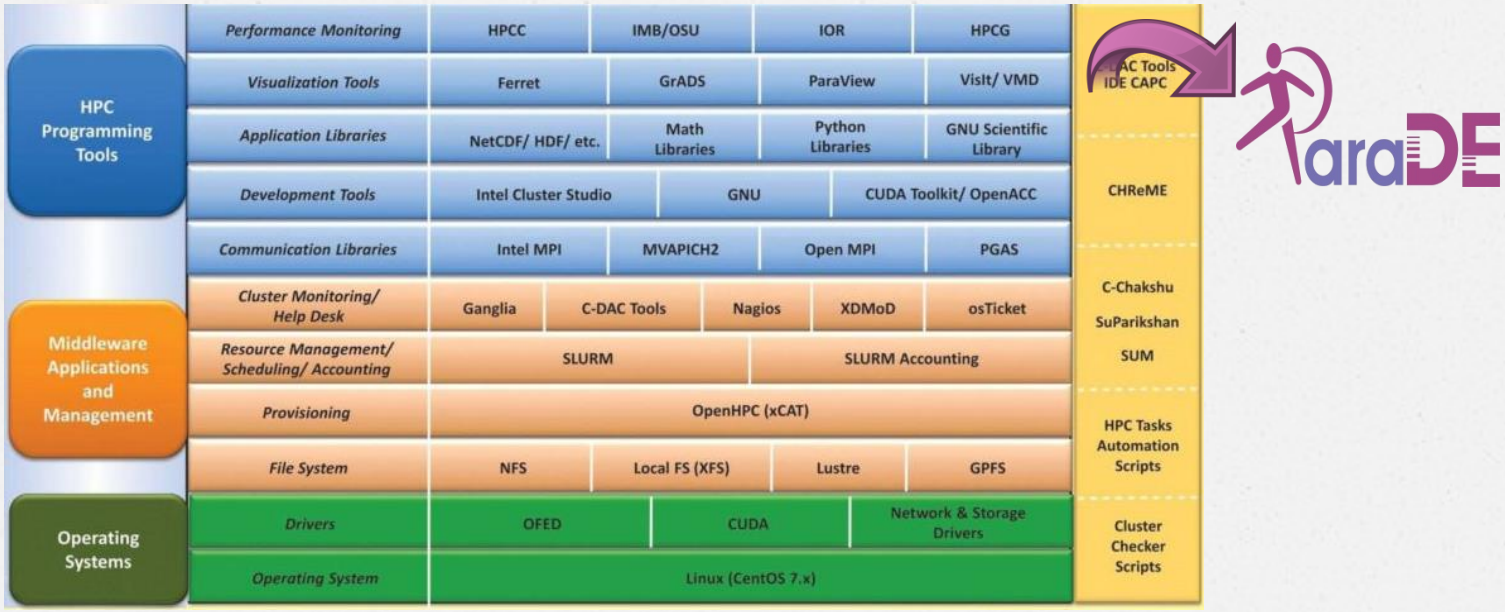
[NSM System Software Product]

