Analysis of Remotely Sensed Images on the Grid Platform from Mobile Handheld Devices – A Trial

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***Abstract*—With the tremendous advances in hand-held computing and communication capabilities, rapid proliferation of mobile computing environments, and decreasing device costs, we are seeing a growth in mobile e-Geoscience in various consumer and business markets. The trend is also picking up in large enterprises where dependency on mobile e-business environments has become routine for thousands of employees conducting daily business activities. Grid is a new technology. With corresponding middleware it can give strong computing power. In this paper we mainly discuss our experience on the middleware development and architecture used in remote sensing data analysis using Mobile handheld devices. It clearly shows that the possibilities of using Grid computing technology to real-time update spatial databases regularly by means of telecommunications systems in order to support problem solving and decision-making *at any time and any place*.**

Keywords- Grid; mobile GIS; Condor

I. INTRODUCTION

Geoprocessing is going mobile. New devices that rely on standardized geospatial products and wireless Internet access present the geospatial market with great growth potential. Mobile GIS extends the enterprise system to personnel outside the office and enables them to work digitally with data relating to the assets they interact with on a daily basis. The resulting benefit is consistently improved productivity. Crews have direct access to the most up-to-date GIS datasets, and they can make changes to them for same-day uploading to the enterprise.

It is very hard to pin down generic requirements for a Mobile GIS because every organization has either a different perception of how it should be used or are constrained by rather poor corporate GIS implementations. So if a Mobile GIS is to be deployed to fulfill its significant potential, it really should be based on having the best GIS infrastructure in place.

While The Grid in the research community usually means a set of resources distributed over the Internet, interconnecting research teams in different locations, a computer vendor cannot easily approach customers to implement such a Grid today. Immediate benefits are not clear, concerns like security exist, technology is still immature [1]. Still, the Grids can provide many benefits to users, such as maximizing resource utilization, enabling collaboration of distributed teams, providing seamless and remote access to a wealth of distributed compute and data resources, anytime, anyplace, to anybody.

In order to realize the goal of pervasive computing, Kurkovsky and Bhagyavati presented a distributed mobile agent-based architecture for wireless computational grids in cellular networks [2]. The proposed an architecture for a wireless grid that facilitates mobile devices to solve resource-intensive tasks by harnessing the power of other such devices. In a cellular network, this distribution is easily accomplished by the base station that can provide mediation and facilitation services. The resulting wireless grid will enable resource-weak mobile devices to accomplish computationally-intensive tasks faster and at less power cost to individual devices, thus enabling a truly ubiquitous computing environment. They modelled the grid as a flexible, self-configuring dynamic network of independent, mobile, intelligent agents using each other's resources in order to solve a shared computational task.

II. GRID PLAFFORM—CONDOR POOL

Condor is one of the grid projects in the world. It is the product of the Condor Research Project at the University of Wisconsin-Madison. Compared with the High-Performance Computing (HPC), Condor provides a High-Throughput Computing (HTC). What the Condor cares is not the number of computed floats in a second, but how many workloads can be done in a period of time. The core of Condor is efficiently using of available resource (http://www.cs.wisc.edu/condor/htc.html). Condor is a specialized workload management system for compute-intensive jobs. Like other full-featured batch systems, Condor provides a job queuing mechanism, scheduling policy, priority scheme, resource monitoring, and resource management. Users submit their serial or parallel jobs to Condor, Condor places them into a queue, chooses when and where to run the jobs based upon a policy, carefully monitors their progress, and ultimately informs the user upon completion (http://www.cs.wisc.edu/condor/description.html). Condor has two powerful means, one is that it can make available resources more efficient by putting idle machines to work; the other is that it can expand the resources available to users.

Gonzalez-Castano et al. proposed a hierarchical design methodology for grid access from handheld devices [3]. After determining all user interactions required and technologies available, they are arranged in layers. All functions in a layer are also supported by all underlying layers. By doing so, the designer is less conditioned by the constraints of a specific, out-of-context platform. Additionally, in a stratified modular design, many software components can be re-used. They also presented a prototype to access Condor from two neighbour layers: PDAs and cell phones.

Our Grid computing testbed is built on Windows 2000 operating system. It is composed of five Pentium 4 PCs. Three of them have memories of 512MB with a 2.6GHz frequency of central processing unit (CPU). The other two have memories of 256MB with a CPU frequency of 2.0GHz. They are connected by local area network (LAN) whose velocity is 100.0Mbps. The installation and configuration of release 6.4.7 of Condor software has been performed on all mentioned PCs by following the instructions reported in http://www.cs.wisc.edu/condor/manual/v6.4. Vanilla environment was adopted in our test. Vanilla is best suitable for Windows platform, but it has no checkpoint and remote system call, two of which are two important exceptional features of Condor. Vanilla environment has no shared file systems, but provide a default file transfer mechanism (see Condor manual at http://www.cs.wisc.edu/condor/manual/v6.4), so lots of files should be transferred to the executable machines before running. The machines in our Condor pool are Hu, Zhong, Wang, Jennyjordan, and Irsa-cgy. Hu is the Condor Manager and the submitter is Irsa-cgy. Irsa-cgy is also used as the single machine for processing the data. Figure 1 shows the architecture of the Condor pool supported mobile geoprocessing ystem.

