



New Consortium for R&D: Fiber Optic Integrated Suite of (DAS/DTS/DPS) Data Solution

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Lumina Geophysical, LLC

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PLUG-IN'S FOR PETREL & DECISION SPACE

DAS MICROSEISMIC & VSP MONITORING



DAS & DTS FRAC MONITORING

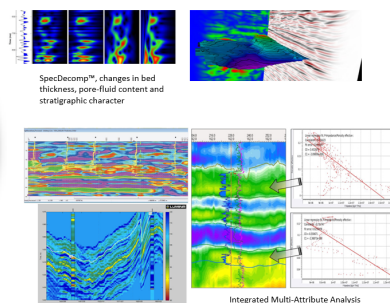


DAS/DTS/DPS RESERVOIR SURVEILLANCE



INTEGRATED SUITE SOLUTION

INTEGRATED SUITE



Geophysics, Seismic Volumes, Seismic Attributes, Interpreted Horizons, Interpreted Faults, Micro-seismic Acquisitions, VSP, Optical Well Log Data DAS, DTS, DPS, Static Model and 4D Interpretation

- Create a Consortium for R&D on Fiber Optic Applications.
- A product like this is not available in the market
- Description:
 - Software for processing, analysis and interpretation of Fiber Optic Data.
 - Plugin in DecisionSpace (Halliburton) and Petrel (Schlumberger) used for integrated analysis of Geological, Geophysical and Engineering Data.
 - Cloud based, use of Artificial Intelligence and robust physics to handle Big Data from **Distributed Acoustic Data (DAS), Distributed Temperature Data (DTS), and Distributed Pressure Data (DPS)**.

Management

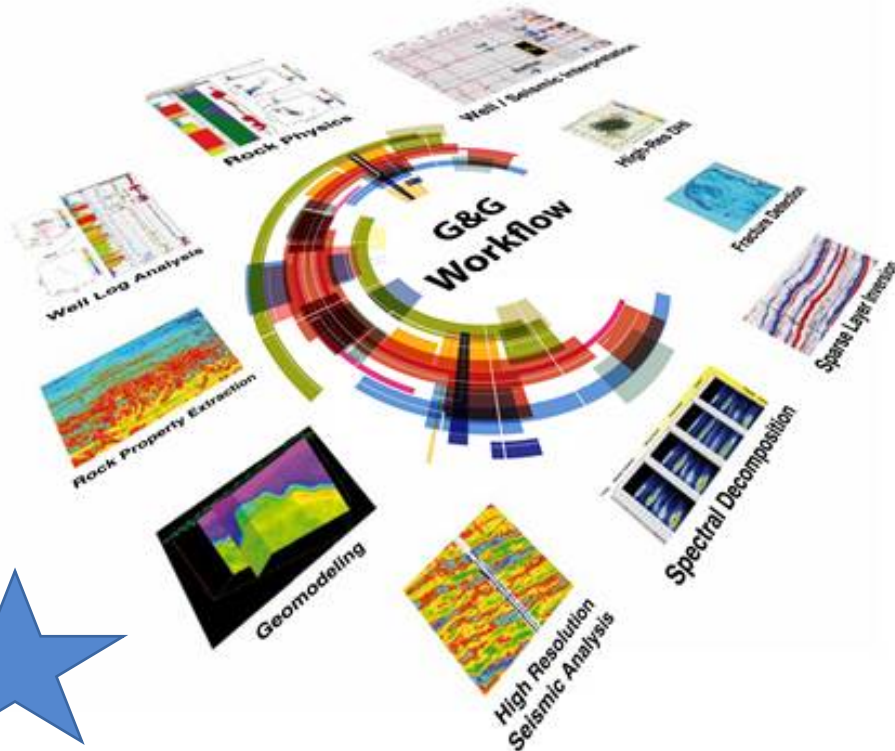


- **John Castagna**, Ph.D., Professor at the University of Houston, Founder & General Director of Lumina in 2010, previously founder of Fusion Geophysical, successfully exited in 2007, Professor at the University of Oklahoma, R&D Scientist at Arco, published dozens of scientific papers in a variety of world renowned scientific periodicals.



