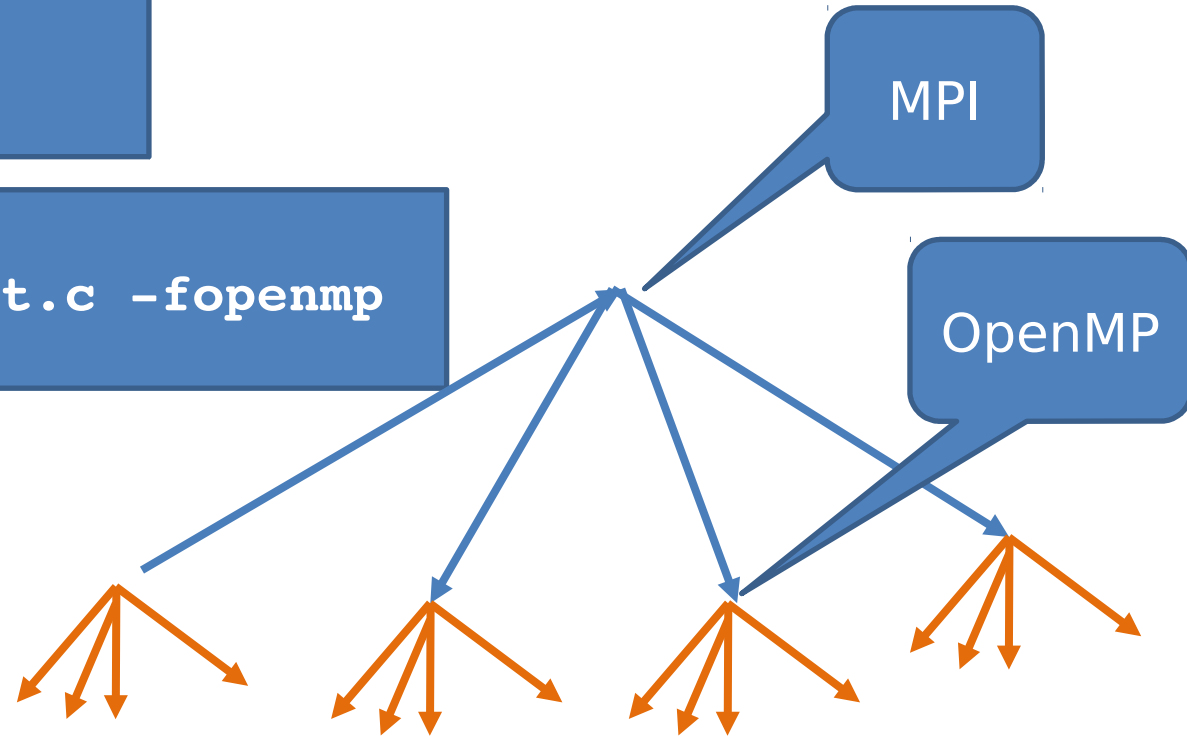


Hybrid MPI + OpenMP Demo

Machine File:
Node1
Node2
Node3
node4

Each node has 8 cores

```
mpicc -o mpi_out mpi_test.c -fopenmp
```



```
Demo: cd ~/mpi program name: hybridpi.c
```

```
mpicc -o mpi_exe mpi_test.c -fopenmp
```

```
export OMP_NUM_THREADS=8
```

```
(bash)
```

```
mpirun -np 4 -machinefile ./machines mpi_exe
```

Hybrid Pi (MPI+OpenMP)