Deepika H V & Nitin Bishnoi

SSDG, C-DAC, Bengaluru

NATIONAL SUPERCOMPUTING MISSION

PARAM Software Stack

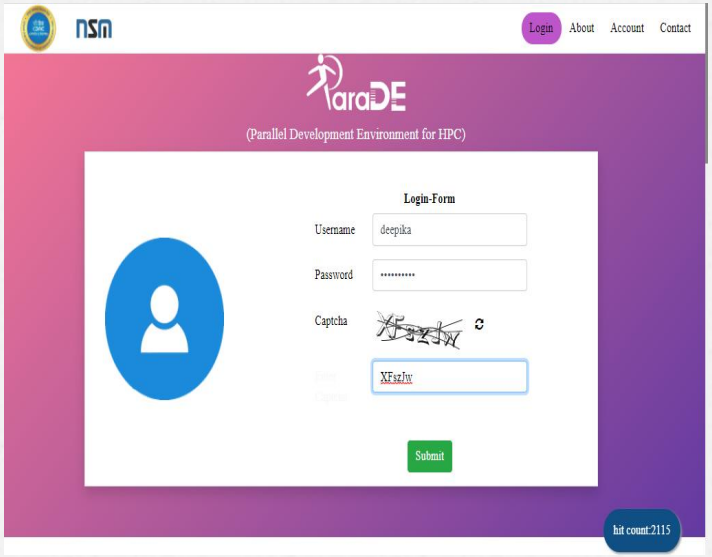


NATIONAL SUPERCOMPUTING MISSION

Parallel Development Environment for HPC

ParaDE

- Integrated Development Environment for HPC



- Browser based IDE
- No installation on client machine
- Single interface for application development

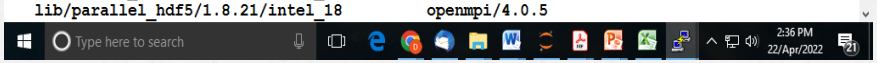
NATIONAL SUPERCOMPUTING MISSION

Working Environment in HPC

- Login to the HPC cluster

```
parade@login03:~
login as: parade
Using keyboard-interactive authentication.
If you truly desire access to this host, then you must indulge me in a simple challenge.
---------------------------------------------------------------

Observe the picture below and answer the question listed afterwards:

 _ _ _ _ _ _ _ _ _
 /\ /\ /\ /\ /\ /\ /\ /\ /\
( A | k | x | Q | E | f | O | n )
 \_/ \_/ \_/ \_/ \_/ \_/ \_/ \_/

Type the string above: AkxQEfOn
Using keyboard-interactive authentication.
Password:
Last login: Wed Apr 20 17:43:58 2022 from deepika-workstation.blr.cdac.in
[parade@login03 ~]$ vi pi-calulation.c
```

```
parade@login03:~
[parade@login03 ~]$ module avail

------------------------------- /opt/ohpc/pub/modulefiles -------------------------------
   EasyBuild/3.9.4                          oneapi/compiler32/2021.2.0
   apps/mom_6/intel_18.2                    oneapi/dal/2021.2.0
   apps/mpiblast/1.6.0/intel_18.2           oneapi/debugger/10.1.1
   apps/roms/3.6/intel_18                   oneapi/dev-utilities/2021.2.0
   autotools                                oneapi/dnnl-cpu-gomp/2021.2.0
   charliecloud/0.11                        oneapi/dnnl-cpu-iomp/2021.2.0
   charliecloud/0.22                (D)     oneapi/dnnl-cpu-tbb/2021.2.0
   clustershell/1.8.2                       oneapi/dnnl/2021.2.0
   cmake/3.15.4                             oneapi/dpct/2021.2.0
   compiler/hpc_sdk/nvhpc/21.7              oneapi/dpl/2021.2.0
   compiler/intel/2017.7.259                oneapi/init_opencl/2021.2.0
   compiler/intel/2018.4.057                oneapi/inspector/2021.2.0
   compiler/intel/2019.5.281                oneapi/intel_ipp_ia32/2021.2.0
   compiler/intel/2020.4.304        (D)     oneapi/intel_ipp_intel64/2021.2.0
   cuda/7.5                                 oneapi/intel_ippcp_ia32/2021.2.0
   cuda/8.0                                 oneapi/intel_ippcp_intel64/2021.2.0
   cuda/9.0                                 oneapi/itac/latest
   cuda/9.2                                 oneapi/itac/2021.2.0                (D)
   cuda/10.0                                oneapi/mkl/latest
   cuda/10.1                                oneapi/mkl/2021.2.0                 (D)
   cuda/10.2                                oneapi/mkl32/2021.2.0
   cuda/11.2                        (D)     oneapi/mpi/2021.2.0
   gcc/8.2.0                                oneapi/oclfpga/2021.2.0
   gnu8/8.3.0                               oneapi/tbb/2021.2.0
   hwloc/2.1.0                              oneapi/tbb32/2021.2.0
   intel/18.0.5.274                         oneapi/vpl/2021.2.2
   lib/netcdf_c/4.3.3.1/intel_18            oneapi/vtune/2021.2.0
   lib/netcdf_fortran/4.4.0/intel_18        openmpi/3.1.5
   lib/parallel_hdf5/1.8.21/intel_18        openmpi/4.0.5
```