- **Carlos Moreno**, Ms., CEO for Lumina Geophysical, Co-founder of Lumina 2010, previously Regional Vice President / Latin America at Fusion Petroleum Technologies from 2003 to 2010, Lead Reservoir Geophysicist at PDVSA from 1994 to 2003, studied at Universidad Simon Bolivar, Geophysicist, University of Oklahoma M.S, Geology.

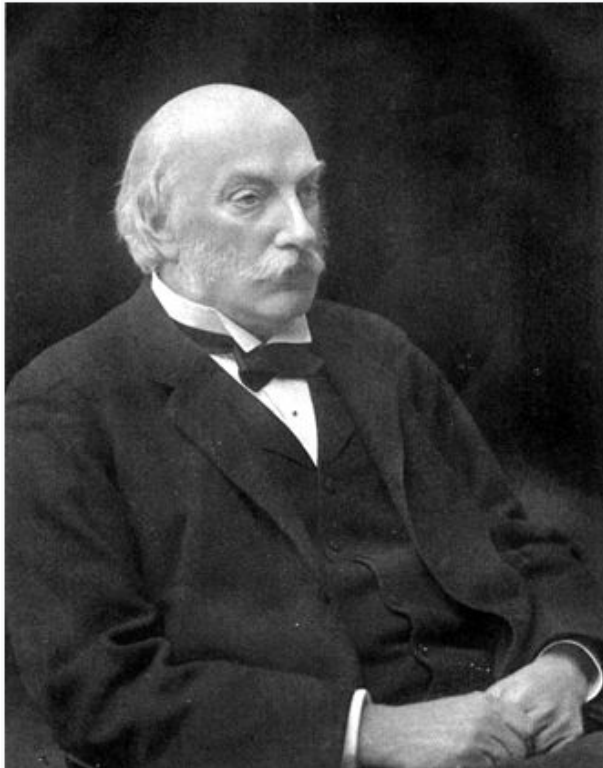
This is who we are



- Founded in 2010 by Professor John Castagna, PH.D, U. of Houston.
- Strong R&D Group, technology software (IP) company focused on Oil & Gas, Exploration and Production, with a range of technical resources, for the *Up-Stream & Mid-Stream*.
- Headquartered in Houston, with regional offices across the globe. With +120 Clients and +200 service projects ranging from small independents to Super Majors, Majors and NOCs.
- Our team of professional executives, with years of industry experience and long records of achievements, marks our success.

