

High Performance Computing Facility for North East India through Information and Communication Technology

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ABSTRACT

High Performance Computing (HPC) speed is measured in the unit of FLOPS (Floating point operations per second) and it is the capacity of a Supercomputer to perform a task in a fraction of second, minute or an hour as per the complexity of the task. HPC has diverse field of applications in all sectors. It has now become a tool used in research and development by scientists and researchers across the world. In this paper, the deployment of HPC infrastructure facility of National Institute of Technology Silchar to North East India for value added education system is presented. North East India comprises of eight hilly states not well connected by road, rail and Air with other parts of India. But it has enough potential to be exploited and enriched in natural resources. The other seven institutions of national importance established by Govt. of India in this part of the country are deprived from many facilities, resources and expertise. In order to provide research facility to all institutions across North East, they are required to be connected to the HPC facility through information and communication technology (ICT). The proposed model of e-connectivity can be implemented in some developing countries worldwide. In order to implement this prototype developed countries should come forward to establish a robust LAN/WAN which is very much required to be deployed to support high speed data transfer. As a result prospective students, research scholars and faculty can get access to the world through internet.

Key words: FLOPS; HPC; ICT; IRCG; NKN

1. INTRODUCTION

High Performance Computing (HPC) refers to any computational activity requiring more than a single computer to execute a task [1]. Supercomputers and computer clusters are used to solve advanced *Computational Science and Engineering Research* problems. HPC has the capacity to handle and analyze massive amounts of data at high speed. Tasks that can take months using normal computers can be done in days or even minutes. It can be used to model and solve highly complex problems in all sectors [1].

The major areas of applications include data storage and analysis, data mining, simulations, modeling, software development, visualization of complex data and rapid mathematical calculations.

Moreover Supercomputers are also used for a wide range of computationally intensive tasks in various fields, i.e. Quantum Mechanics, weather forecasting, climate research, oil and gas exploration, molecular Modeling for computing the structures and properties of chemical compounds, biological macromolecules, polymers, and crystals and physical simulations such as simulations of the early moments of the universe, airplane and spacecraft aerodynamics, the detonation of nuclear weapons, and nuclear fusion [2].

Further HPC can also be used to develop and redesign products, optimize production and delivery processes, analyze or develop large datasets, conduct large-scale research projects, store large amounts of data for future analysis, perform consumer trend monitoring, searching or profiling, create computer visualizations that explain research results, carry out simulations and / or modeling of complex processes [3].

Looking at the prospects of HPC and its diverse applications, it is very important for the students and researchers to use in their education system. Due to lack of this HPC facility faculty, students and research scholars of North East India are deprived from high end research activity.

North East India is the eastern-most region of India connected to East India via a narrow corridor squeezed between Nepal and Bangladesh. It comprises the contiguous Seven Sister States (Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, and Tripura), plus the Himalayan state of Sikkim [2]. These states are not well connected by road, rail and Air with other parts of the country due to hilly regions. Hence many of the areas are undeveloped and unemployed. However, the North East is enriched with natural resources, handicrafts and unique cultures.

Therefore, in this juncture it is essential to transfer knowledge and information, share resources using ICT to the North East people. Hence, the drive of HPC in North East India has been initiated by NIT Silchar, one of the premier institute of Govt. of India established in 1967 at Silchar, the southern part of Assam state to connect all institutes of national importance. This is as per the vision of HPC mission of Hon'ble President of India for capacity and capability building in North East India. His vision includes steps required for deepening research and technological innovation for meeting national development goals, technology-enabled learning, building international networks and linkages for quality improvement and initiatives for capacity and capability development. The proposed models of

eConnectivity of all North East NITs are shown in Fig. 1 and Fig. 2.

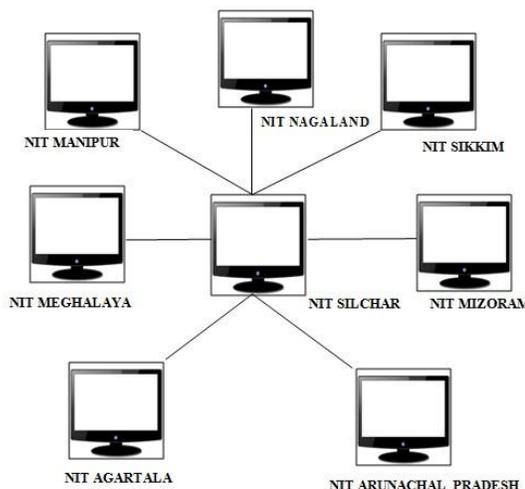


Fig. 1 eConnectivity of Seven NITs of North East India with NIT Silchar

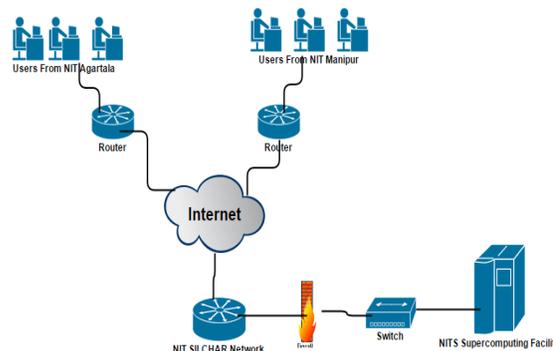


Fig. 2 Proposed model of North East e-Connectivity with NITS Supercomputing Centre through ICT