- Write code on editor or import existing code to the cluster
- Search for compatible compilers and libraries to compile

- Understand the submission process on the cluster
- Create a LRM based script to execute the application

parade@login03:~

```
[parade@login03 ~]$ sinfo
PARTITION AVAIL  TIMELIMIT  NODES  STATE NODELIST
standard*    up 3-00:00:00     10 drain* cn[030-031,067-069],gpu010,hm[017,026,038-039]
standard*    up 3-00:00:00    106  alloc cn[001-028,033-060,070-072,074-101,105-110],hm[001
,025,027-037]
standard*    up 3-00:00:00     43   idle cn[029,032,061-066,073,102-104],gpu[001-009],hm[00
2-016,018-024]
gpu          up 3-00:00:00      1 drain* gpu010
gpu          up 3-00:00:00      9   idle gpu[001-009]
hm           up 3-00:00:00      4 drain* hm[017,026,038-039]
hm           up 3-00:00:00     13  alloc hm[001,025,027-037]
hm           up 3-00:00:00     22   idle hm[002-016,018-024]
cpu          up 3-00:00:00      5 drain* cn[030-031,067-069]
cpu          up 3-00:00:00     93  alloc cn[001-028,033-060,070-072,074-101,105-110]
cpu          up 3-00:00:00     12   idle cn[029,032,061-066,073,102-104]
[parade@login03 ~]$ vi slurm_script
```

NATIONAL SUPERCOMPUTING MISSION

- View the result and optimize if required

parade@login03:/scratch/parade/ParaDE/ExecutionDirectory/PI_Calculation

```
[parade@login03 PI_Calculation]$ cat output_19074.out
========================================
SLURM_CLUSTER_NAME = paramutkarsh
SLURM_ARRAY_JOB_ID =
SLURM_ARRAY_TASK_ID =
SLURM_ARRAY_TASK_COUNT =
SLURM_ARRAY_TASK_MAX =
SLURM_ARRAY_TASK_MIN =
SLURM_JOB_ACCOUNT = cdac
SLURM_JOB_ID = 19074
SLURM_JOB_NAME = PI_Calculation
SLURM_JOB_NODELIST = cn[064-065]
SLURM_JOB_USER = parade
SLURM_JOB_UID = 21040
SLURM_JOB_PARTITION = standard
SLURM_TASK_PID = 348
SLURM_SUBMIT_DIR = /scratch/parade/ParaDE/ExecutionDirectory/PI_Calculation
SLURM_CPUS_ON_NODE = 2
SLURM_NTASKS =
SLURM_TASK_PID = 348
========================================
Number of processes 2
Number of Threads 2
Pi Is Approximately 3.1415926535898993
[parade@login03 PI_Calculation]$
```