This is our mission

The Right Honourable
The Lord Rayleigh
OM PRS



Known for

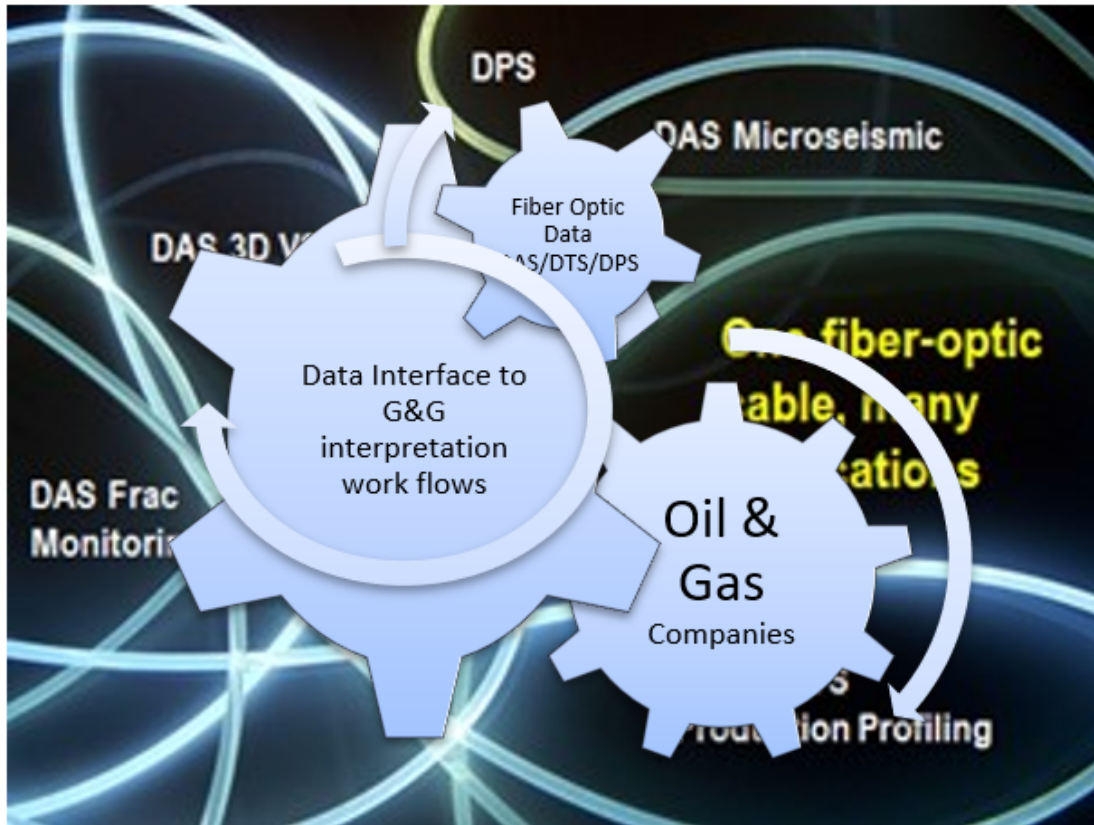
- Discovery of argon
- Rayleigh waves
- Rayleigh scattering
- Rayleigh criterion
- [Rayleigh's criterion](#)
- Rayleigh's method of dimensional analysis
- Rayleigh–Ritz method
- Rayleigh–Ritz inequality
- Rayleigh quotient
- Rayleigh–Lorentz pendulum
- Duplex theory
- Sound theory
- Rayleigh flow
- Rayleigh problem
- Rayleigh–Plesset equation
- Rayleigh–Schrödinger perturbation theory
- Rayleigh–Taylor instability
- Rayleigh–Jeans law
- Rayleigh's equation
- Janzen-Rayleigh expansion

the first theoretical treatment of the elastic
known as "Rayleigh scattering", which nota
as "Rayleigh waves". He contributed ex

12 November 1842 – 30 June 1919

Mission: Create Deep Knowledge and Experience in Applications of Fiber Optic Technology for the O&G Upstream Industry.

