Emerging trend with Remote Collaborative Visualization & Centralized System Analytics in Seismic Data Processing: - An Optimized Workflow for enhancing business efficiency

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Abstract
As an emerging trend towards technology induction, it is proposed to connect the major HPCC processing centres for exploring the features FUNCTIONALITIES of G&G processing software interchangeably, optimal /prioritized usage of hardware resources and facility to job submission, monitor, visualize, QC etc. the data remotely in best possible manner. In order to implement this facility, we primarily need to have an optimal network connectivity and bandwidth to efficiently harness the functionalities broadly mentioned above.

This paper is to emphasise the emerging trends in modern day visualisation for business efficiency, wherein system analytics are used for monitoring workloads and access to unused resources for better utilisation. Further, accessibility of data via bulky workstation footprints are eliminated and replaced by desktops/ thin clients. The adaption of technology based collaborative visualisation even on challenging/high latency networks to customise an end-to-end solution would open up new collaboration possibilities and enabling new working capabilities, sharing of domain expertise and optimal effective usage of overall IT infrastructure/software.

Introduction
At present, G&G processing centres in ONGC is disintegrated as the data pertaining to a region resides locally and resources required to visualise/process/interpret the data needs to be provisioned locally. As a result, each of the region has got independent H/W & S/W resources to process/manage the data thru applications without any centralised resource monitoring for tapping the under-utilised resources at the work-centre. Moreover each work-centre has to be equipped with large no. of high end workstations with enhanced graphic capabilities to address the accessibility of data & visualisation issue.

At present, G&G processing cloud is connected through ONGC WAN on business network. With rapid increase in cyber threats and to comply with the NCIIIPC guidelines, ONGC has envisaged implementation of G&G LAN in a captive model. As per the present IS policy, G&G LAN comprising of all the G&G data centres including HPCC centres as depicted in Fig 2a needs to be segregated complying to security & government compliance.

The proposed workflow for Remote Collaborative Visualization & Centralized System Analytics across processing centers with schematic & connectivity as in Fig 1 are depicted as follows

- data loading from media at specified center due to very large size of seismic data
- Data shall reside locally.
- Job submission, monitoring & QC by remote user(s). remote Visualization of data & QC plots
- Maximize hardware usage by optimal utilization of resources
- Balancing of workload among the Processing centers.
- Better sharing of expertise & resources without much physical movement.
- Improved collaboration among Processing centers
- Centralized monitoring and effective system management

Methodology
There is a lot of advantages in adopting to a methodology, wherein centralized system analytics and multi-cluster HPCC monitoring is done in stage-I and depending on the resource utilization pattern, further allocation of resources based on prioritized jobs can be done across the ONGC G&G processing centers.

Once the resources are allocated for a prioritized project, and the life cycle of the project starts, the usage of the extensive QCs along with job submission and visualization with secured remote accessibility becomes prudent.
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An effective remote visualization solution (stage-II) which works well with bandwidth constraints and technology driven approach is required to meet the objective as depicted in Fig 2b

The PBSA application consists of three components:

- PBSA Data Collector
- PBSA Parser
- PBSA Web Application

The main responsibility of the PBSA Data Collector is to make the PBS Professional accounting logs accessible to the PBSA Web Application. The Data Collector has two functions. It first copies the accounting logs from your site’s PBS Professional accounting log location to an intermediate holding area. Secondly, it transports the information stored in the holding area to the machine where the PBSA Web Application and Parser are installed.

The PBSA Parser reads the PBS Professional accounting logs, parses the appropriate information from the accounting logs, and then loads this information into a database. The PBSA Web Application is a graphical web-based accounting, analytics and reporting application.

The architecture of deployment is depicted in Fig 3 and features/ benefits, customized charts /functionalities as shown in Fig 4, 5, 6 are enumerated as under:

- Allows users of HPC systems to gain insights into how well expensive HPC resources are being used, to inform better planning and purchase decision-making.
- More flexibility in creating clean, concise charts, including additional chart options (such as XYZ plots), to furnish a deeper understanding of organization’s HPC infrastructure and better root-cause analysis with powerful chart designer
- Ability to track activity by job, software, hardware, user, project, node class, etc.
- Ability to track hardware utilization, including accounting for configuration changes over time (i.e. adding/deleting nodes; downtime)
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- Insights into user efficiency and productivity based on usage of resources, job success rates, etc. — so user efficiency issues can be identified and corrected
- Insights into group productivity, so users can be added/moved to/from different groups as necessary to optimize productivity

Consequent to the post test scenario of role based HPCC monitoring across ONGC processing centers and subsequent allocation of managed resources (compute + capacity), a secured remote accessibility is proposed for job submission, QCs and collaborative visualization with existing bandwidth. Advanced features/highlights like advanced adaptive Video compression, GPU utilization etc. as detailed below with two product lines i.e. Display Manager (web based model ) and RGS (Client Server based model) with underlying architecture depicted in Fig 7 and highlights as detailed below:

**Fig 4: Periodical chart review of Memory utilization**

**Fig 5: Weekly chart review of CPU core utilization**

**Fig 6: Quarter wise chart of CPU core utilization (at prime, non-prime, Holidays etc.)**

**Fig 7: RGS Architecture with components**

Display Manager/RGS (Remote Visualization solution) is a convenient way to deliver application performance and data security while getting the most out of your IT infrastructure with enormous benefits as below:

**Increased corporate security with IP protection**— remote users (G & G users, Software Engineers) are able to access design information without proprietary data being transferred outside of the corporation; only image pixels (zero data movement) are transmitted to the remote users. Of course, access to USB devices must still be properly and securely configured.

