Design, Implementation & Integration of customized seismic software solutions through Application Programming Interface - A value addition in Exploration Data Management

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Summary

All the seismic application software vendors provide an interface known as **A**pplication **P**rogramming **I**nterface, which acts as a middleware between the end-users and the software kernel. The libraries necessary to access the data structures are provided in the form of some convenient functions, so that any user-defined customized interface can be developed & integrated with the existing infrastructure.

These routines sometimes, become very useful for the end-user, to solve certain localized problem, whose solution is not directly available within the software.

This paper depicts the importance of such interface libraries and its integration with the existing seismic software environment. The interface libraries provided by Geocluster (CGG) and Geodepth(Paradigm), the most commonly used basic processing software & advanced interpretative processing tool respectively, are taken as the reference to explain the usefulness of such APIs in development of customized programs , as a solution to end-users, for localized geophysical problems. It depicts the importance of APIs in solving localized geophysical problems, main components of APIs, present systems & requirement of integrated applications, illustrations w.r.t Geocluster & Geodepth. It also highlights some of the implementations using these APIs, already in place at different work-centers of ONGC.

Introduction

Any E & P upstream organisation is equipped with the state-of-art hardware & software technology with advanced HPC computing / storage solutions in finding complex solution to geophysical problems. All the processing systems have full functionality of handling numerous problems pertaining to subsurface imaging. The seismic development, being an inherent part of a software environment is used since the advent of mainframes like IBM 3083 with WGC Software, TATA ELEXI -3600 with DIGICON software, ND-570 with GECO software, EC-1061 with SDS-3 software etc into the industry, when source codes were available to manipulate the programs according to the specific requirements of the end-users. Due to the change in the business model, modern day software vendors are not keen to provide the source code, perhaps to sustain business interest thru license schemes or to preserve intellectual rights. However, the development of software, on top of their existing framework would still be possible through the vendor supplied libraries, which not only allows building external applications to use the existing software environment, but also integrates it in the existing workflow.

Customisation of software is required as per the user requirements. The software development life cycle depends upon the utility of its usage. Standalone applications have been made , since the advent of digital era of geo-scientific computing to attend to some of the problems like handling field geometry data ,generation of contouring packages for mapping of near-surface velocity modelling, calculation of statics, optimisation of charge-depth , calibration of seismic instruments etc pertaining to data acquisition.

Similarly, requirement for add-on software have also been met through the developments of programs like segy-check , Interactive generation/plotting of SPS ,reformatting of vendor specific data, handling deviated well data, generation of line crossings, automation for calculation of grids, interactive trace editing etc.

But the requirement of using APIs comes when the application developed requires to be integrated with the existing infrastructure to take advantage of the varied suite of already existent tools, e.g a external format not recognisable by the existing software can be decoded in a standalone mode , but the retrieved data can only be useful, if it can be further processed, thus the requirement of integration of algorithms into existing environment using data classes/structures available within arises .

As the application software are developed keeping a generic view into consideration, there is always a scope for certain developments to be incorporated, to handle user-specific/region-specific needs, which are not bundled within the software. The utilisation of add-on seismic software always finds a scope in all the three arms of exploration business i.e. Data Acquisition, Data Processing & Data Interpretation.

A proper consolidation of such external applications is extremely important to exploit the full functionality of the software & the seamless integration of such algorithms in existing software environment is provided with the help of a set of libraries, utilities, graphic routines commonly known as **A**pplication **P**rogramming **I**nterface.

