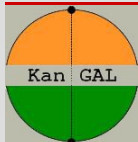




IITK REACH Symposia 2010 10-12 October'10

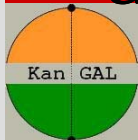
High Performance Computing: Applications in Science and Engineering

Amalendu Chandra (Convener)
Kalyanmoy Deb



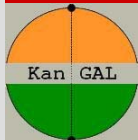
High Performance Computing (HPC)

- ▶ Usage of computers for solving complex computing problems
 - ▶ Nanotechnology, molecular modeling, biology
 - ▶ 3D modeling and simulation, optimization
 - ▶ CFD, weather modeling
 - ▶ Gaming, Data mining, etc.
 - ▶ Usually requiring TeraFLOP of computations (Trillion floating point operations per second)
 - ▶ Indispensible companion for higher education and research today
 - ▶ Slide rules for 60-70s, calculators for 80s, miniframes and mainframes for 80-90s
 - ▶ Direct correlation between computing power and extent/quality of research
-



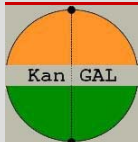
Different Computing Paradigms

- ▶ High Performance Computing (HPC)
 - ▶ High Performance Technical Computing (HPTC)
 - ▶ High Throughput Computing (HTC)
 - ▶ Many-task Computing (MTC)
 - ▶ Metacomputing
 - ▶ Supercomputing
 - ▶ Grid Computing
 - ▶ Cloud Computing
 - ▶ Parallel Computing
 - ▶ Distributed Computing
 - ▶ Heterogeneous Computing
 - ▶ Futuristic: [Quantum Computing](#)
-



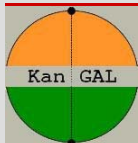
Top FIVE Performers (June 2010)

- ▶ On Linpack benchmark
- ▶ **Cray XT5** (Jaguar), 1759 Tflops, ORNL, USA, 2009
- ▶ **Dawning TC3600** (Nebulae), 1271 Tflops, NSCS, Shenzhen, China, 2010
- ▶ **IBM BladeCenter** (Roadrunner), 1042 Tflops, Los Alamos, USA, 2009
- ▶ **Cray XT5** (Kraken), 871 Tflops, NICS, USA, 2009
- ▶ **IBM BlueGene** (Jugene), 825 Tflops, Julich, Germany, 2009



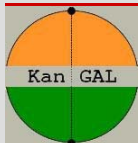
PetaFlop to ExaFlop Projections

- ▶ PetaFlop: 1000 TeraFlops
- ▶ Current Best: 1.76 PetaFlop
- ▶ Moore's Law: Speed doubling every 14 mths, 2009 machine is 18,000 times faster than that in 1993
- ▶ 2011-2012: 20 PetaFlop machine by IBM & Office of Science, USA (design confirmed)
- ▶ 2015: 100-250 PetaFlop machine (projected)
- ▶ 2018: ExaFlop machine (1000 PetaFlops) (projected)
- ▶ Might see in our lifetime ZettaFlop, YottaFlop, XonaFlop, WekaFlop or VundaFlop machines
- ▶ Or may there be a different type of computing paradigm!



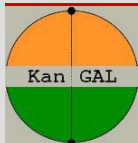
HPC Facilities in India

- ▶ India (in Top500, June'10, <http://www.top500.org>)
 - ▶ Rank 33: Computational Research Laboratories, TATA SONS, **132.8 Tflops**, HP Cluster, 2008
 - ▶ Rank 93: Indian Institute of Tropical Meteorology. **55.1 Tflops**, IBM Power 575, 2010
 - ▶ Rank 182: CDAC, **38.1 Tflops**, Param Yuva, 2008
 - ▶ Rank 369: **IIT Kanpur**, **29.01 Tflops**, HP Cluster, 2010
 - ▶ Rank 389: IT Services Provider, **28.36 Tflops**, HP Cluster, 2009
- ▶ IITK is the only IIT/IISc. featuring in Top500
- ▶ China: Rank 2, 2 in Top10 and 24 in Top500
- ▶ HiPC: An Intl. conference in India since 1995



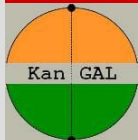
Usage of HPC

- ▶ Task can be small or large
- ▶ Task may involve an uniprocessor or multiprocessors
- ▶ Task may be compute-intensive, data-intensive, or communication-intensive, or a combination
- ▶ Task may be static or dynamic
- ▶ Task may be homogeneous or heterogeneous
- ▶ Task may be loosely coupled or tightly coupled



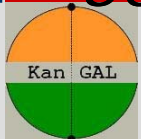
HPC Research

- ▶ New applications
 - ▶ Venturing to solve problems which were not possible to solve earlier
- ▶ New algorithms/methodologies for problem solving
- ▶ Solving existing problems more efficiently
- ▶ New implementations – compilers, code parallelization
- ▶ New hardware development
 - ▶ Faster, more data-handling, faster communications
- ▶ “Solution is of the computer model, need not be of the real system”



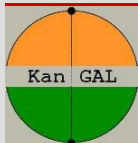
Symposium on HPC

- ▶ Sanjay Mittal (IITK): *Using HPC for understanding of **Fluid Flows***
- ▶ S. Sherlekar (INTEL): *An **Applications** Perspective of High-Performance Computing*
- ▶ R. Sankararamakrishnan (IITK): *From sequence analysis to simulations: Applications of high-performance computing in modern **biology***
- ▶ Sanjeev Aggarwal (IITK): *Automatic **Parallelization** of Programs*
- ▶ Prashant Goswami (C-MMACS): *Will HPC ever meet the demands of **weather and climate forecasting?***
- ▶ Amalendu Chandra (IITK): ***Molecular simulations and HPC@IITK***
- ▶ ~~*30 Posters on various **applications (IITK)***~~



Acknowledgements

- ▶ Patron, Prof. S. G. Dhande
- ▶ Golden Jubilee Committee
- ▶ V. Chandrasekhar and his REACH organising team and support staff
- ▶ K. Muralidhar and Manindra Agrawal, REACH Advisory Committee
- ▶ All the invited speakers
- ▶ Additional thanks to IITK invited speakers for their time for the pre-presentations
- ▶ All the poster authors and presenters
- ▶ Special thanks to Prof. Gautam Biswas ...



Chair of the Session



Prof. Gautam Biswas
Director, Central Mechanical Engineering Research
Institute (CMERI) Durgapur and
Professor, Department of Mechanical Engineering,
IIT Kanpur

