MULTI-CHANNEL RADAR DEPTH SOUNDER (MCRDS) SIGNAL PROCESSING: A DISTRIBUTED COMPUTING APPROACH

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ABSTRACT

The idea of global sea level rise forced many scientist and government representatives to search for hard data to prove or disprove the idea of ice sheet regression [1]. In response to this request, the Center for the Remote Sensing of Ice Sheets (CReSIS) (historically the University of Kansas Remote Sensing Laboratory) set out to design a RADAR Depth Sounder that could accurately measure the thickness of large sea and land ice masses. From ice-core simulations performed between the years of 2002 and 2003 it was suggested that a RADAR system tuned between UHF 300-1300MHz for sounding thin ice and VHF 50-250MHz for sounding thick ice would measure ice thicknesses with less than a 20cm variance [2]. This finding led to the creation of a Multi-Channel RADAR Depth Sounder (MCRDS) for use in the Arctic and Antarctic regions in an effort to provide missing ice thickness information in high attenuation areas including calving fronts. Beginning in 2006, both Arctic and Antarctic aerial missions utilized MCRDS radar technology to map ice sheet depths. The vast amount of computing power needed to store and process the collected data led to the 2007 funding of the National Science Foundation's Polar Grid: Cyber infrastructure for Polar Science Major Research Instrumentation [3]. Polar Grid funding allowed clustered computing power to be purchased for the purpose of processing CReSIS radar data in-situ.

Purpose of the Study

The purpose of this study was to verify the viability of distributed computing principles with the use of the CReSIS Synthetic Aperture RADAR Processor (CSARP). In short CSARP required a large amount of computing power and time to perform needed operations on MCRDS collected data. Although it was suggested that a decrease in processing time would occur with the addition of computing cores, the true benefits or lack thereof was neither explored nor quantified using true data collected from the field during initial cluster deployments in Greenland of the year 2008.

Research Questions

This study intended to prove within a 5% level of significance that the addition of computing cores increases the performance of the CSARP algorithm. This study also was designed to answer the following sub-questions:

- What hardware requirements are necessary to store and process CReSIS collected data?
- What facility environmental requirements are there to house a cluster with 32-cores to process a data set?
- What is the process to prepare a cluster from a middle-ware stand-point?
- What MATLAB toolkits and/or expansion kits are necessary to run CSARP?
- Can an open-source job scheduler replace the MATLAB proprietary Distributed Computing Server currently required by CSARP?

Methodology

The methodology of the paper followed the process of first defining the needs of CSARP including all supporting software and hardware. Once defined the needs of the cluster computing hardware was addressed within the location housing the cluster. Once completed the cluster computer roles were defined and the operating system was both installed and configured. Next the MATLAB Distributed Server (MDS) components including the Flex License Manager, MATLAB Distributed Computing Environment (MDCE), MDS Job Manager, and workers were installed and configured within the cluster. At this point the CSARP code was installed and tested. Data collection then began with the CSARP algorithm being tested and repeated three times for 1, 2, 4, 8, 16, and 32 workers. Lastly the collected performance means were statistically tested through an analysis of variance (ANOVA) within a significance level of 5%. The ANOVA test was a formal test to find the probability of a mean occurring [4]. ANOVA checks the variability both between groups of data and within groups of data. If the attained p-value was less than the 5% level of significance, it would have indicated there was a significant difference. If greater, it would have indicated that there was no significant difference.

Results

Through the installation process it was noted what hardware and environmental needs were necessary to house a 32-core cluster capable of running CSARP including all additional toolboxes and MATLAB expansions. Through this line of research it was also found that though the Job Manager could be

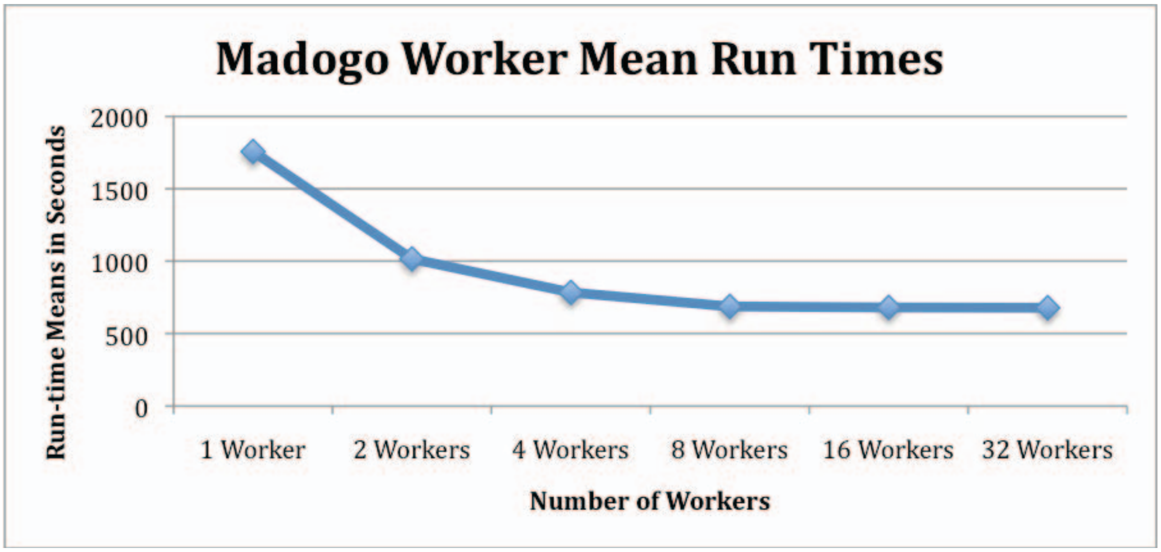

Figure 1: Madogo cluster worker mean run times

replaced with a third-party job scheduler, the change would be mute without the capability to go above the eight workers supported without the MDCE service. The final results of the ANOVA testing found that within a 5% level of significance, there was enough evidence to suggest that there was an increase in performance with the addition of workers. In total there was a calculated ~67% increase in performance between 1 worker and 32 workers as seen in Figure 1: Madogo cluster worker mean run times.

REFERENCES

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