



Hue Streams | Seismic Compression Technology

Hue Streams real-time seismic compression results in a massive reduction in storage utilization and significant time savings for all seismic-consuming workflows.

Seismic data is the largest consumer of data storage in exploration divisions, accounting for up to 90% of enterprise storage requirements, and the size and complexity is continually growing - posing several challenges to the industry. With the advent of wide-azimuth seismic and other high-density acquisition technologies, surveys are commonly 40-50 terabytes or more.

Considering the number of ongoing projects and assets across the globe, there are massive amounts of data in daily use, which means that there is also a very sizeable

investment into moving, copying and loading seismic data; including the massive amount of network bandwidth consumed in the process.

Co-locating compute, data, and visualization environments minimize data movement outside the data center and maximize performance, but the data storage requirements, network bandwidth and application latency still apply inside the typical data center.

Key Benefits of Seismic Compression

Significant reduction of overall storage size required for seismic data.

Higher interactivity for interpretation applications. This ensures a smoother end-user experience with the application.

Significant time savings across the workflows where seismic data is generated, saved,

Improved user's efficiencies, number of projects that can be handled by a team, time to discovery, etc.

RESEARCH AND CURRENT PRACTICES

Quality

Seismic data compression has been investigated many times over the years, with most emphasis on the quality and appropriateness of the compression technology, and as a result there are now recommendations and standards for data compression both in oil and gas as well as other industries.

Current practices in interpretation and derisking involve extensive attribute analysis, reservoir characterization from DHI/AVO, inversion studies, etc., which implies that input data must be adequate for quantitative purposes. Not all seismic compression methods guarantee true amplitude, and that is crucial for any quantitative workflows.

Compression

From a broader workflow perspective, if data can be compressed during acquisition, less data has to be transferred for in-house processing and analysis, making data available sooner for decision-making.

In processing and imaging, it is appealing to compress data to increase the throughput of the compute system (cluster) due to bandwidth ceilings in data transfer.

In an exploration setting, where teams need to condition and interpret huge surveys, valuable time is wasted on copying of uncompressed data, decreasing the effectiveness and efficiency of entire organizations.

Decompression

While a significant part of the effort around compression has been related to the "transportation and storage" of seismic data, the ability to use compressed data during interpretation is a significant factor to the success of any new seismic compression technology.

A critical challenge has been to convert SEG-Y into formats that can handle random data access during interpretation. Many brick format are available, where SEG-Y is resorted into 3D bricks to enable fast random access to data subsets.

The lengthy time to convert SEG-Y into bricked formats has been and still is an issue, but to make things worse, these methods decrease in effectiveness with larger seismic datasets. If decompression speed is too slow, many of the savings coming from compression and network transfer are lost, and can make compressed data an inappropriate format during interpretation.

As bricked datasets grow, the mapping of the bricks becomes complex and all commercial packages struggle above 50GB. Formats that need to handle more than 3 dimensions, for example prestack or wide azimuth data (4D and 5D), add even more complexity for bricked handling.

NEXT-GENERATION SEISMIC COMPRESSION

HUE STREAMS

Hue Streams is a next-generation seismic compression technology that offers significant technical and economical advantages to the oil and gas industry.

Over the past 8 years, Hue has conducted R&D on a data format (VDS) and compression technology for seismic data, resulting in a stand-alone product called Hue Streams. Hue's technology has achieved an optimal combination of compression quality and performance.

A unique and unintuitive characteristic of Hue Streams is that **Hue Streams makes direct access to compressed data faster than direct access to uncompressed data**; this turns the whole paradigm upside down. Now, compressed data can finally be a native format and it can be used equally well for seismic acquisition, processing and interpretation. Hue Streams scales across multi-CPU's and GPU's, enabling batch compression and the ability to scale with faster I/O subsystems. On a laptop, Hue Streams compresses SEG-Y at over 300 MB/sec, using only the system CPU. The compression ratio with highly usable data quality is in the 20-30X range.

Super majors, national oil companies and independent software vendors have already conducted rigorous analysis and benchmarking of the compression technique, and have been using it in production for several years.

SCIENTIFIC BENCHMARKING

Hue has completed tests with the latest version of one of the most popular industry applications and their most recent compression technology.