Debug code in case of errors

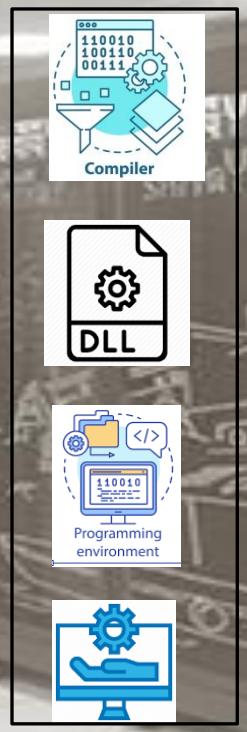
```
parade@login03:~
ib64/qt-3.3/bin:/usr/local/bin:/usr/bin:/usr/local/sbin:/usr/sbin:/home/parade/.local/bin:/
home/parade/bin)
[parade@login03 ~]$ module load compiler/intel/2020.4.304
[parade@login03 ~]$ mpicc test_mpi.c -g -o test_mpi
[parade@login03 ~]$ gdb ./test_mpi
GNU gdb (GDB) Red Hat Enterprise Linux 7.6.1-120.el7
Copyright (C) 2013 Free Software Foundation, Inc.
License GPLv3+: GNU GPL version 3 or later <http://gnu.org/licenses/gpl.html>
This is free software: you are free to change and redistribute it.
There is NO WARRANTY, to the extent permitted by law.  Type "show copying"
and "show warranty" for details.
This GDB was configured as "x86_64-redhat-linux-gnu".
For bug reporting instructions, please see:
<http://www.gnu.org/software/gdb/bugs/>...
Reading symbols from /home/parade/test_mpi...done.
(gdb) b main
Breakpoint 1 at 0x4008a5: file test_mpi.c, line 6.
(gdb) r
Starting program: /home/parade/./test_mpi
[Thread debugging using libthread_db enabled]
Using host libthread_db library "/lib64/libthread_db.so.1".

Breakpoint 1, main (argc=1, argv=0x7fffffffcd18) at test_mpi.c:6
6           MPI_Init(NULL, NULL);
Missing separate debuginfos, use: debuginfo-install glibc-2.17-324.el7_9.x86_64 libgcc-4.8.
5-44.el7.x86_64
(gdb) n
10          MPI_Comm_size(MPI_COMM_WORLD, &world_size);
Missing separate debuginfos, use: debuginfo-install libibverbs-54mlnx1-1.54103.x86_64 libnl
3-3.2.28-4.el7.x86_64 librdmacm-54mlnx1-1.54103.x86_64 numactl-libs-2.0.12-5.el7.x86_64 ucx
-1.11.0-1.54103.x86_64 zlib-1.2.7-19.el7_9.x86_64
(gdb)
```

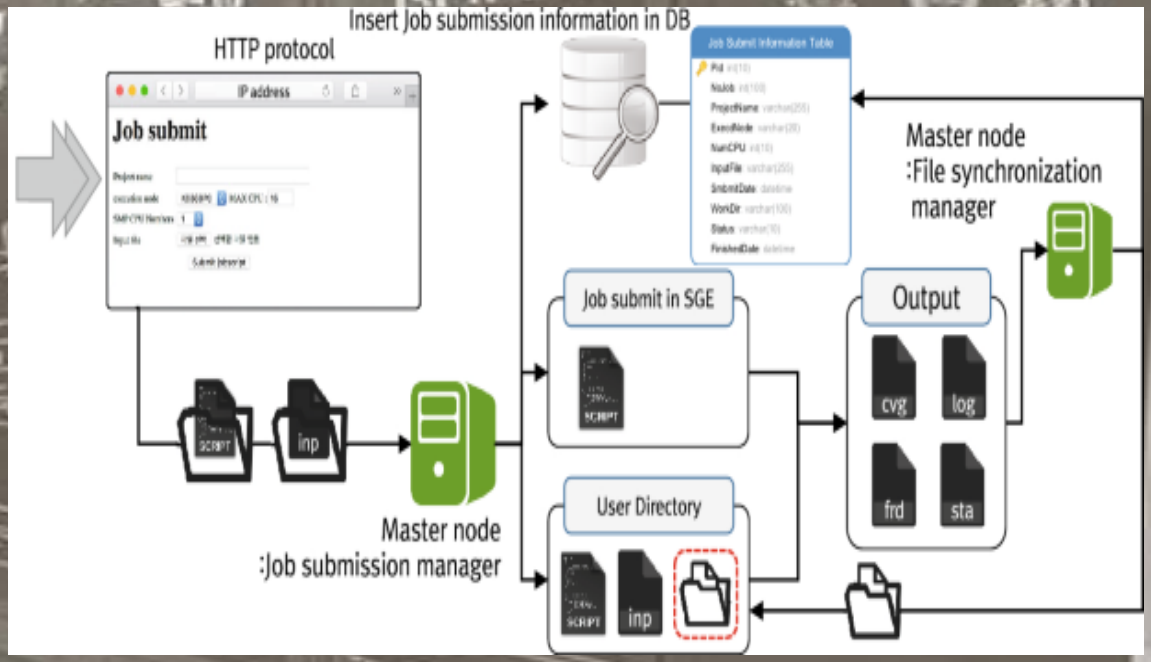
- Profile the code to analyze the program for decreasing the execution time