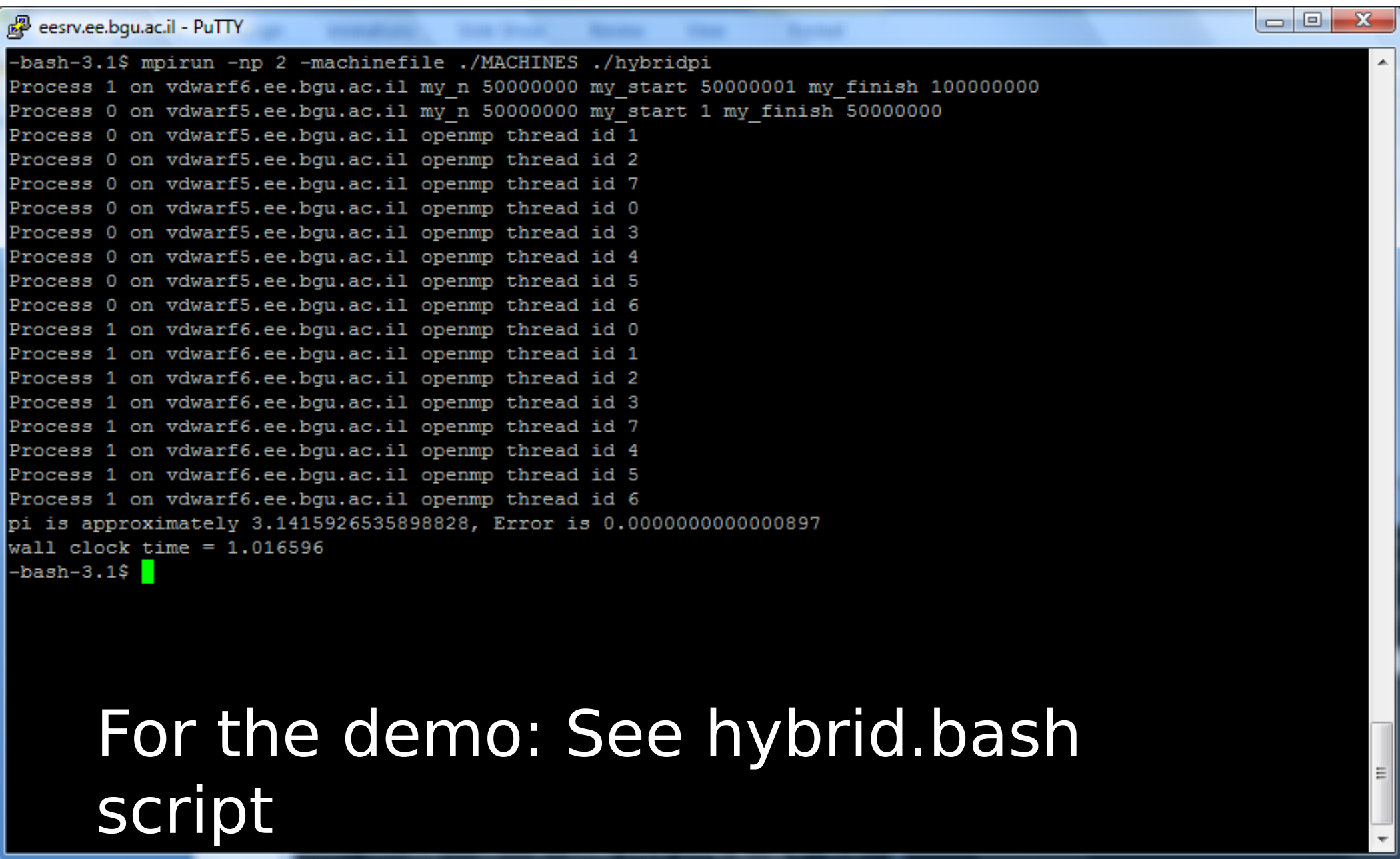
```
#include <stdio.h>
#include <mpi.h>
#include <omp.h>
#define NBIN 100000
#define MAX_THREADS 8

int main(int argc, char **argv) {
    int nbin, myid, nproc, nthreads, tid;
    double step, sum[MAX_THREADS] = {0.0}, pi = 0.0, pig;
    MPI_Init(&argc, &argv);
    MPI_Comm_rank(MPI_COMM_WORLD, &myid);
    MPI_Comm_size(MPI_COMM_WORLD, &nproc);
    nbin = NBIN/nproc;
    step = 1.0/(nbin*nproc);
```

```
#pragma omp parallel private(tid)
{
    int i;
    double x;
    nthreads = omp_get_num_threads();
    tid = omp_get_thread_num();
    for (i=nbin*myid+tid; i<nbin*(myid+1); i+=nthreads) {
        x = (i+0.5)*step;
        sum[tid] += 4.0/(1.0+x*x);
    }
    printf("rank tid sum = %d %d %e\n",myid,tid,sum[tid]);
}
for(tid=0; tid<nthreads; tid++)
    pi += sum[tid]*step;

MPI_Allreduce(&pi,&pig,1,MPI_DOUBLE,MPI_SUM,MPI_COMM_WORLD);
if (myid==0) printf("PI = %f\n",pig);
MPI_Finalize();
return 0; }
```

Hybrid MPI+OpenMP continued



```
eesrv.ee.bgu.ac.il - PuTTY
-bash-3.1$ mpirun -np 2 -machinefile ./MACHINES ./hybridpi
Process 1 on vdwarf6.ee.bgu.ac.il my_n 50000000 my_start 50000001 my_finish 100000000
Process 0 on vdwarf5.ee.bgu.ac.il my_n 50000000 my_start 1 my_finish 50000000
Process 0 on vdwarf5.ee.bgu.ac.il openmp thread id 1
Process 0 on vdwarf5.ee.bgu.ac.il openmp thread id 2
Process 0 on vdwarf5.ee.bgu.ac.il openmp thread id 7
Process 0 on vdwarf5.ee.bgu.ac.il openmp thread id 0
Process 0 on vdwarf5.ee.bgu.ac.il openmp thread id 3
Process 0 on vdwarf5.ee.bgu.ac.il openmp thread id 4
Process 0 on vdwarf5.ee.bgu.ac.il openmp thread id 5
Process 0 on vdwarf5.ee.bgu.ac.il openmp thread id 6
Process 1 on vdwarf6.ee.bgu.ac.il openmp thread id 0
Process 1 on vdwarf6.ee.bgu.ac.il openmp thread id 1
Process 1 on vdwarf6.ee.bgu.ac.il openmp thread id 2
Process 1 on vdwarf6.ee.bgu.ac.il openmp thread id 3
Process 1 on vdwarf6.ee.bgu.ac.il openmp thread id 7
Process 1 on vdwarf6.ee.bgu.ac.il openmp thread id 4
Process 1 on vdwarf6.ee.bgu.ac.il openmp thread id 5
Process 1 on vdwarf6.ee.bgu.ac.il openmp thread id 6
pi is approximately 3.1415926535898828, Error is 0.00000000000000897
wall clock time = 1.016596
-bash-3.1$
```

For the demo: See hybrid.bash
script