The agreement between NIT Silchar and Centre for Development of Advanced Computing (C-DAC) for establishment of HPC Infrastructure and deployment of technologies in North East is presented in Section 2. A brief description on HPC system work flow is presented in Section 3. The HPC Infrastructure and Research Group at NIT Silchar are presented in Section 4. The social benefit out of this project implementation is stated in Section 5, the international adaptability is presented in Section 6 and finally conclusions are drawn in Section 7.

2. C-DAC & NIT SILCHAR

Centre for Development of Advanced Computing (C-DAC) is a premier research and development

Society under Department of Electronics & Information Technology (DeitY) under Ministry of Communication and IT, Govt. of India. It extends its full fledged support for the implementation of IT infrastructure project. It spreads across 11 cities in the country. The various labs of C-DAC carry out cutting edge R&D and innovation activities ranging from conceptualization to field deployment in a number of areas within the space of electronics, information and communication technologies having national and international importance. C-DAC and NIT Silchar are under the agreement of MOU for the establishment of High Performance Computing at NIT Silchar and to drive HPC mission in the North East India.

3. HIGH PERFORMANCE COMPUTING (HPC) WORK FLOW

The HPC workflow is shown in Fig. 3. The remote researchers and analysts are connected to the HPC Compute clusters through internet and wide area network (WAN) as shown in this figure whereas the local researchers and analysts are directly connected to it.

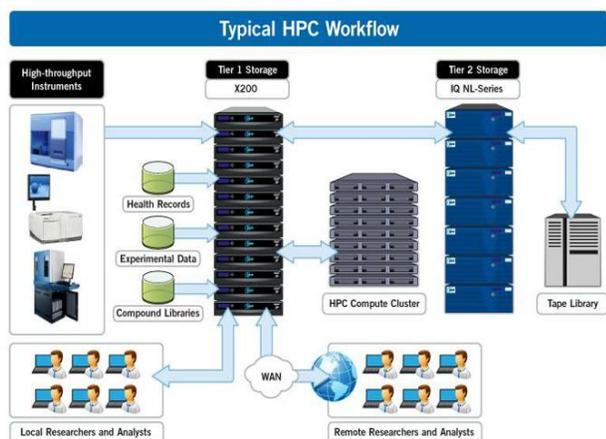


Fig. 3 Typical HPC workflow [4]

High throughput instruments are connected through storage to the HPC compute clusters. HPC has a diverse field of applications in all areas and the resulting data such as health records, experimental data, and compound libraries are also connected to the HPC Compute cluster through tier 1 storage as shown in Fig. 3.

4. HPC INFRASTRUCTURE AND RESEARCH GROUP AT NIT SILCHAR

NIT Silchar has established the first of its kind state-of-the-art NITS Supercomputing Centre, *Centre of Excellence in High Performance Computing* build with the x86_64 bit latest Intel Ivy Bridge processing and Accelerators (Intel Xeon Phi and NVIDIA Kepler Co-processing) technologies with a compute power of 15 Tera Flops. It runs over 272 processors using state-of-art data center with 2 Precision Air Conditioning (PAC), grouped in 2 racks connected by high-speed optical network.

Intel Xeon Phi delivers over a TFLOPS of double-precision peak performance. Additionally, as compared with Intel Xeon processor E5 family-based servers, the Intel Xeon Phi coprocessor delivers up to 2.3 times higher peak FLOPS and up to 3 times more performance per watt and up to 7 times better performance on certain financial services applications [4] whereas, NVIDIA Kepler is the world's fastest and most efficient high performance computing (HPC) architecture. With innovative computing technology and features, it is applicable to a broader range of scientific computing applications and makes hybrid computing more accessible for application developers and researchers [5].

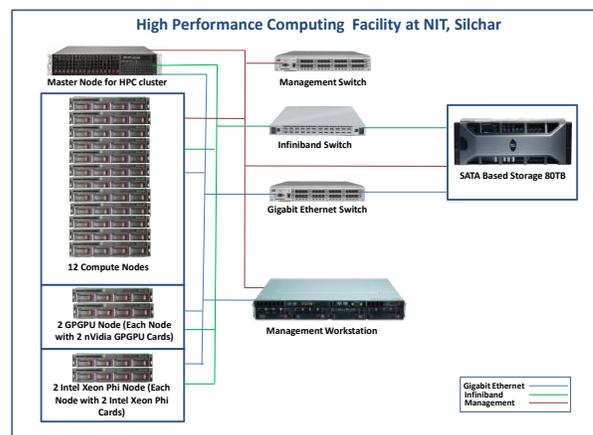


Fig. 4 High Performance Computing Architecture at NITS Supercomputing Centre

This establishment of HPC Centre at NIT Silchar is replicated by the concept of Blue Water of

University of Illinois, Urbana Champaign, USA. The High Performance Computing architecture at NITS Supercomputing Centre is shown in Fig. 4.