3. paramganga.iitr.ac.in

```
[parade@login04 ~]$ gcc -pg mg_serial.c -o mg_serial -lm
[parade@login04 ~]$ ./mg_serial ^C
[parade@login04 ~]$ gprof -b mg_serial gmon.out >profile.log
[parade@login04 ~]$ cat profile.log
Flat profile:

Each sample counts as 0.01 seconds.
  %   cumulative   self              self     total
 time   seconds   seconds    calls  us/call  us/call  name
100.19      0.01     0.01      101    99.20    99.20  compute
  0.00      0.01     0.00   999900     0.00     0.00  dist
  0.00      0.01     0.00      100     0.00     0.00  update
  0.00      0.01     0.00        2     0.00     0.00  cpu_time
  0.00      0.01     0.00        2     0.00     0.00  timestamp
  0.00      0.01     0.00        1     0.00     0.00  initialize
  0.00      0.01     0.00        1     0.00     0.00  r8mat_uniform_ab

                     Call graph


granularity: each sample hit covers 2 byte(s) for 99.81% of 0.01 seconds

index % time    self  children    called     name
                0.01    0.00     101/101        main [2]
[1]     100.0   0.01    0.00     101        compute [1]
                0.00    0.00  999900/999900     dist [3]
-----------------------------------------------
                                               <spontaneous>
[2]     100.0   0.00    0.01                 main [2]
                0.01    0.00     101/101        compute [1]
                0.00    0.00     100/100        update [4]
                0.00    0.00       2/2          timestamp [6]
                0.00    0.00       2/2          cpu_time [5]
                0.00    0.00       1/1          initialize [7]
-----------------------------------------------
                0.00    0.00  999900/999900     compute [1]
[3]       0.0   0.00    0.00  999900         dist [3]
-----------------------------------------------
```

