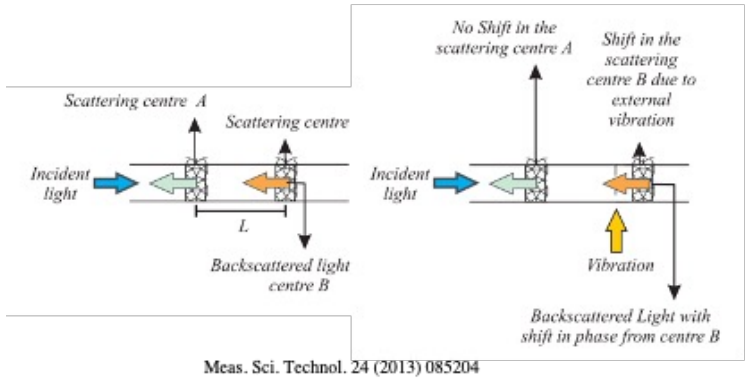
Environmental Monitoring with DAS

MoMacMo Environmental DAS Services

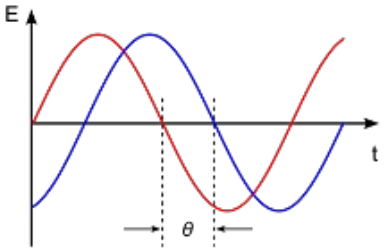
- Understanding DAS
  - We have an in-depth understanding of DAS systems and applications
  - We can assist you in picking the right application and technology
- DAS Project Planning
  - MoMacMo provides complete project planning services for DAS projects
  - Best practices for field deployment and metadata standards
  - Full Life cycle DAS Data management from the field to interpretable results
- DAS Data Processing
  - MoMacMo DAS processing framework for multi-scale strain analysis
  - Scalable native cloud technologies from mobile to supercomputers

Understanding Distributed Acoustic Sensing (DAS)

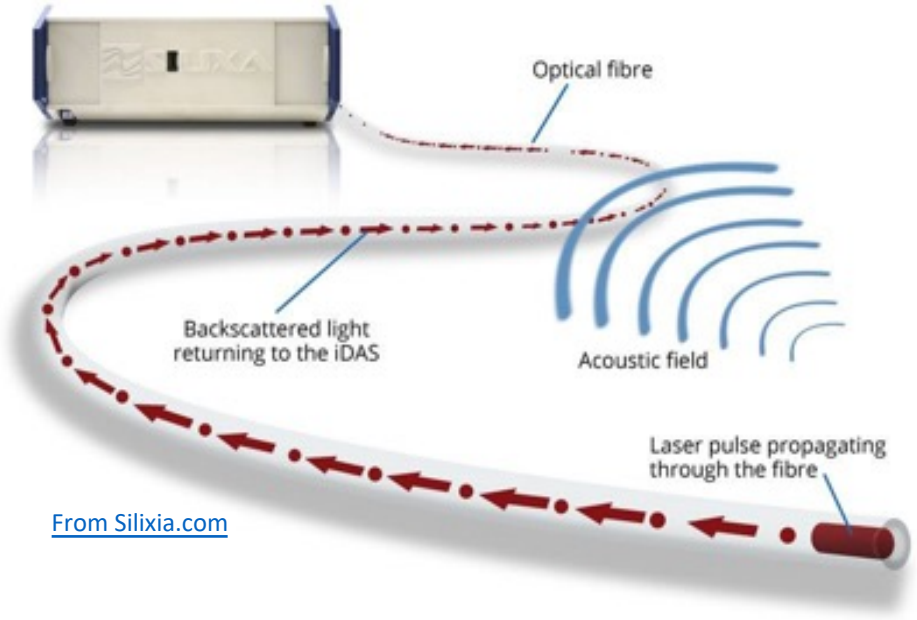
- Distributed Acoustic Sensing (DAS) uses optical fibers to measure vibration
- Imperfections in the fiber create reflections that bounce light back to the sensor
- Distance to each reflector is proportional to the time it was received
- Magnitude of the vibration is proportional to the phase difference between the sensing pulse and the reflected pulse



Meas. Sci. Technol. 24 (2013) 085204



Phase change!