Working in a heterogeneous environment sometimes, leads to situation when certain constraints in data interoperability dominate the actual geo-scientific problem, for e.g handling proprietary formats in addressing trace & auxiliary data. An optimal cost-effective solution to such problems lies in the usage of API & its further integration, as represented in **Fig 3.**

Application Programming Interfaces

The nature of algorithms most commonly used in seismic data processing can be categorised as Input/output oriented or compute intensive geo-scientific problems. The seismic software environment can be broadly classified as follows:

Batch processinga
- ❖ Single-channel processing(Trace-by-trace)
- ❖ Multi-channel processing (Group of traces)

Interactive Interpretative processing
- ❖ Residual velocity analysis
- ❖ Horizon/fault interpretation
- ❖ RMS/Interval velocity estimation
- ❖ Tomography / PSTM / PSDM

The libraries are provided to access the datasets pertaining to trace volume i.e seismic and velocity as well as auxiliary data like statics, elevations, mute , velocity etc, and provides the flexibility to conceive the algorithm and manipulate with the dataset accordingly. The resultant dataset is fully integrated with the existing environment and can be subjected to above mentioned interactive/batch modules for future use.

Most commonly used software for geophysical data processing are as follows:

Pre-processing (FPU/on-board)	Basic Processing (Time Processing)	Advanced Processing (PSTM+Depth Processing)
Geocluster (CGG) Omega (WGC) Seis-up (Geo-center)	Focus (Paradigm) Tensor (PGS) Promax(Landmark) Omega (WGC) Geocluster (CGG)	Geodepth (Model building + Application) Geovista (Model Building) Omega (WGC)

A developer’s toolkit, consisting of libraries/ routines/data structures is provided to integrate a geophysical problem into the existing environment. The development stages are AM: Analysis Module, which takes care of the semantics & PM: Processing Module, where actual execution of he job takes place. XMOD is the GUI builder provided by Geocluster to generate the interactive module be used with Xjob as an integration tool. The routines are written in C / FORTRAN embedded with vendor provided data structures. XMOD is an X-motif customized interface for interactive application builder.

OpenGeo is Paradigm’s εpos developer’s toolkit. Programmers can use OpenGeo to create software to read data in, and write results to, the Paradigm εpos databases, thereby providing interoperability with the rich suite of visualization, processing and interpretation editing tools provided by VoxelGeo®, GeoDepth®, Geolog® and other Paradigm products. OpenGeo also provides tools to develop new user interfaces, and to develop and run external applications in Paradigm’s software environment. The toolkit provides libraries for accessing the data pertaining to Project, Trace File, Interpretation I/O, Grid File, Well Data, Geological Model, Geometry, File Manager Data Attributes, FileView along with full documentation about its usage. All the libraries mentioned above are callable thru C++ code supplemented by FileView, a hierarchy of C++ classes to implement GUI end of the File Manager Application. Visix, an object-oriented framework & a C++ wrapper for Motif, enables software engineers to

- – Deliver all the power, reliability, and flexibility of the industry’s leading UNIX GUI toolkit
- – Write extremely compact, economical source code

– Achieve a high degree of code readability
– Enhance GUI design by using object-oriented programming

Implementations

Utilizing the features of Geocluster's API along with XMOD GUI builder & Geodepth's Opengeo libraries ,represented in **Fig 1** & **2** , respectively , following are some of the implementations, which are developed according to the specific user needs. The routines are written in fortran for Geocluster whereas C++ callable are used for Geodepth programming.

Geocluster

newrc – For handling of duplicate ffid in the field, generated in seismic acquisition. Such ffids are

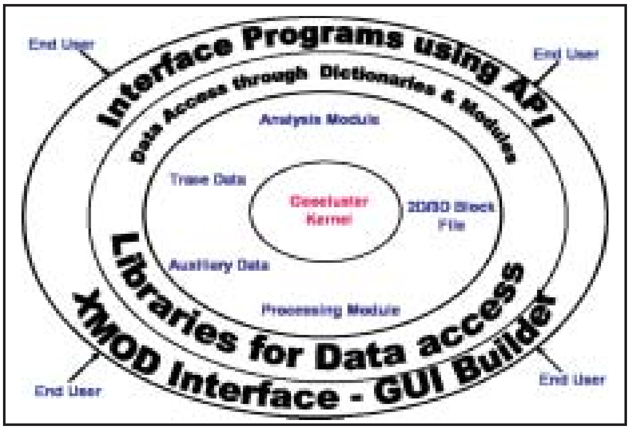

Fig 1: Schematic diagram showing data access along with API libraries of Geocluster Framework

