Parallel Programming – Assignment 1: 12563-SAIPRASANNA.AN

SCIENTIFIC PROBLEM: Real-Time Modeling of Human Heart Ventricles at Cellular Resolution.

SUPER COMPUTER USED: Sequoia – IBM Blue Gene/Q at Lawrence Livermore National Laboratory.

TOP 500 RANK: 2 (According to the rankings released on November – 2012).

PARALLEL PLATFORM: Both **distributed** and **shared memory** parallelism.

TOOLS USED:

- Initialization tasks and data aggregation for I/O: MPI.
- Internode communication: MPI Isend and Irecv. (300 micro sec per time step – very high).
- Reimplementation -Internode Communication: BG/Q low-level Systems Programming Interface.

COMMUNICATION NETWORK: Five-dimensional TORUS.

OPTIMIZATION APPROACH: Combines biology-aware and hardware-aware tuning.

PERFORMANCE AND SCALING:

- 50 times faster. (Optimized code compared with unoptimised version based on simplistic implementation of Diffusion operator using MPI and Open MP).
- On half-machine- Throughput exceeds 4.3 PFlop/s (Over 43% of peak).
- With perfect weak scaling, predicted performance is 8.6 PFlop/s and throughput should exceed 9 heart beats per minute for a 0.1 mm resolution 370 million cell grid on the full Sequoia.
- Time to solution is 400-500 times faster compared to existing methods.

SCIENTIFIC OBJECTIVE ACHIEVED:

Sudden cardiac death (SCD) is generally accepted to result from ***Arrhythmias.*** This development of highly efficient and scalable cardiac electrophysiology simulation supports ground breaking resolution and detail to elucidate the mechanisms of SCD from arrhythmias thus helping to better apply existing therapies and spur the development of new therapies with greater efficacy and fewer detrimental effects.