Computing Infrastructure at NCMRWF.

The availability of a supercomputer was considered as most important for the core function of using an Atmospheric General Circulation model (AGCM) to produce medium-range Numerical Weather Prediction (NWP) forecasts. In the year 1988 the choice fell on Cray XMP-14 (One processor and four million words memory) vector machine, and the Cray XMP-14 computer arrived at NCMRWF and was dedicated to the nation on 25th March 1989. Since then the Computing facility available at NCMRWF has seen significant augmentations.

The National Centre for Medium Range Weather Forecasting (NCMRWF) is a Centre of Excellence in Weather and Climate Modelling under the Ministry of Earth Sciences. The mission of the Centre is to continuously develop advanced numerical weather prediction systems, with increased reliability and accuracy over India and neighbouring regions through research, development and demonstration of new and novel applications, maintaining highest level of knowledge, skills and technical bases.

Improved and reliable forecast of weather and climate requires routine operations as well as research & development using very high resolution dynamical models with high complexity (e.g. coupled ocean-atmosphere-biosphere-cryosphere models). Operations of these models and the necessary R & D to improve them will be possible only if the High Performance Computing Facilities are upgraded at frequent intervals. The practical impact of weather, climate and ocean prediction on the population and economy drives the usage of high performance computing (HPC). HPC requirement at MoES organizations increases from year to year as new programmes are initiated and existing programs are updated.

Hence, considering the need of high computational power, MoES regularly augments its computational resources in a phased manner. Majority of MoES institutions have access to HPC infrastructure since 2009. Since managing HPC systems at different constituent units is a herculean task, MoES decided in 2014 that it will manage and augment HPC facility at two Institutions, viz. IITM & NCMRWF for use of all MoES fraternity.

NCMRWF went through a series of HPC augmentation. In the year 2001 it augmented it computing facility to 28.8 Gflops with the acquisition of Cray SV1 Supercomputer and then in 2006 the computing power was augmented to 1.1 Terflops with the acquisition of Cray X1E. In the 2010 the computing power was further augmented to 24.4 Teraflops with the acquisition of IBM Power6 computer. In the year 2013 NCMRWF acquired a 350 Terra flop IBM Idataplex HPC and code named it as Bhaskara. The Baskara HPC was a Highly Parallel Supercomputing System built on IBM System X technology. There are 1052 compute Nodes with each node have 2 number of 8 core Processors (Intel Xeon E5-2670 2.6GHz cache 20MB) and the Memory is 4 GB DDR3 per core and 64 GB per node. The total RAM/Memory of the cluster is more than 67 Tera bytes and a 3 Peta Bytes disk based storage solution built on IBM GSS technology with read and write performance of about 100 Giga Bytes per second and the Tape Storage solution is based on Tivoli Storage 3500 tape library with Tivoli Storage Manager for automatic backup and restore and HSM functionalities.

The Operating environment is with Red Hat Enterprise Linux as Operating System, GPFS as the cluster Parallel file system, IBM XCAT as cluster administration and Management tool, UFM (Mellanox Unified Fabric Manager) for Fabric Management,

Platform Load Sharing facility (LSF) as the job scheduler and all other software, such as compilers, debuggers, profilers, MPI libraries, development environment are based on Intel Cluster Studio and IBM Parallel and Scientific Computation Environment.

In the year 2017, NCMRWF upgraded its computing facility with the acquisition of a 2.8 Petaflop Cray XC-40 system and code named it as Mihir. The latest supercomputer at NCMRWF Noida "MIHIR" is a Cray-XC40 LC [Liquid Cooled] System with 2320 nodes running Intel Xeon Broadwell E5-2695 processors with a peak performance of 2.8 Peta FLOPS and a total system memory of 290 TiB. The system is composed of 13 Compute cabinets and uses Cray's Aries NOC with Dragonfly Interconnect network topology. In addition, the system consists of 12 Intel KNL 7210 accelerator nodes with a peak performance of 31.92 TFLOPS and a total memory of 1.1 TB. The System is having a 5.6 Peta bytes disk based storage solution. The system has Spectra Logic TFinity tape library with 48 LTO-7 Drive for data backup of 16 PiB.

The entire system operates on Cray's customized Linux OS, called Cray Linux Environment. The cluster supports architecture specific compilers from Cray as well as Intel and open-source GNU compilers. System also hosts architecture specific parallel libraries like OPENMP, MPI, libsci, Intel Cluster software etc. To facilitate users with parallel program development, DDT parallel debugger and profiler is enabled on the system. The system uses PBS Pro as Workload Manager.

The Mihir HPC is being used by NCMRWF for its research and Development actives and real time execution of its seamless weather prediction system. In addition, the Mihir is also being used by IMD and INCOIS for their operational weather and ocean prediction models.