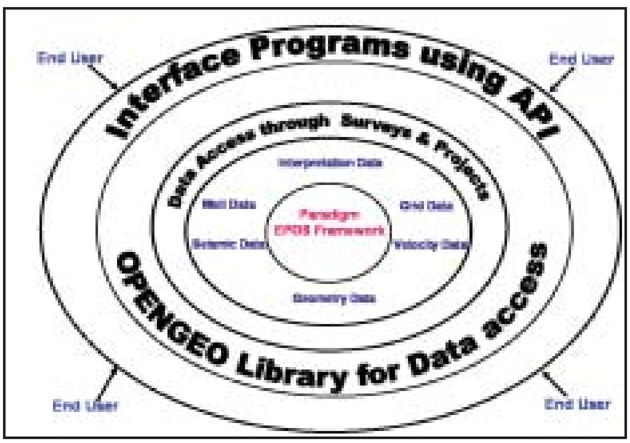

Fig 2: Schematic diagram showing data access along with API libraries of Paradigm Framework

to be managed at the time of processing for renumbering the duplicate ffid, represented in **Fig 5**.

trbal - For trace balancing according to amplitude criterion , represented in **Fig 5.**

zgmap – For generation of selective X,Y Grid for generation of locmap i.e sub-volume of the survey considering INLINE/XLINE simultaneously, represented in **Fig 6**

zfbl - For first break residual statics in VSP by least square curve fitting method.

zlabl - For generation of use-defined side label for customized display of user-defined parameters in CGM format to be incorporated in MECANO for final plot generation & data submission (logo ,spread , direction symbols incorporated in the program).

ztxmg – For trace mixing from neighborhood according to amplitude criterion, required to fill up the missing traces, represented in **Fig 6**

trtxt - For generation of trace from series of amplitude values, required in cases of reading proprietary formats, and integrating it within the main workflow.

A proprietary format of Geometrics(VSP) was decoded & merged with Geocluster for VSP data processing, as a result of recording the data in hard disk , due to the non-availability of cartridge drives. The method was put to use for many wells in ROKHIA(TRIPURA) area, and is still being used (Data is recorded in proprietary SEGD-IEEE format).

Geodepth

The following modules are already developed and tested :

Intermediate re-sampling of seismic data along with format conversion – required for optimal utilization of time/space especially for intermediate data generation.

For de-gaining of gathers in Geodepth to make it geometrically uncorrected, prior to PSTM.