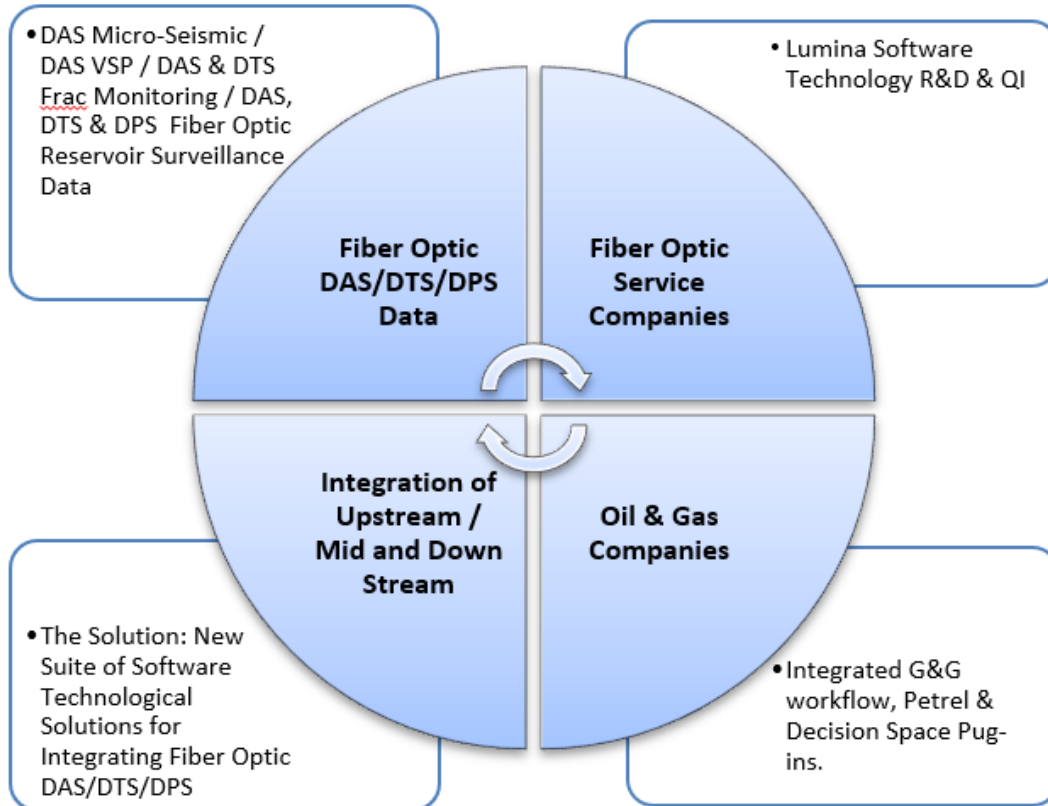
This is our vision



Vision: To become the leader in integrated solutions for Fiber Optic Data (DAS/DTS/DPS) of the O&G upstream Industry.

What we want to achieve

INTEGRATED SOFTWARE SUITE OF G&G TECHNOLOGICAL SOLUTIONS



- Develop first commercial software and build expertise for O&G Fiber Optic applications

“The lack of available processing platforms leads to another issue: absence of specialist level expertise, which encompasses geophysical knowledge for data processing, hydraulic fracturing and log analysis knowledge for data interpretation, and computer programming knowledge to manipulate the massive amount of captured data (Warren et al., 2012)”

This is our technology or process

Contents [\[hide\]](#)

- 1 Fundamentals of Rayleigh scatter based fiber optic sensing
- 2 Capabilities of Rayleigh-based systems
 - 2.1 Maximum range
 - 2.2 Strain resolution
 - 2.3 Spatial resolution and spatial sampling period
 - 2.4 Acquisition rate
 - 2.5 Temperature measurements
- 3 Comparison with other fiber optic distributed sensing techniques
 - 3.1 Phase-sensitive coherent optical time-domain reflectometry
- 4 Applications
- 5 See also
- 6 References

Distributed acoustic sensing

From Wikipedia, the free encyclopedia

- **Primary Areas of Research & Development**
 - DAS Micro-Seismic 2D/3D/4D
 - DAS VSP 2D/3D/4D
 - DAS/DTS Frac Monitoring
 - DAS/DTS/DPS Reservoir Surveillance
- **Secondary Areas of Research & Development**
 - DAS/DTS Inflow Profiling
 - DAS Gas Lift Monitoring
 - DAS Acoustic Library

Here are examples of successes

4D DAS VSP as a tool for frequent seismic monitoring in deep water

¹Shell International Exploration and Production Inc.

²Shell Global Solutions International B.V.