The detail specifications of the NITS Supercomputing Centre as follows. It is equipped with 34 number of Intel® Xeon® Ivy bridge (E5-2650V2) processors with peak performance of 14.94 Teraflops. It has 272 processors of x86_64 based processing cores and total Memory of 1.088 TB (1088 GB) where each node of 64 GB. The master node consist of 6 x 600 GB, 15K RPM, SAS 6Gbps hot-plug HDDs (hard disk drives) whereas each compute node consist of 2 x 500 GB, 7.2K RPM, Enterprise SATA hot-plug HDDs. It is also equipped with 4 x Intel® Xeon® Phi 5110P Accelerators (8 GB, 60 Co-Processing Cores) and 4 x Nvidia K20X GPU (6 GB, 2688 Co-Processing Cores). The 84 TB SATA hot-plug HDDs are configured as RAID5. It is connected with 36 Ports 56Gbps 4X FDR Infiniband as a Primary Network, 48-port Gigabit Ethernet as a Secondary Network and 48-port Gigabit Ethernet as Management Network. The operation of the Supercomputing Centre is operated and controlled by Visualization Management workstations.

The software configuration of HPC infrastructure includes licensed Red Hat Enterprise Linux Server release 6.4 in all the master and compute nodes, IBM® Platform™ HPC 4.1.1.1, LSF Express 9.1.1.0 job scheduler and Intel Cluster Studio.

This infrastructure facilitates a common computational resource centre for the academic research programmes; catalyse the impact of high quality engineering education and high-end computational work for engineering research community. The High Performance Computing Centre (HPCC) shall promote research and teaching by integrating leading-edge, high-performance computing techniques, enabling technologies and visualization for the faculty, PhD scholars, and students of all engineering disciplines of the

institution to cater the socio-economic development of North East India.

Computational Science and Engineering which is by nature interdisciplinary and widely accepted along with theory and experiment. Aerospace, Automotive, Biological, Chemical, Electronics, Electrical, Mechanical, Civil, Physical Science, Pure & Applied Mathematics and other industrial sectors now rely on simulation for technical decision and product development.

Therefore in order to drive the momentum an *Interdisciplinary Research Computing Group (IRCG)* for *Computational Science and Engineering Research* has been formed. The objective of IRCG is to inculcate a new dimension in the culture of the institution in the direction of multidisciplinary research and collaborations, establishing a pattern of cross-disciplinary research effort, an acceptance of such effort as the norm that shall position the institution for major opportunities in all fields of engineering and applied research. The IRCG shall also focus towards establishing a new interdisciplinary graduate program in Computational Engineering that allows entry from any field of science & engineering to support in the capacity/capability building and create a new field of employable opportunities.

5. SOCIAL BENEFIT

NIT Silchar extends all technical support to establish campus wide Internet connectivity and connecting to NITS Supercomputing Centre, with support from faculty and students to all North East NITs. The students, research scholars and faculty of North East NITs can get the access of high performance computing for modeling and simulation as required in their research work. Due to lack of faculty/instructors, many of the courses are not being taught properly. Hence Virtual Class Room facility for many online courses can be extended to recipient institutes by high speed NKN (National Knowledge Network) provided by Govt. of India. Students, research scholars and faculty of North East NITs can

get the access of e-Journals and e-Books from the Central Library facility of NIT Silchar which is under the agreement of MOU with University of Illinois, Urbana Champaign, USA. Apart from National Institutes of Technology, Universities, Research laboratories and state government engineering institutes of North East, this HPC facility can be extended.

6. INTERNATIONAL ADAPTABILITY

This proposed model of connecting of all North East India NITs can be replicated in some developing countries worldwide. In order to implement this prototype, developed countries should come forward to establish a robust LAN/WAN which is very much required to be deployed to support high speed data transfer. As a result prospective students, research scholars and faculty can get access to the world through internet. The developing countries of east Asia can be extended this eConnectivity facility from India. Therefore Govt. of India has recently started a new policy called Look East for capacity and capability building.

7. CONCLUSIONS

By implementation of this project technology-enabled learning can be provided to the students, researchers and faculty which will result in capacity and capability building of North East region. Research scholars and faculty can log-in into the HPC System and do their research for innovation in diverse field of applications. NIT Silchar could share its Library Information System by allowing access of e-journals and e-books. Virtual Class Room facility extended for few subjects of UG/PG program.

ACKNOWLEDGEMENTS

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