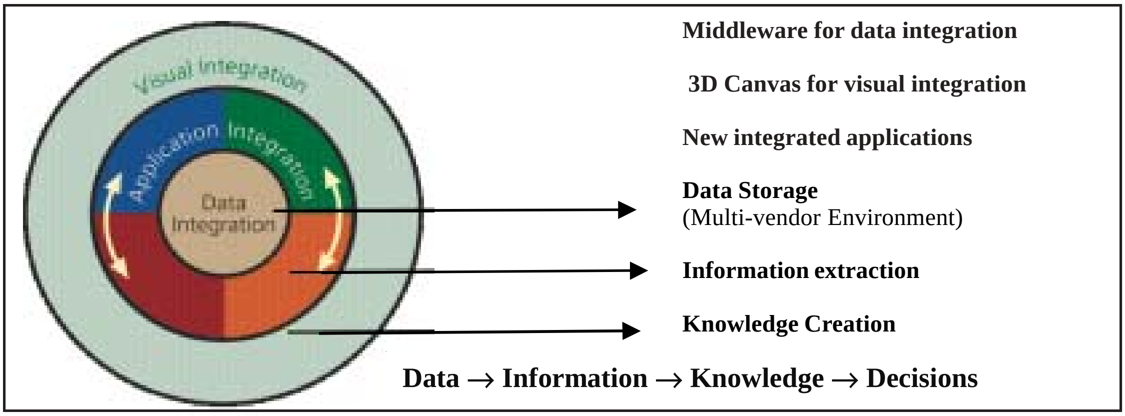

Fig 3: Three-Level Integration as an Enabler of Workflow Efficiencies

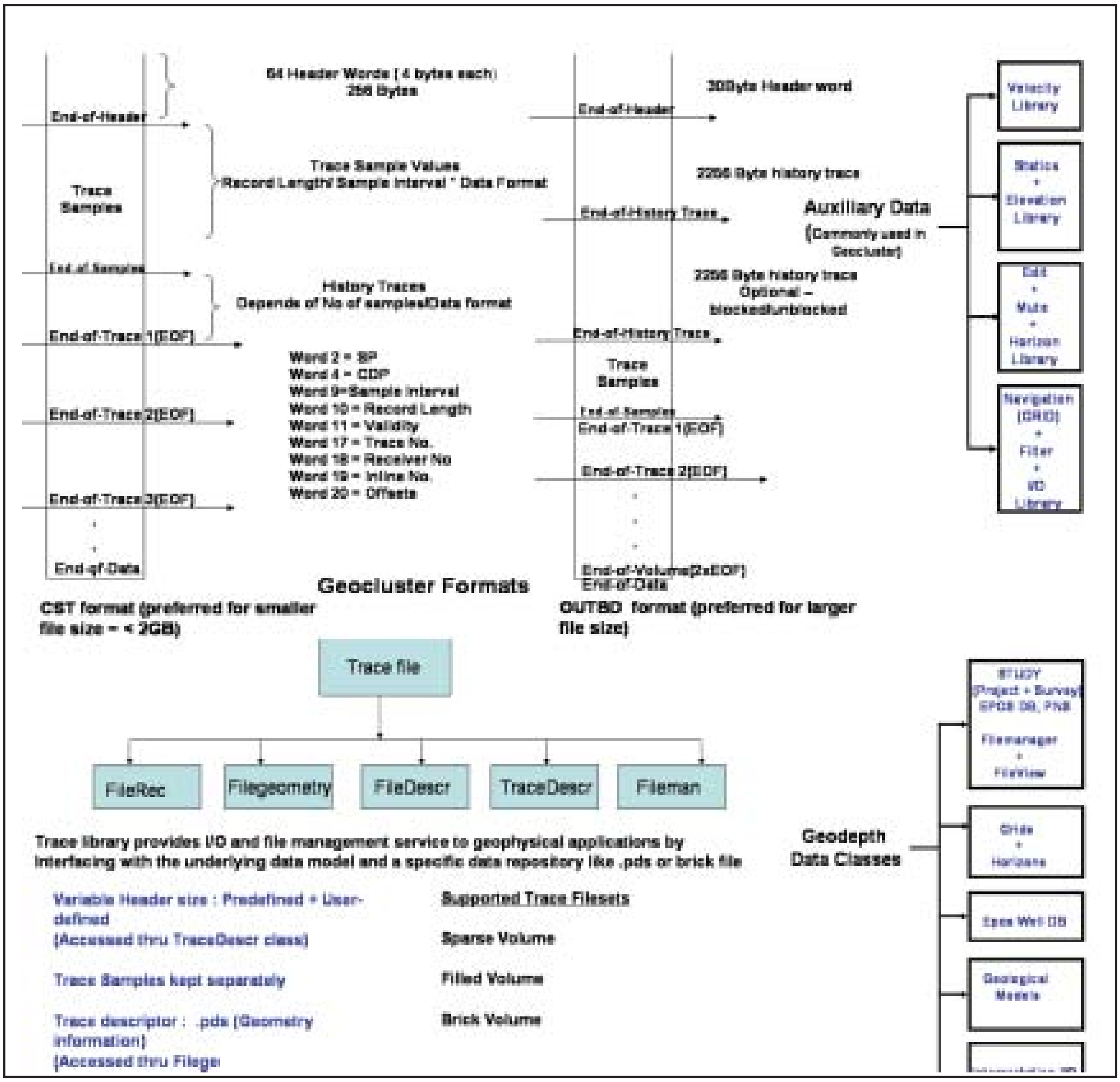

Fig 4: Data Classes (Trace + Auxiliary) / format description of Geocluster / Geodepth