In the year 2020, NCMRWF installed a 10 PetaByte High Performance Storage System (HPSS). HPSS cache is a disk storage which is medium between HPSS tapes and GPFS/Lustre file system for Migration and Restoration of Data. Various policies are configured on HPSS cache regarding data retention and removal. Data processing on HPSS is file based. Once a file is migrated to cache, it will be moved to tapes after a designated time interval of unchanged modification time.

NCMRWF has already initiated the process for the next augmentation of its High Performance Computing System. The computing power shall be enhanced to 8.3 Petaflops with a storage capacity of around 25 Petabyte.

NCMRWF has a robust Local Area Network (LAN) with a 10Gigabit backbone and all the nodes are connected to a switch ensuring dedicated bandwidth allocation. The connectivity to the external world is provided on a 10 GBps link through the National Knowledge Network (NKN). NCMRWF uses the NKN extensively in its operational workflow. A Closed User Group has been configured between sister organisations to ensure efficient transfer of data and products.

Mihir HPC with 2.8 Petaflop and 6 PetaByte of Storage, 2320 compute nodes - 1300 Nodes available to NCMRWF and the rest to IMD and INCOIS.
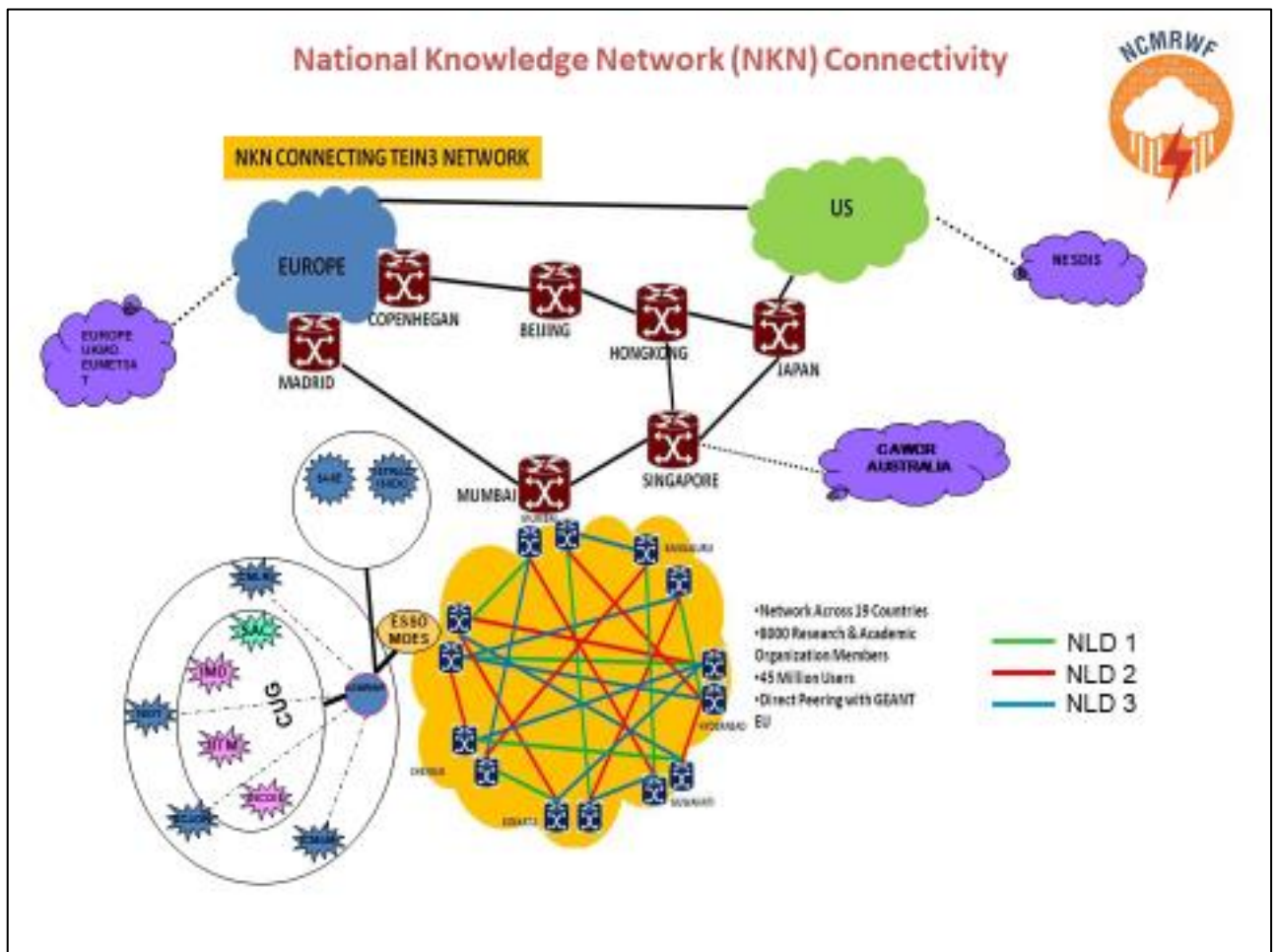
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