III. Remote Sensing data analysis form mobile handheld devices

Earth Observation involves the download, from space to ground, of many raw images per day. The analysis and sharing of these huge amounts of data is a big challenge for the remote sensing community. The emerging computational grid technologies are expected to make feasible the creation of a computational environment handling many PetaBytes of distributed data, tens of thousands of heterogeneous computing resources, and thousands of simultaneous users from multiple research institutions (Giovanni *et al.* 2003).

We will take NDVI calculating for example. One track of MODIS data (800x5000) used for the calculation of NDVI was acquired on 11 August 2003. We submitted the job from a WAP mobile phone to our Condor pool.

We then submitted a job to Condor pool to calculate NDVI. We divided whole images into 4 parts. In theory, we could divide them into any number of parts. The 4 jobs have been submitted to our Condor pool. After each calculation, the results will be merged into one image. All these operations were performed automatically. Figures 2-7 show the interface on WAP phone and the procedures and results, including the job status checking. Figures 6-7 are obtained by NOKIA mobile phone.

IV. Conclusion

Grid technology is very effective method for remote sensing data analysis. It can give strong computing power in grid environment. The middleware is the key technology of use of Grid computing tools. Lots of work on the development of middleware to handle the remote sensing data analysis using Grid computing technologies are still in its very early stage. It is a good experience for other middleware used in remote sensing image processing. The number of divided sub-jobs must be proper according the actual station of the grid resource. If the number of divided sub-jobs is too more, the performance will be fall on the contrary in the special grid environment.

In the future, mobile GIS will extend the enterprise GIS into the field through wireless communication technology. In this coming scenario, data layers would be sent directly to and from the mobile platform and the office. Currently, however, such a data sharing process is impractical due to bandwidth limitations in wireless technology.

After making it to the field, mobile GIS offers a variety of functions, mostly focused on working with existing data from the enterprise. Field technicians can edit and update feature and attribute data onsite. As real-time access becomes a reality, mobile GIS will use existing data for more sophisticated query and analysis operations.

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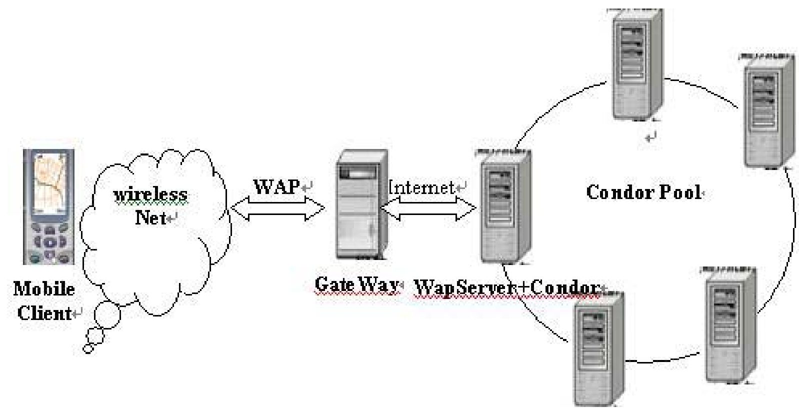

Figure 1. The architecture of the Condor pool supported mobile geoprocessing system.

Figure 2. Option Screen

Figure 3. After job submission, quickly check the job status

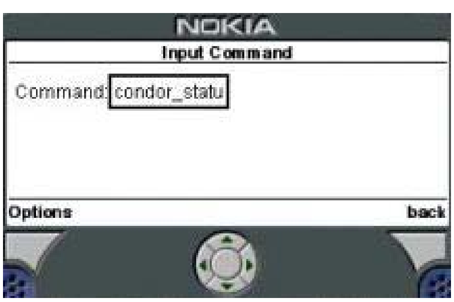

Figure 4.Command Input

Figure 5. After job finished, check log file of the job

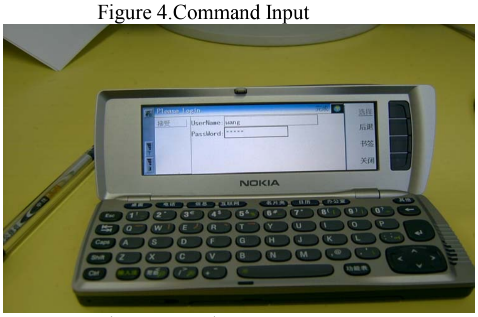

Figure 6. Login Screen

Figure 7. NDVI quick look result