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TEXAS ADVANCED COMPUTING CENTER
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TEXAS
The University of Texas at Austin

Hybrid Computing LAB

TACC OpenMP Tutorial

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HYBRID_HELLO

Eval hybrid code, compile, launch, MPI inside OpenMP

- Compile code with MPI wrapper and OpenMP options.
- Slurm request for 2 nodes with 1 rank per node
- Set run environment (68 threads/task, use default affinity)
  - export OMP_NUM_THREADS=68
- Evaluate MPI mask with amask
- Launch with TACC's ibrun launcher (=mpirun)
  - ibrun a.out #ask usual
- Insert MPI code within an OpenMP parallel region
  - Change MPI_Init to MPI_Init_thread
  - Use single directive to for a single MPI_Bcast call.

HYBRID_REDUCTION

Create your first hybrid code, combining OpenMP/MPI

- Sum up a sequence of numbers in a parallel OpenMP region
- Sum up the partial values from the OpenMP calculations.

```
MPI_init(NULL,NULL);
MPI_Comm_rank(MPI_COMM_WORLD,&rank );
nthreads=omp_get_max_threads();

#pragma omp parallel for reduction(+:sum) num_threads(nthreads)
for(i=1;i<=nthreads;i++)sum=sum+ omp_get_thread_num() + (rank*nthreads)

MPI_Allreduce(&sum,&tot_sum,1,MPI_INT, MPI_SUM,MPI_COMM_WORLD);
```

- Compile with MPI “compiler” and –qopenmp option.

HYBRID_PI

Perform MPI_Allreduction in OpenMP parallel region

- A parallel integration of 4/(1+x^2) calculates PI.
- OpenMP parallel regions perform integration over intervals, and MPI sums the result (partials) from each rank in a MPI_Allreduce.
- The MPI partial summation is moved inside an OpenMP parallel region. (Sounds familiar?)
- The appropriate MPI_Init is performed.
- Results are checked.

HYBRID_NUMA

Launching HYBRID CODE with AFFINITY

- Hop on a SNC-4 numa node (idev, and select SNC4 reservation)
- Set run environment:
  - # of ranks (launcher) -np #
  - # of cores for each rank's mask I_MPI_PIN_DOMAIN=##
  - # of threads for each rank OMP_NUM_THREADS=###
- export …
  ibrun -np # a.out
- env … mpiexec.hydra -np # a.out
- env ... mpiexec.hydra -np # myscript

- For SNC-4 numa nodes:
  When DOMAIN=numa, 4 masks are set ...