A. Mateeva¹, J. Lopez¹, D. Chalenski¹, M. Tatanova¹, P. Zwartjes², Z. Yang¹, S. Bakku¹, K. de Vos², and H. Potters²

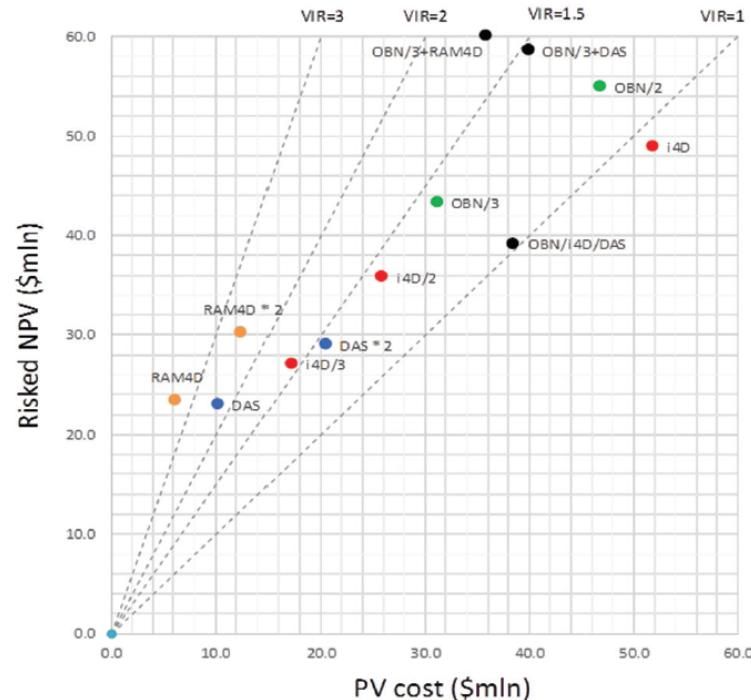


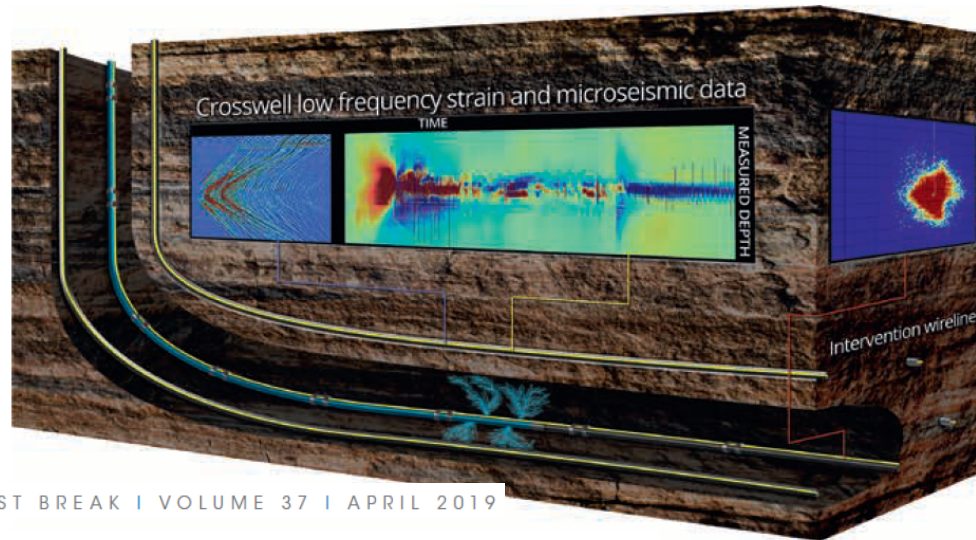
Figure 4. Crossplot of risked NPV versus present value cost over 10 years for a variety of monitoring methodologies. Costs include acquisition, processing, and integration of the data. The annual frequency of application is shown as a number in the method label (e.g., /2 means biannually while *2 means twice per year).

- ...OBN and DAS, as well as additional monitoring solutions: i4D (targeted OBN with a small number of nodes) and rapid autonomous marine 4D (RAM4D) — an unmanned watercraft used as a source vessel for DAS (Chalenski et al., 2017).
- The crossplot reveals several key points regarding 4D DAS VSP:
- Annual monitoring with **DAS VSP** (marked “DAS” on the plot) **is the least expensive of all current monitoring options** (the ultra-low-cost RAM4D is an aspiration).

Here are examples of successes

¹ Silixa

* Corresponding author, E-mail: pete.richter@silixa.com



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Figure 2 Real-time Hydraulic Fracture Monitoring (HFM) in multiple wells using engineered fibre deployed permanently and on a wireline intervention cable.

Hydraulic fracture monitoring and optimization in unconventional completions using a high-resolution engineered fibre-optic Distributed Acoustic Sensor

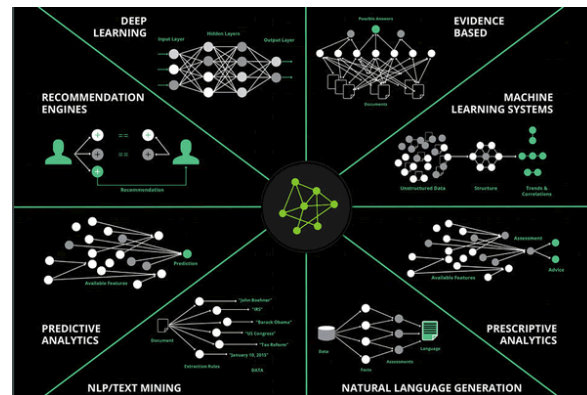
P. Richter¹, T. Parker¹, C. Woerpel¹, Y. Wu¹, R. Rufino¹ and M. Farhadiroushan¹ present an advanced optoelectronic Distributed Acoustic Sensor that utilizes a new generation of engineered optical fibre with 100x (20 dB) improved sensitivity compared to that of standard fibres.

