URSI GASS 2021, Rome, Italy, 28 August - 4 September 2021

Imaging with the ngVLA: Algorithmic complexity and Size of Computing Estimates

S. Bhatnagar*(1), M. Pokorny(1), and R. Hiriart(1)
(1) National Radio Astronomy Observatory, Socorro, NM, USA, http://www.nrao.edu

The Next Generation VLA (ngVLA) telescope will improve sensitivity by 10x and resolution by 2-3 orders of magnitude compared to the existing telescopes. Operating in the range 1GHz to 110GHz, the array consists of more than 200 antennas spread across a radius of more than 1000 Km. The science drivers for ngVLA require unprecedented imaging sensitivity to angular scales ranging from milli-arcsec to several arcmin in a single image. The data rates from the ngVLA will therefore be 4-5 orders of magnitude higher than the VLA. The goal of data processing architecture for the ngVLA is therefore to routinely produce science ready data products (SRDP).

High data rates, high angular resolution and high sensitivity to an unprecedented range of angular scales poses severe challenges on many fronts, all of which will be required together to enable SRDP mode of operation. Existing imaging and image reconstruction algorithms may need improvements to achieve routine high dynamic range imaging at wider range of scales than has been achieved so far. Computing platforms will require use of parallelization at scales orders of magnitude larger than routinely used presently. Use of massively parallel hardware like cluster of GPUs and FPGAs may require re-design of existing algorithms. Parallelization at these scales will involve many orders of magnitude more hardware components. A reliable calibration and imaging system will therefore also require a software framework and scientific algorithms, both of which are robust to the inevitable intermittent hardware failures. All these, combined with 4-5 orders of magnitude higher data rates quickly leads to Peta-FLOP scale computing for ngVLA deployed on massive heterogeneous computing cluster.

Mapping scientific requirements to imaging performance of the telescope and the required algorithms is therefore critical in developing an integrated system for end-to-end operations for the ngVLA. This requires understanding of the algorithmic complexity, numerical performance and computational scaling to data rates from the ngVLA. In this talk we will discuss the algorithmic complexity required to achieve the science goals and estimates of the size of computing for the ngVLA. We will discuss the measurements we have made so far of the computational performance of the various algorithms and their scaling on cluster of general purpose multi-core CPUs. Finally, we will also touch upon our initial experiments with adapting the algorithms to harvest the computational power of massively parallel platforms like GPU and FPGA.