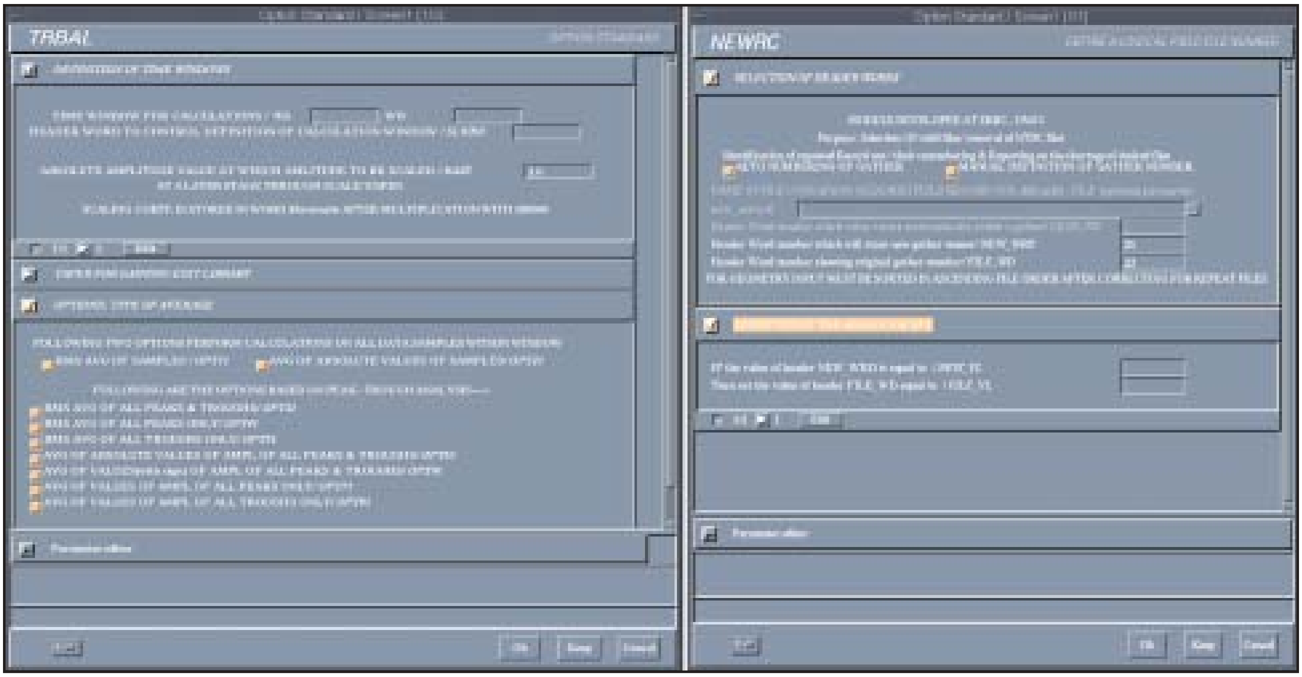

Fig 5: Modules showing TRBAL (for Trace balancing) & NEWRC (for handling duplicate FFID) integrated with Geocluster Environment

