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Comparative Evaluation of Seismic Data Converters: SEGY to VDS

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Abstract

The increase in seismic data and its complexity has led to a search for more efficient storage and reading formats. In this context, Volume Data Store (VDS) format is emerging as a promising alternative, due to its brick organization and random access, which facilitate operations in cloud computing environments and machine learning tools. This study investigated the performance of two conversion solutions for data from the SEGY format to VDS: a proprietary software, Headwave™, and the open-source OpenVDS+ API. The comparative analysis considered conversion time and compression rate. The results showed that both tools could convert SEGY data into a VDS format, generating output files with equivalent dimensions. However, there was a significant disparity in conversion time between the two tools.

Introduction

Oil and gas industry has shown a growing demand for high-resolution seismic data, resulting in large volumes of information and the need for efficient storage and processing solutions. This context presents significant challenges, especially in cloud computing environments. Although applications in cloud computing environments are advantageous in terms of scalability, studies have shown that it can present performance bottlenecks requiring optimized processing and storage solutions (ALVES and DRUMMOND, 2014).

The Volume Data Store (VDS) was designed to store multidimensional volumes efficiently, overcoming the limitations of traditional formats such as SEGY (THE OPEN GROUP, 2023a). The main difference lies in the way the data is organized, the VDS uses a brick-based organization with random access (THE OPEN GROUP, 2023b). This architecture enables selective reading of data, segmented compression and parallel access, thereby optimizing operations in cloud computing environments and reducing latency when loading information, as well as facilitating integration with machine learning tools. Furthermore, the VDS format offers compression methods that allow quality and performance to be adjusted according to the application's requirements (THE OPEN GROUP, 2023a).

This study investigated the performance of two conversion solutions for data from the SEGY format to VDS: a proprietary software, Headwave™, and the open-source OpenVDS+ API. The comparative analysis considered conversion time and compression rate. Although both tools support additional functionalities such as seismic data manipulation and metadata analysis, in this study they are used exclusively for format conversion and quality control. By analyzing the resulting file sizes and processing times under different compression configurations, the study seeks to identify performance patterns and practical implications for workflows in high-performance.

Methodology

The study consisted of converting SEGY files into the VDS format, using a public seismic dataset provided by Brazilian National Agency for Petroleum, Natural Gas and Biofuels (ANP). From several datasets, 40 seismic volumes were selected after their quality control; it analyzed the EBCDIC headers and trace headers in the seismic files in SEGY format to check the integrity and consistency of the metadata before and after conversion to VDS format.

Comparative tests were carried out on two workstations with different configurations in order to evaluate possible performance variations related to hardware capacity and to identify processing bottlenecks. Both machines used an Intel® Core™ i7-12700 processor (12 hybrid cores, 2.10 GHz base clock) and a dedicated NVIDIA® GeForce RTX™ 3060 graphics card. One configuration had 16 GB of DDR4 RAM, while the other had 64 GB of RAM. The operating system adopted was Windows 10 Pro 64-bit.

The objective is to compare two available solutions from Bluware™, Headwave™ and OpenVDS+, considering conversion time and compression rate. The proprietary software Headwave™ aimed at visualizing and manipulating large volumes of seismic data, while the open-source library OpenVDS+ is a binary library that allows you to read and write data in VDS format.

The metrics established can be described as follows, conversion time is the time required to convert a SEGY dataset to VDS format and compression rate is the ratio between the size of the original SEGY file and the size of the resulting VDS file.

Considering that VDS format offers compression methods that allow quality and performance to be adjusted according to the application's requirements, the metrics established were analyzed using wavelet compression method, with different tolerances: 0.01, 0.10, 1, and wavelet lossless. Tolerances are the degree to which data can be lost in the wavelet compression method, whereas in lossless wavelet compression, no degree of data can be lost during the process.

In addition to its organization in bricks, the VDS has a parameter called “fast slices”, which organizes the seismic data in 2D slices to facilitate extremely rapid access, speed up processes of querying and retrieving data during the processing and interpretation workflows. This parameter can be added in the data conversion process and was also analyzed in this study.

Results

The conversion tests of the seismic volumes from SEGY to VDS revealed a few variations in the final size of the files generated. Figure 1 shows the conversions performed by the two tools. On the X-axis, we have the parameters used, compression, and tolerances, with or without fast slices, in hierarchical order. On the Y-axis, we have the horizontal line at 100% as a reference, representing the original size of each volume. The vertical bars above this line show the increase in the final file size. Below this line, we have a decrease in these files.

In general, the files generated by the OpenVDS+ tool showed a higher percentage compression rate compared to Headwave™, although both tools showed consistency in the relative sizes between the different data sets. These results suggest that both tools perform compression effectively, possibly using different algorithms or optimization strategies.