From Silixia.com

Distributed Acoustic Sensing Systems

- There are many manufacturers of DAS systems
- Applications include:
  - Intrusion detection
  - Equipment monitoring
  - Traffic monitoring
  - Seismology
- DAS produces seismograms that are comparable to traditional earthquake sensors

OptaSense® A LUNA company

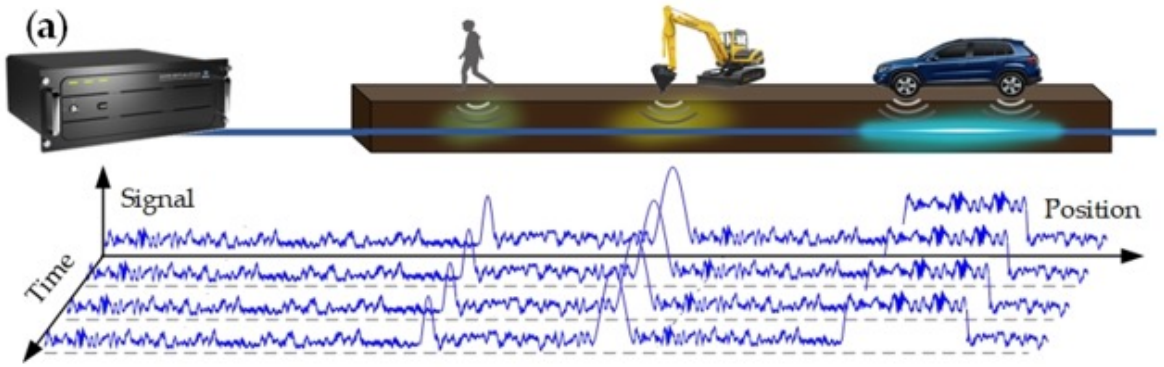
Fotech

Bandweaver

SILIXA actionable insight

AP SENSING advanced photonic

Fiber SenSys® AN OPTEX GROUP COMPANY



MoMacMo DAS experience

- Application of DAS for seismology is relatively new
- MoMacMo has 10 years of experience with DAS in the energy industry:
  - Hydraulic fracture monitoring
  - Vertical seismic profiles
  - Experimental reflection seismic
- Our co-founder, Prof. Robert Ferguson, is a pioneer in using DAS for autonomous vehicles and smart cities

LOW FREQUENCY DISTRIBUTED ACOUSTIC SENSING

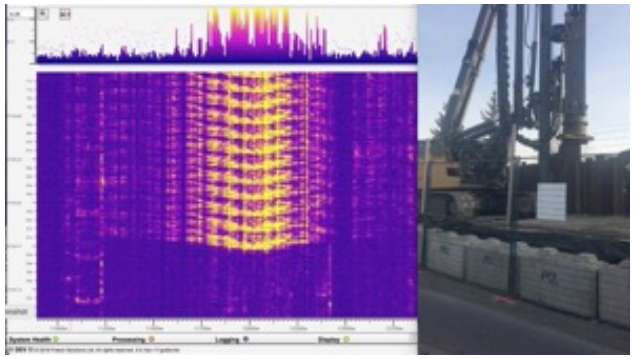
Abstract

The invention relates to DAS observation has been proven to be useful for monitoring hydraulic fracturing operations. While published literature has shown focus on the high-frequency components (>1 Hz) of the data, this invention discloses that much of the usable information may reside in the very low frequency band (0-50 milliHz). Due to the large volume of a DAS dataset, an efficient workflow has been developed to process the data by utilizing the parallel computing and the data storage. The processing approach enhances the signal while decreases the data size by 10000 times, thereby enabling easier consumption by other multi-disciplinary groups for further analysis and interpretation. The polarity changes as seen from the high signal to noise ratio (SNR) low frequency DAS images are currently being utilized for interpretation of completions efficiency monitoring in hydraulically stimulated wells.