PROGRAMMING on A Supercomputer

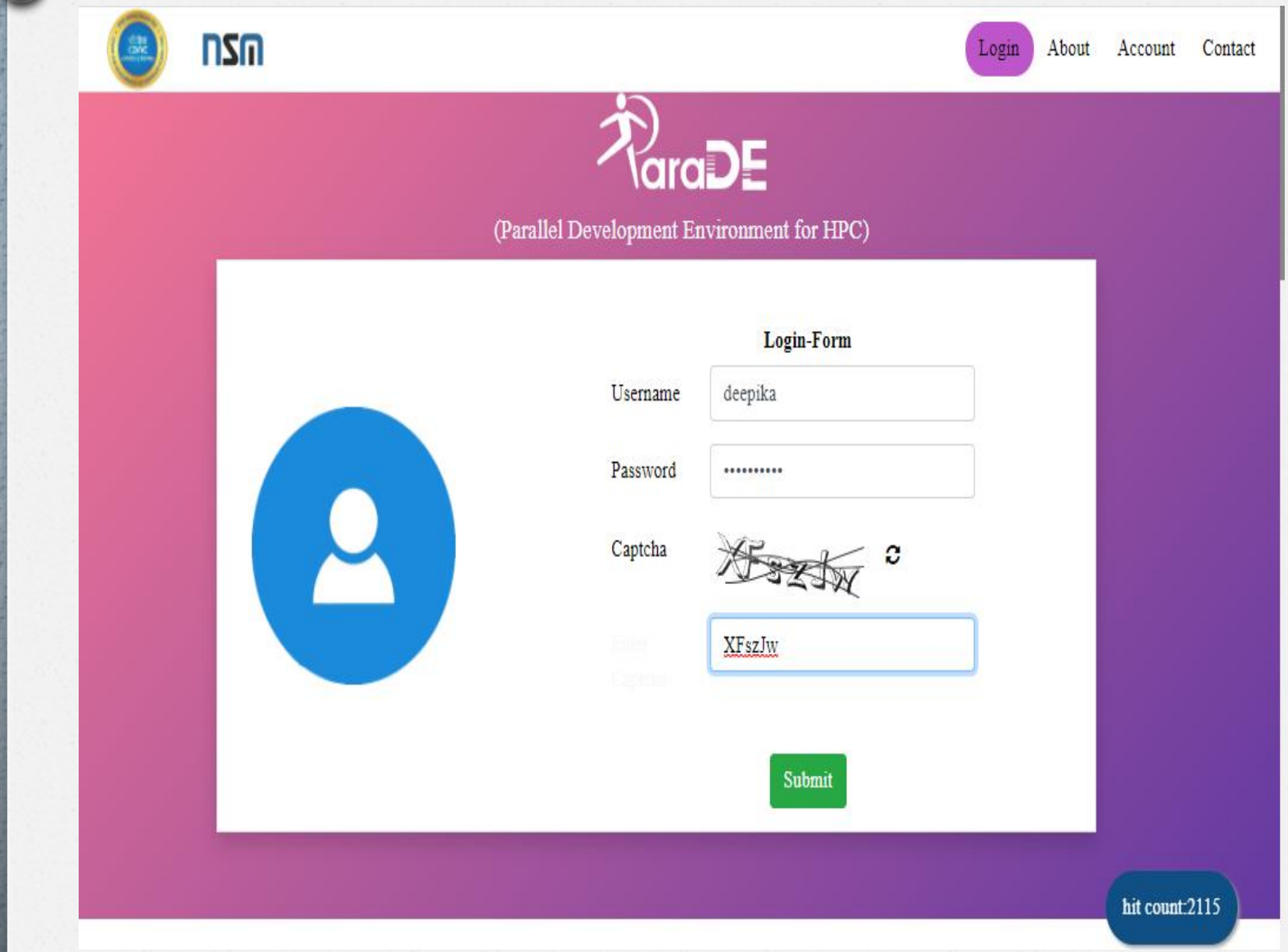


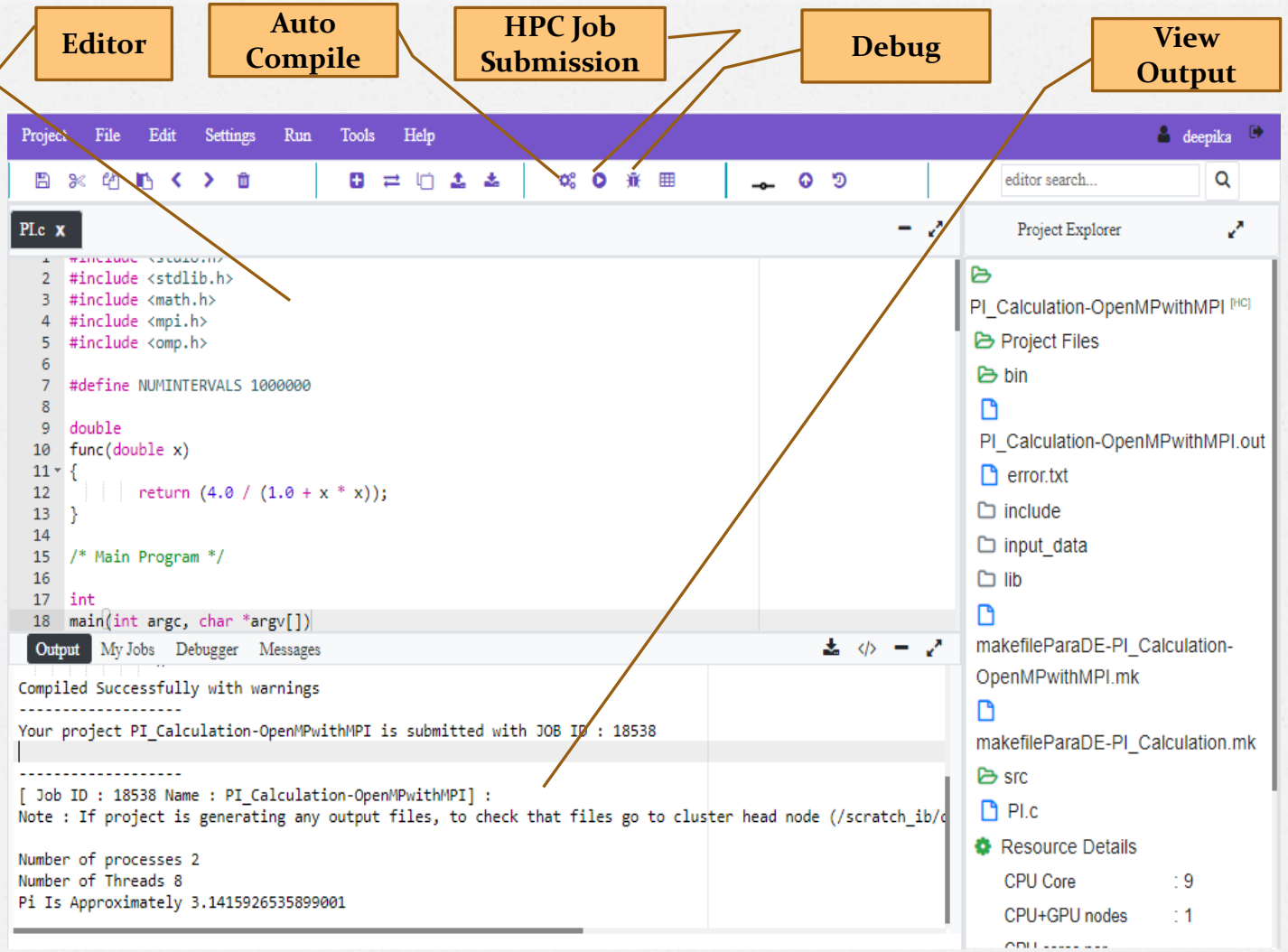


NATIONAL SUPERCOMPUTING MISSION

PROGRAMMING on A Supercomputer with ParaDE

NATIONAL SUPERCOMPUTING MISSION




Editor
Auto Compile
HPC Job Submission
Debug
View Output
Project
File
Edit
Settings
Run
Tools
Help
deepika
editor search...
PI.c
#include <stdlib.h>
#include <math.h>
#include <mpi.h>
#include <omp.h>
#define NUMINTERVALS 1000000
double
func(double x)
{
return (4.0 / (1.0 + x * x));
}
/* Main Program */
int
main(int argc, char *argv[])
Output
My Jobs
Debugger
Messages
Compiled Successfully with warnings
Your project PI_Calculation-OpenMPwithMPI is submitted with JOB ID : 18538
[Job ID : 18538 Name : PI_Calculation-OpenMPwithMPI] :
Note : If project is generating any output files, to check that files go to cluster head node (/scratch_ib/
Number of processes 2
Number of Threads 8
Pi Is Approximately 3.1415926535899001
Project Explorer
PI_Calculation-OpenMPwithMPI [HC]
Project Files
bin
PI_Calculation-OpenMPwithMPI.out
error.txt
include
input_data
lib
makefileParaDE-PI_Calculation-OpenMPwithMPI.mk
makefileParaDE-PI_Calculation.mk
src
PI.c
Resource Details
CPU Core : 9
CPU+GPU nodes : 1