Conclusion

- The next generation of DAS system, utilizing the engineered fiber, offers 100x improvement in sensitivity compared to standard fiber and provides unprecedented data quality both on permanent and wireline intervention cables.
- The intervention wireline cable can be economically deployed for crosswell strain identification on frac hits, microseismic monitoring, and time-lapse Vertical Seismic Profiling (VSP) acquisition. The wireline data can be combined with the permanently installed fibers to provide a wide volume coverage for fracture monitoring and completion diagnostics.
- Much of the data is real-time or near real-time, so that the combined data sets can be used within the completion workflow to better understand the implications of key operational decisions with a high level of confidence.

Short-term plan

	Upstream
Geoph	DAS Microseismic
Geoph	DAS VSP 2D/3D/4D
Geoph	DAS Marine Data Processing 2D/3D
Geoph	DAS Ocean Bottom Cable 3D/4D



- Partner with Operators to gain access to data
- Create software with capabilities for Big Data:
 - Cloud based
 - Capability for Artificial Intelligence for:
 - Data mining
 - Basic processing
 - Analysis
 - Interpretation
- Already in industry's workflow
 - Plugins for DecisionSpace and Petrel

Long-term plan

Eng	DAS/DTS Frac
Eng	DAS Inflow Monitoring
Eng	DAS Gas Lift
R&D	DAS/DTS/DPS Reservoir Surveillance
R&D	DAS Acoustic Library
	Midstream
Eng	DAS Pipeline Surveillance

DAS - Acoustic Library



Artificial Intelligence

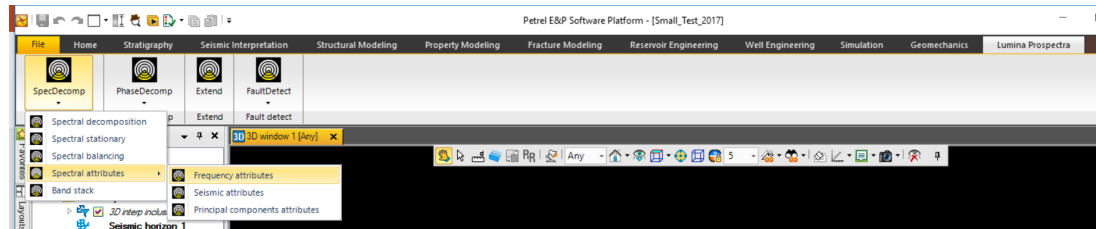
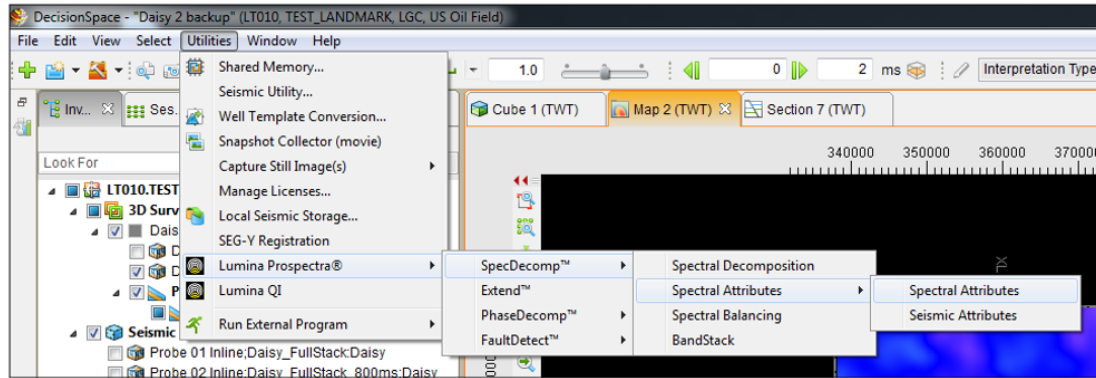


Cloud Computing

	Railroad Monitoring
Eng	DAS Railroad & Subway Surveillance
	National Security
Sec	Boarder Surveillance
	Roads & Infrastructure
Eng	Roads Monitoring & Surveillance
Eng	Bridges Monitoring & Surveillance
Eng	Dam Monitoring & Surveillance
	Maritime
	Harbor Shipping Channel Surveillance

- Partner with Fiber Optic vendors to integrate the workflow from the acquisition of the data
- R&D directed to industry needs
- Add additional capabilities to the software :
 - Engineering applications for:
 - Completion
 - Fracking
 - Reservoir surveillance
 - Incremental applications for:
 - Data management
 - Field QC and full processing
 - Analysis & Interpretation
 - Integration with engineering tools
 - Other O&G applications in Midstream and Downstream, etc.