**User Rich Experience:** Adaptive data compression algorithms based on the network bandwidth and latency provides a rich experience, even on challenging networks.
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Convenience and time savings — users may remotely access centrally located applications, remotely leveraging large central compute resources. It eliminates the need to transfer huge volumes of data to another site. Further, the remote sites may be mobile, lightweight clients, reducing travel time and expenses.

Reduced management costs—centralization allows reduction in management costs by consolidation and single-point-of-contact system management.

Increased productivity—remote document/model reviewing and collaboration increases users’ productivity and communication effectiveness. Users may review and interact with complex 3D images worldwide, simultaneously.

Increased training effectiveness—training with complex applications and complex user sequences is facilitated by allowing multiple users to follow interaction with applications. Costs are lowered because user workstations need not have expensive copies of applications installed.

Increased resource utilization/optimization — remote receivers can be lower spec platforms (for example, a thin client or a desktop system with 2D graphics only) while still displaying workstation-class 2D and 3D graphics. This reduces acquisition costs and extends the usage life of legacy equipment. HP RGS/Display Manager also opens up new ways of using remote visualization. The ability to transmit and share graphics in real-time changes the way we are able to work by opening up new collaboration possibilities and enabling new working capabilities.

Seamless Integration: Resources can be accessed irrespective of any operating environment i.e. Linux or Windows and any hardware platform ranging from Tablets, Desktops, and Workstations etc.

Experimental Details/Results/Observations

Case study of preliminary testing has been done with processing centers at GEOPIC-DDN, Mumbai-SPIC & RCC-Chennai with RCC-Vadodara w.r.t to processing applications in terms of accessing of jobs/lists, QC and rendering of seismic volumes for visualization along with benchmark applications using well established/standard of remote visualization software which works well in challenging networking conditions. The test was also extended on non G & G systems for accessing the bandwidth consumption, reliability and efficacy of the existing ONGC WAN network.

Further, tests have been done for measuring the QoS for effective visualization of data to establish the requirement for adequate/requisite bandwidth & connectivity

1) Benchmark / processing applications are tested using Nvidia K2000 GPU card in the server/workstation under Linux environment in a LAN.

2) The same applications are also tested in a simulated LAN network of 2Mbps, 8Mbps, 16 Mbps with Linux Server and Linux& Windows client.

3) The same applications are also tested in available ONGC WAN network between ONGC-Vadodara and GEOPIC, SPIC-Mumbai, CEC-OG, Scope Minar Delhi, RCC-Chennai etc. on real time basis.

Network quality is comprised of several key elements – latency, bandwidth, and “packet loss” (the frequency of data transmission errors). Several performance-related features as detailed below were tested to allow fine-tuning the interactive experience in a low-bandwidth or high-latency network environment.

Image Quality: The Image Quality setting (“Q value”) controls how aggressively HP RGS compresses the image data, and therefore controls the amount of image data transmitted over the network as shown in Fig 8.

Advanced Video Compression (AVC): This option enables a modern video codec to greatly reduce the network bandwidth needed for high-quality video streams. It is ideal for video or 3D applications in textured mode as shown in Fig 9.

Additional QoS Feature: Other Quality of Service (QoS) feature that improves the user experience by addressing common network bottlenecks, such as packet loss, network latency, and Wi-Fi congestion. It automatically ensures the best end-user QoS by optimizing the underlying network conditions over wired, wireless, managed, and unmanaged networks. A good quality network, including acceptable latency, bandwidth, and packet loss is crucial to good performance as shown in Fig 10, 11.
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Based on the performance parameters, several experiments to fine tune the overall user experience has been carried and effects have been depicted as shown in the figures.

The results of the bandwidth consumed/utilization on local LAN for running the benchmark and existing processing applications both on Windows & Linux client with standard bandwidth/network monitoring tool of respective OS using established Industry S/W for Remote Visualisation implementation like HP-RGS, Altair Display manager etc. is evaluated as depicted.

Various Tests have done on Real time basis with existing seismic data processing App. and benchmark applications along with bandwidth consumption study

It has been observed that the latency between the work-centers are within the permissible limits, but the main constraint may be the present bandwidth across G&G data processing centers along with the no. of hops thru various switches/routers for reaching the packets to the target in the existing ONGC WAN environment.

In order to have a rich user experience, a secured connectivity of a dedicated point-to-point network with sustained bandwidth of min. ~32 Mbps is proposed between these data processing centers.

**Conclusions**

It is quite pertinent to adhere to the best practices of centralized resource monitoring and optimize the resource availability and allocation of the same based on system analytics across concerned data processing centers. As a technology induction initiative, the proposed integrated workflow for Centralized System Analytics & Remote Collaborative Visualization is proposed to be adopted as an emerging trend for business efficiency specifically for seismic data processing.

As lots of advantages are derived in the integrated workflow as mentioned elsewhere in the paper, hence it would effectively enhance the end user experience for G&G processing projects.

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The views expressed in the paper are solely of the authors and do not necessarily reflect the views of the organization which they belong to.

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Technical white papers on PBS Analytics and fine tuning of applications.
Technical white papers on optimizing performance with HP RGS

Abbreviations and naming conventions
LAN – Local Area Network
WAN – wide area network
HPCC – High performance computing Cluster
GPU - Graphic processing unit
QoS – Quality of Service
FPS – Frame per sec.
AVC – Advanced Video Compression