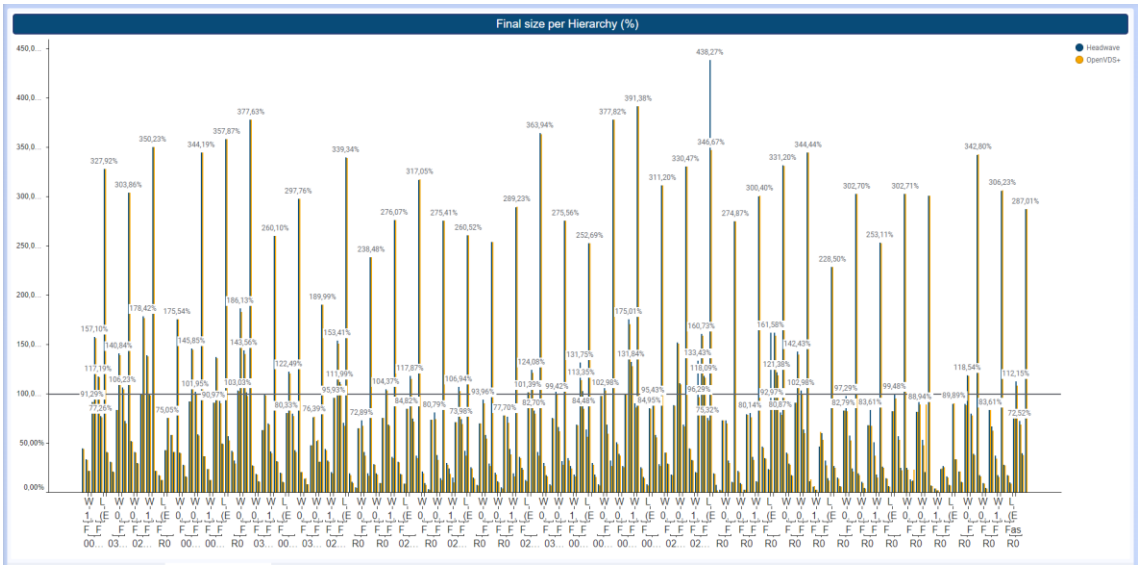

Figure 1: Final file size (%) by parameter hierarchy (compression tolerance and fast slice) for Headwave™ and OpenVDS+.

Figure 2 shows the distribution of conversion times (in seconds) for different parameters, such as the use of fast slice and the types of wavelet and lossless compression. Conversions carried out with OpenVDS+ had longer processing times in different scenarios. This was mainly observed in cases where one or both of those parameters were applied: lossless compression and fast slice. On the other hand, Headwave™ performed more efficiently in all tests, showing less variation in conversion time between the different parameters analyzed.

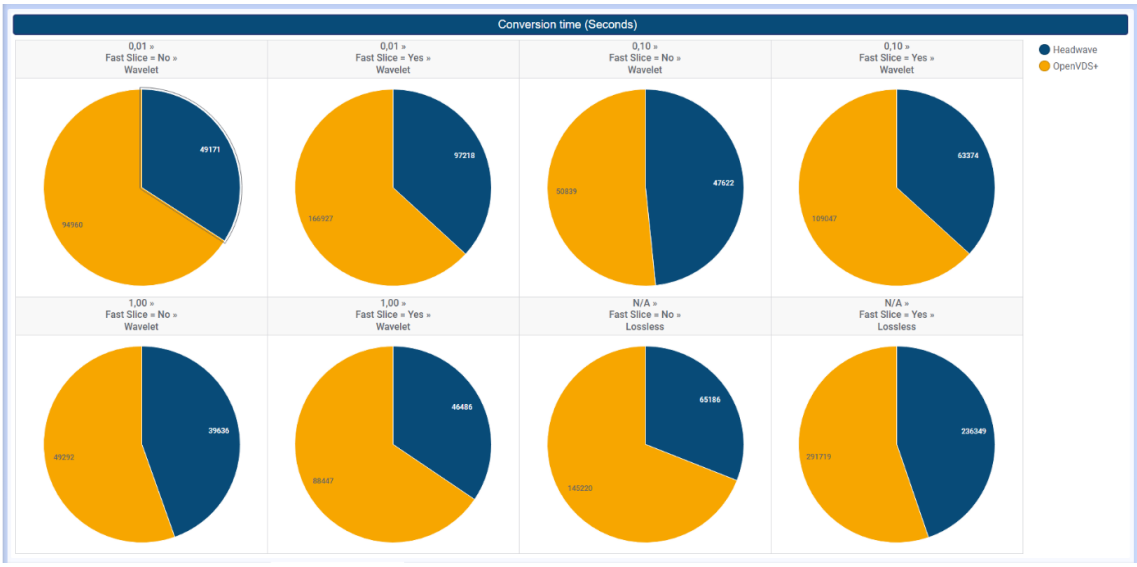

Figure 2: Conversion time (in seconds) per compression type and execution parameter.

Conclusions

The results show that both tools evaluated are effective in converting seismic volumes from SEGY to VDS format. OpenVDS+ tool promoted greater file compression in some scenarios, which could result in significant benefits in terms of reducing storage costs and optimizing workflows based on cloud infrastructure. On the other hand, Headwave™ showed superior performance in terms of conversion time, demonstrating greater speed and stability, even in configurations that required

greater computing power and suggesting a possible optimization in the way data is handled during conversion. The choice of the most appropriate solution will therefore depend on the user's specific priorities, considering factors such as processing speed, compression rate and the need for an integrated visualization environment.

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