Inventors: **JIN; Ge**; *(Houston, TX)* ; **MOSHER; Charles C.**; *(Houston, TX)* ; **FILICE; Frank P.**; *(Houston, TX)* ; **KRUEGER; Kyle R.**; *(Houston, TX)* ; **ROY; Baishali**; *(Houston, TX)* ; **TURA; Ali**; *(Golden, CO)* ; **JURICK; Dana M.**; *(Houston, TX)*

Applicant:	Name	City	State	Country	Type
	CONOCOPHILLIPS COMPANY	Houston	TX	US	

Family ID: 59786319
Appl. No.: 15/453434
Filed: March 8, 2017

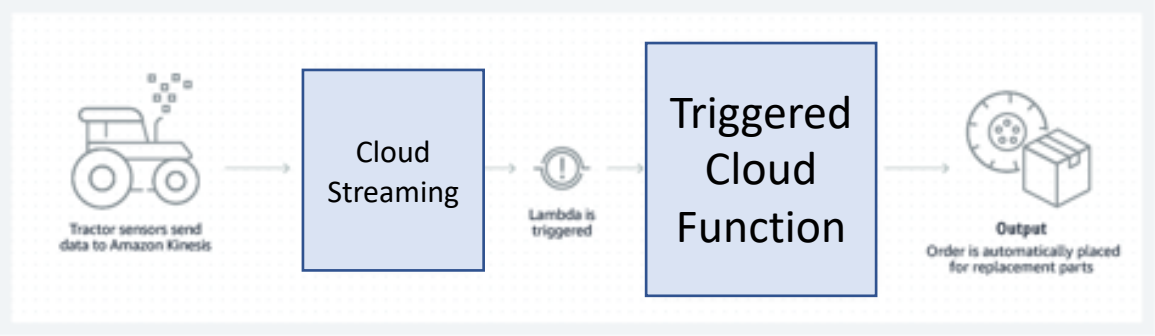


DAS Project Planning

- DAS projects can utilize traditional seismic reflection survey planning
  - But there are significant differences between DAS and traditional sensors
  - MoMacMo uses well known industry standard practices for seismic survey design with appropriate modifications for DAS surveys
- MoMacMo provides best practices and open source code for:
  - GPS locations and cable shape computation
  - Continuous record management and precise timing
  - Metadata standards for acquisition and processing
  - Full life cycle DAS data management
- MoMacMo will assist you in planning, acquiring, and processing DAS datasets for environmental applications

DAS Data Processing

- DAS systems can generate Terabytes of data per day
- Processing and management of this data is a daunting task
- MoMacMo has technology to create multi-scale versions of the data at a range of scales - days to milliseconds
- We use cloud storage (AWS S3), Apache Spark Machine Learning, and JavaSeis.org technology for parallel I/O and compute
- Our systems can generate interpretive datasets from raw DAS data at rates as low as $10 USD per day