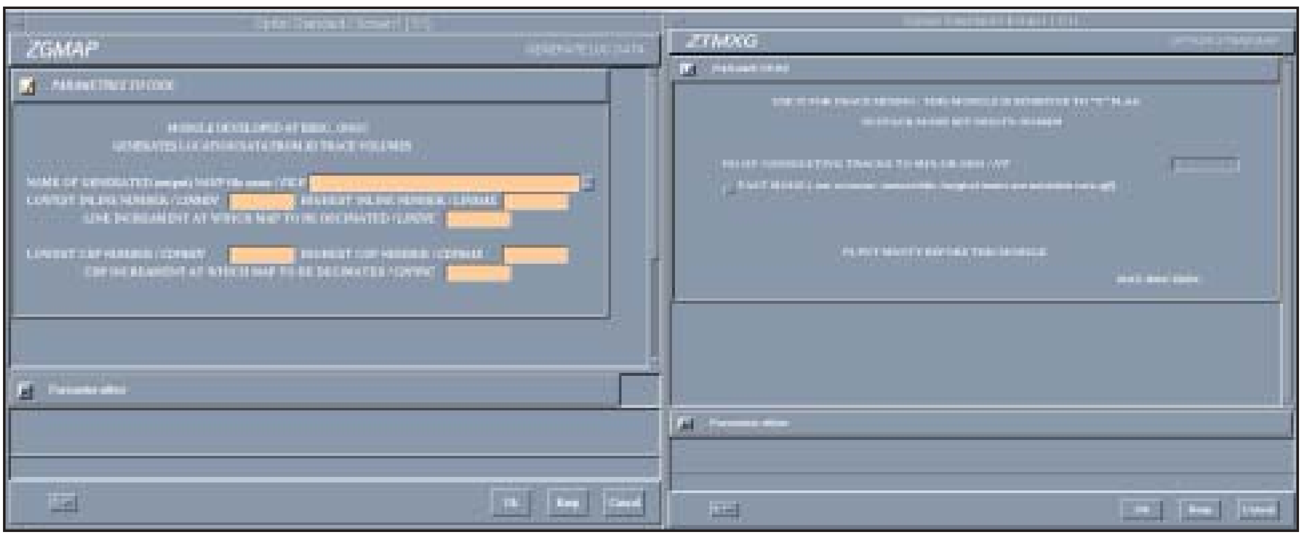

Fig 6: Modules showing ZGMAP (for customized X/Y Grid Generation) & ZTXMG (For trace mixing from neighborhood according to amplitude criterion integrated with Geocluster Environment

For inputting of data (2D/3D) (Pre-stack & Post-stack) directly from Geocluster format (OUTBD & CST format), bypassing the intermediate generation of SEG-Y.

For outputting the data (2D/3D) , (Pre-stack & Post-stack) directly to Geocluster format, bypassing the intermediate generation of SEG-Y for further , post-stack processing – Mandatory, as Geodepth doesn't have the post-processing features. It is extremely Helps in regular & frequent transfer of data along systems (multi-vendor) , thus saving processing time/space.

Generation of difference volumes (Velocity & Post-stack seismic) – Iteratively generated velocity / seismic volumes can be viewed as a QC.

For estimation of DMO parameters like offset / azimuth class prior to DMO. One sample can be imported to Geodepth for fold/offset/azimuth analysis, as the headers are only required in this case.

For calculation of geometry weights, and transferring the weights to Geocluster and continue DMO/ PSTM, accounting for acquisition footprints – These footprints are due to irregularity in the offsets and azimuth of the traces in the bin, which finally affects DMOstack, migrated stack & AVO output. Thus geometry weight calculation can be adopted as a processing sequence prior DMO/Migration, if trace weights can be transferred.

General purpose viewer for Geodepth format files – Useful in cases while scanning / data QC, in graphics terminals which doesn't support Paradigm applications.

The following applications are under development & testing :

For generation of gathers representing travel time trajectory for estimation of aperture from velocity volume, as a QC prior to migration - As Kirchhoff's summation method need calculation of non-zero offset travel times through a RMS velocity volume along which a summation of amplitudes are done. To use it optimally during runtime, a careful estimation of hyperbolic trajectory is necessary in inline and crossline directions to access the lateral extent corresponding to the target horizon.

For generation of residual static maps, generated iteratively to QC the residuals , followed by geo-statistical analysis, and then filtering and smoothing for removing spurious values and continue further processing.

Generation of 3D surfaces maps, for subjecting it to 3D ray-tracing prior to acquisition – The undulations present in the horizons can be correctly dealt with, by generating horizon grids and then subjecting it to ray-tracing & helps in estimating the attributes correctly.

The integration of such applications with Geodepth environment are represented in **Fig 7** and **Fig 4** shows the data class representation for Geocluster & Geodepth applications.