NATIONAL SUPERCOMPUTING MISSION

DEMO

Features of Parade

Debuggers, Profiler, Converter, Libraries, etc

Auto Compile

HPC Job Submission

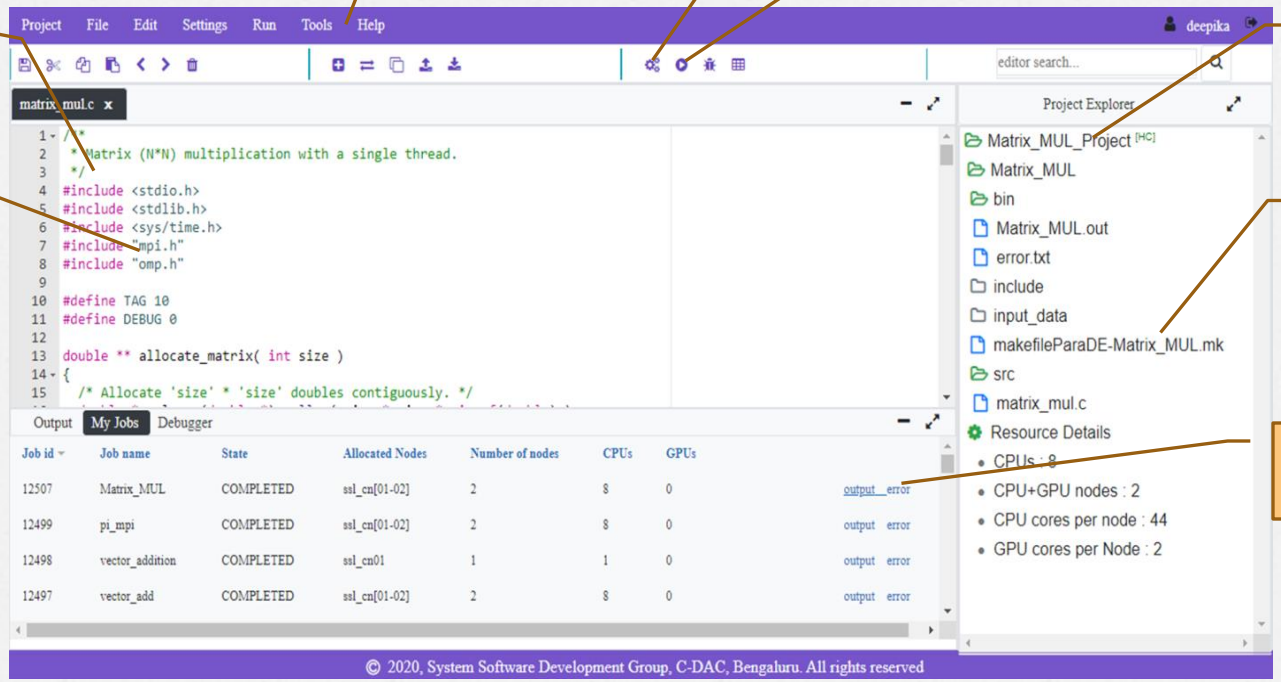
Context Sensitive Editor

Project Management

Multiple Parallel Paradigms

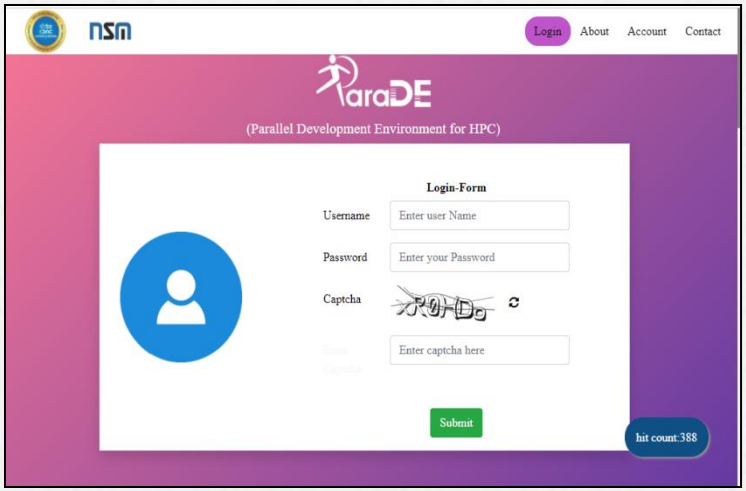
Automatic Makefile Generation

Output/Error Viewing



IDE for HPC

- Anytime
- Anywhere



- Single interface for HPC programming

NSM
NATIONAL
SUPERCOMPUTING
MISSION

Make your life easy on HPC

https://paramshakti.iitkgp.ac.in:8447/parade

Any Queries ? ? ?

NSM
NATIONAL
SUPERCOMPUTING
MISSION

Thank You

Email : nsmss@cdac.in