Purpose: At AAPM 2010, we presented the concept of using Cloud Computing to speed up clinical Monte Carlo calculations. Cloud Computing refers to a set of technologies that offers on-demand computing resources using a pay-as-you-go pricing model. We presented a feasibility study that included a variety of clinical relevant calculations using protons, electrons, and photons in water and a voxel patient geometry (Zubal phantom). While our initial study was designed for proof-of-concept, this research presents a more refined platform with an emphasis on particle therapy and demonstrates its potential to enable Monte Carlo dose calculation for routine clinical use.

Methods: A Cloud Computing based distributed Monte Carlo dose calculation system called McCloud was developed. The system is based on Amazon EC2, Fluka, and a variety of "glue" technologies. The calculation involves these key steps: (1) A cluster is allocated in the Cloud. (2) A Monte Carlo task is launched on each node in the cluster. Extra care is used for random seed generations to ensure the correctness of the simulations. (3) The progress of the computation is dynamically monitored. (4) Once the computation is finished in the cluster, the results are aggregated using a linear model or a tree-based distributive model, and a final dose distribution is returned to the user.

Results: We found that for 14 Million 75MeV protons, an analog Monte Carlo simulation can be completed in 5 minutes 36 seconds. For this particular computation, the cost is less than 2 USD (based on official pricing at 8 cents per node per hour). Studies using various cluster sizes have shown the 1/n speed up expected from analytical Monte Carlo simulations.

Conclusions: Our implementations demonstrate the power of the existing cloud computing model, an extremely promising new paradigm for clinical and research computing. Further research is underway.

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