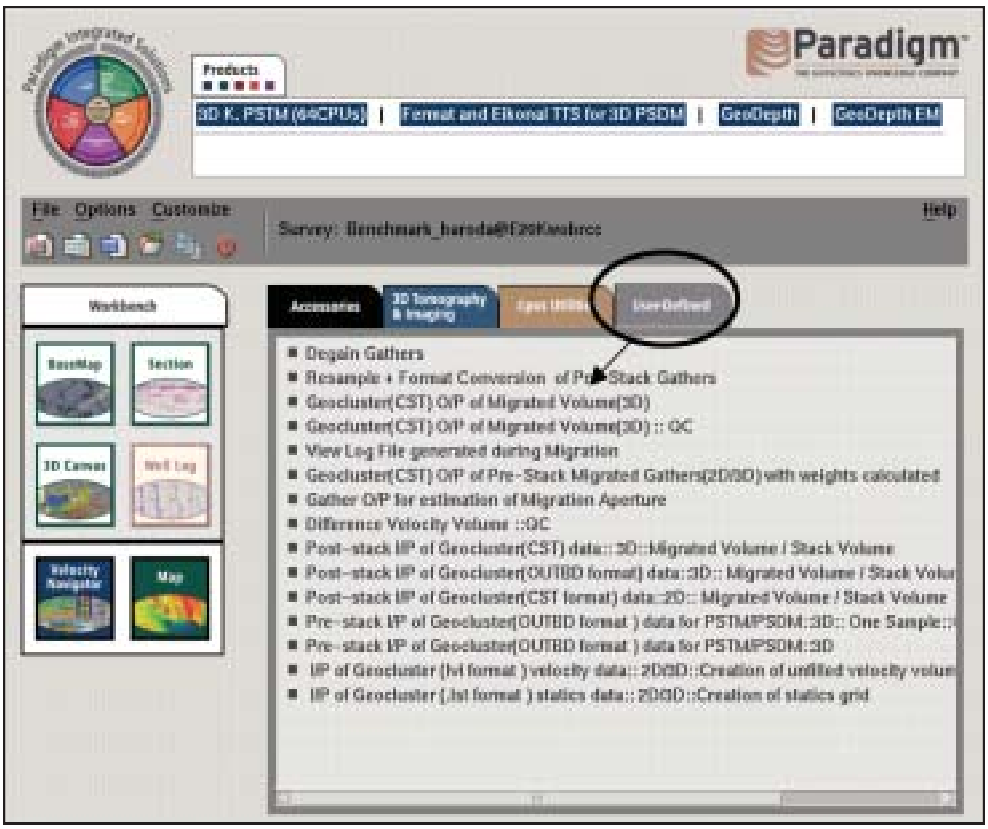

Fig 7 : Integration of customized user-defined modules/programs with Geodepth Environment

Conclusion & future scope

With the introduction of many advanced processing packages like 2D-3C, 4D processing etc. for solving specific problems, such APIs will continue to be useful in finding solutions of local geophysical problems. Data aggregation by interfacing with 3rd party products like Promax , tensor etc would be possible to save processing time/space.

Such developments can also be ported from RISC based platforms (IBM, SUN) to CISC based platforms running Linux, with the increasing demand of cluster-based computing environment, thus making it available to other work-centers.

User –specific requirements for interfacing with interpretation data would promote the interactivity between the geophysical & petro-physical data. Such programs can also be used regularly as an input to the field crews prior to field acquisition.

QC in the processing domain like residual velocity analysis, estimating acquisition weights, selection of optimized offset/azimuth class would be regularly done to leverage the existing applications.

Public domain geophysical solutions can also be adapted to the existing software environment to leverage the existing seismic software.

Flexibility of using specialized tools/ programs to find solutions for complex geophysical problems, without considering much about data integrity/portability. Data acquisition, Data processing & Data interpretation can work in cohesion in a fully integrated environment, taking advantage of the advanced tools available, concentrating on domain specialization. Taking advantage of the latest trend of network connectivity and availability of high performance shared storage solutions, the barrier in total system integration, from software perspective can be minimized to a large extent as the limitation of data interoperability / maneuverability can be solved thru the usage of APIs.

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