Using an industry relevant 24-gigabyte North Sea Quad dataset, here are some of the results:

	Major commercial software	Hue Streams	Improvement
Resulting file size	2,97GB	1.69 GB	1.76 X
Compression Ratio	8.08X	14.2X	+1.76 X
PSNR	67.8 dB	70.1 dB	+2.3 dB
Compression speed	12.89 MB/sec	1000 MB/sec	+77.6 X
Completion time from SEG-Y	45 min	1 min 10 sec	-38.6 X
Decompression speed	50 MB/sec	10 000 MB/sec	+~200 X

The compressed file generated by the commercial software

Is lower quality, indicated by a lower PSNR (Peak Signal to Noise Ratio)

Introduces degradation for (important) strong amplitudes more than weaker ones

Exhibits significant bricking artifacts

Has a non-homogeneous impact across the spectrum

By keeping the same quality ratio, here is how Hue Streams compares to the commercial software:

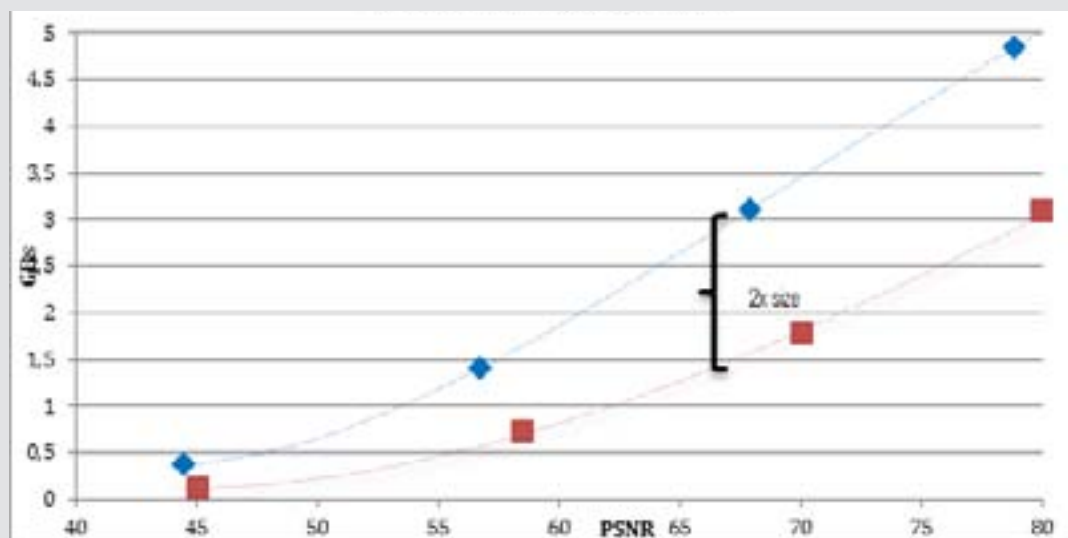
50% smaller compressed files

More than **20x** faster bricking and compression

More than **20x** faster decompression

Difference between original and compressed data at 1/1000 of the min to max amplitude.

Comparison between Hue Stream on the left and the commercial software compression on the right, showing the striking difference in noise introduced by the two different compression technologies.



Compression File Size / PSNR

Hue Streams' advantages over the commercial package gets even better with bigger datasets.

REAL-LIFE APPLICABILITY: WHAT IS THE DIFFERENCE?

The time it takes to transfer seismic data across networks:

SEG-Y FILE SIZE	Dedicated 100Mbit line	Dedicated 1Gbit line	Dedicated 10Gbit line
1TB	1 Day 1 hour 37 min. 54 sec	2 Hours 30 Min 11 sec	15 Min 1 sec

The same file compressed with Hue Streams:

HUE STREAMS FILE SIZE	Dedicated 100Mbit line	Dedicated 1Gbit line	Dedicated 10Gbit line
70 GB	1 Hour, 45 Min. 7 Seconds	10 Min 16 sec	1 Min 1 sec

The time saved each time one of these files is transferred:

SEG-Y TO HUE STREAMS	Time saved on dedicated 100Mbit line	Time saved on dedicated 1Gbit line	Time saved on dedicated 10Gbit line
1TB -> 70 GB	Almost 24 hours saved	Over 2 hours saved	Over 14 minutes saved
50TB -> 3.5 TB	Over 50 days saved	Over 45 hours saved	Over 11 hours saved

Compared to the best compression in one of the most popular commercial offerings:

HUE STREAMS VS 3RD PARTY	Time saved on dedicated 100Mbit line	Time saved on dedicated 1Gbit line	Time saved on dedicated 10Gbit line
70 GB vs. 140 GB	Over 1.5 hours saved	Over 10 min saved	Over 1 min saved

From a user's time perspective, in a daily workflow a proper estimate would be a minimum of 5-7% savings. This can be converted into costs (salaries); or into number of projects that can be handled by the team over 1 year; or how quickly some decisions and discoveries can be made by the same team.

Obviously, all of these calculations are meaningless if using the compressed data is slow and impractical; this is the key breakthrough of Hue Streams, as it makes access to compressed data faster than to uncompressed data.

To summarize: The savings or gains that can be achieved from a geoscience workflow perspective, team efficiency or simply IT cost savings are significant.

PROVEN BENEFITS OF HUE STREAMS

Hue Streams can add advanced compression of seismic data to existing applications, with the following benefits:

- Reducing the size 10-50X, and reducing disk space and system memory needs
- Reducing the time to move, copy and access seismic data, while enabling high speed access to the compressed data so that it can be seamlessly utilized by interactive and batch applications.

A very important part for any compression technology, in particular in an industry where noise is heavily present, is how much the compression impacts or is impacted by noise. Hue Streams is resilient to different levels of noise in the data; the amount of real ambient noise in the dataset does not matter much (it might on dataset size, but not in the quality for a given tolerance level). Hue's tests indicate that Hue Streams provides safe compression for any quality data set when used at a given compression level.

Additional benefits related to compression and decompression:

- Adjustable and high-speed compression and decompression
 - | Multi CPU/GPU parallelized wavelet compression/decompression
 - | Numerically stable between CPU and GPU
 - | No clipping or truncating, maintains values outside of the value range
 - | Quality based compression level (gives same quality of compression throughout whole volume, not variable on amplitude, keeps continuous signal):
 - Highest data quality in the industry, relative to file size
 - Over 10 dB higher quality (measured in PSNR) with same size compression compared to latest technology in leading software application
 - | Scaling is limited by I/O speeds, so faster I/O will linearly speed up compression/decompression
 - | Faster compression and decompression compared to the latest technology in leading software application
 - ~3GB/sec decompression
 - ~350MB/sec compression
- On-demand parallel asynchronous data loading and production.

Some of the benefits of the Hue VDS format:

- Multi-dimensional (6), multi-channel (10), multi-LOD (12), multi-variate representation
 - | 3D (brick) and 2D (slice) dimensions layers
 - | Constant block/sparse handling (Full NoValue support)
 - | 1Bit/8Bit/16Bit/Float/Double/Int32/Int64, Scalars and Vectors
- Random data access to very large files (tested support for petabyte-scale data sets)
- 10-20X faster bricking than typical industry solutions
- Importers for SEG-Y, ZGY, SEP, GOCAD, GeoProbe, etc...

TECHNOLOGY LICENSING

Hue Streams can be licensed for proprietary and commercial software applications, with significant savings in infrastructure costs as well as improved efficiency and user experience. Adding Hue Streams to the data layer of the application enables the creation and utilization of Hue Streams compressed files directly from the application. Adapters for legacy formats are easy to develop, enabling on the fly import and export to and from legacy, as well as across different formats.

In addition, Hue's technology can enable on the fly computation from the compressed data using multi-CPU's or multi-GPU's, in a way that simplifies algorithm development. This will enable significant additional value as a follow up step.

Hue is also investigating the creation of a Hue Streams Consortium. The consortium will drive the evolution of the technology and the members will benefit in several ways:

- Non-commercial license to use
- Access to the technology 6 months before anyone else
- Direct future developments and priorities
- Bi-annual meetings
- Preferential licensing, services and training



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