How will it work? Is it working now?



- Many tools from Lumina are already plug-ins for Petrel and DecisionSpace (Filters, attributes and basic processing tools)
- Lumina's HPC capabilities have been tested successfully by Halliburton, as well as internally
- Lumina's R&D team is currently developing tools using AI tools
- Lumina already has software running in the cloud
- All of the above can reduce greatly R&D path towards a working product

Fiber Optic Cables Market is Expected to Reach US\$ 7.95 Billion By ...

<https://globenewswire.com/.../Fiber-Optic-Cables-Market-is-Expected-to-Rreach-US-7-...> ▼

Mar 26, 2018 - ... **Oil & Gas**, Medical, Telecom and Others)))- **Growth**, Future Prospects and ... **Fiber optic cable** provides a constant, stable and fast internet ...

Fiber Optic Sensors Creating New Possibilities For Fracturing

<https://www.aogr.com/.../fiber-optic-sensors-creating-new-possibilities-for-optimizing-...> ▼

The fiber line represents the downhole system component in **oil and gas** wells. ... an even better subsurface picture of fracture **growth** and effectiveness, but it still ... the distributed **fiber optic** sensing **technology** to illuminate activities that were ...

Global Fiber Optic Sensor (FOS) Market to Witness a CAGR of 6.2% during 2018-2024

In Press by — 360 Feed Wire

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March 13, 2019 - 5:58 AM EDT

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Global Fiber Optic Sensor (FOS) Market to Witness a CAGR of 6.2% during 2018-2024

NEW YORK, March 13, 2019 (GLOBE NEWSWIRE) -- The **global fiber optic sensor market** is likely to augment from **USD 3.42 billion** in 2017, and is expected to reach **USD 5.20 billion** by 2024, witnessing a **CAGR of 6.2%** during the forecast period. The market growth is primarily attributed to the growing application in oil & gas vertical, rising demand for data-based analysis, and increasing research and development activities. Additionally, considerable growth in telecommunication industry is further impelling the growth of the market. However, high sensitivity of the sensors may restrain the market growth to some extent.

Fiber Optics Market Size is Poised to cross USD 7 billion by 2026 ...

<https://www.marketwatch.com/.../fiber-optics-market-size-is-poised-to-cross-usd-7-bill...> ▼

Mar 8, 2019 - **Fiber Optics** Market Size is Poised to cross USD 7 billion by 2026. ... The plastic **optic fiber** market is expected to notice a high **growth** during the projected period. The core material (polymer) used for construction of plastic **optic fiber** is different from the material (glass) used in single mode and multimode.

• Market Size:

- \$708.8m in 2016 Fiber Optics market size. Projected >\$6.5bn in 2025
- \$2.0bn in 2016 Land seismic equipment and acquisition market size
- \$49.026bn in 2014 - The Shale (Tight) Oil Market Capex
- TBD – Deep Water 4D Monitoring

SWOT Analysis

• Strengths:

- Experience in managing Consortiums and R&D projects
- Already developing mainstream plug-ins
- Experience in AI
- Experience in Big Data, HPC, and Cloud

• Weaknesses:

- Early stages of the technology
- Knowledge in applications biased to operators
- Access to Fiber Optic data limited to operators

• Opportunities:

- Need for software from Processing to Interpretation of Fiber Optic
- Growth of the Fiber Optics technology
- Lead cost effective technology in its early stages
- Expand to other areas outside O&G Upstream

• Threats:

- Limitations of the technology in comparison to streamlined technologies, like conventional seismic
- Find experienced people in the topic

Action Steps



- Create a Consortium with O&G operators (5-10) that own fiber optic data
- Provide to the consortium members will receive working products as per plan
- Detailed R&D map to be presented after consortium is formed:
 - Draft of roadmap is available upon request



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