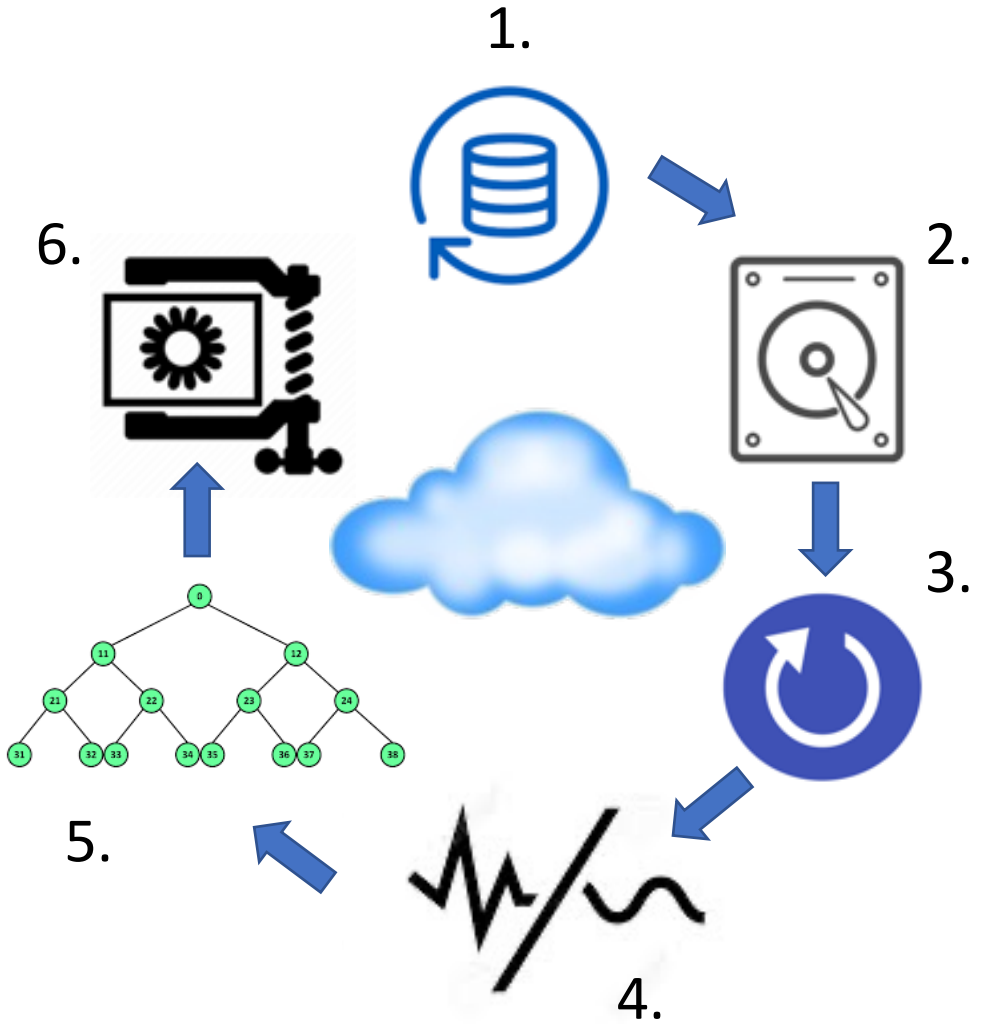


- DAS HDF5 files are loaded to cloud storage
- Event triggers a cloud function to read the HDF5 and convert to JavaSeis format
- Metadata from HDF5 is used to establish the time segment of the data
- The JavaSeis dataset “grows” in real time and can be viewed and processed any time
- QC tools allow us to watch and monitor data and performance from any device
- Ready for Machine Learning and other analysis

DAS Data Management Life Cycle

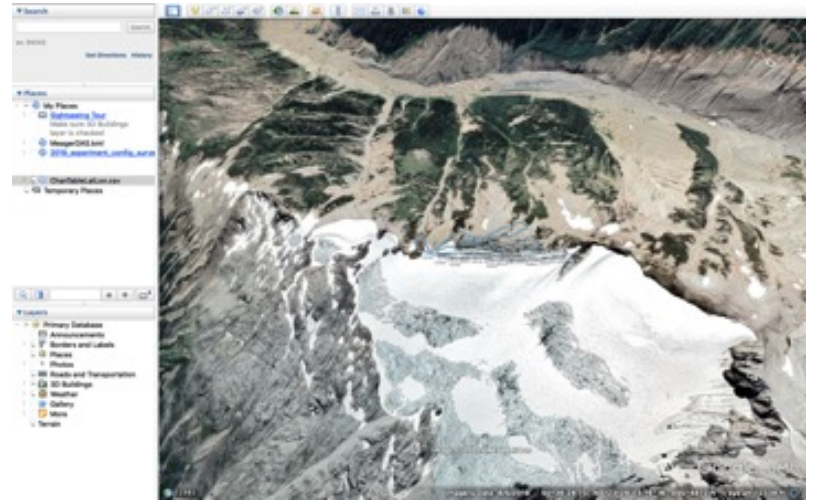
MoMacMo services to:

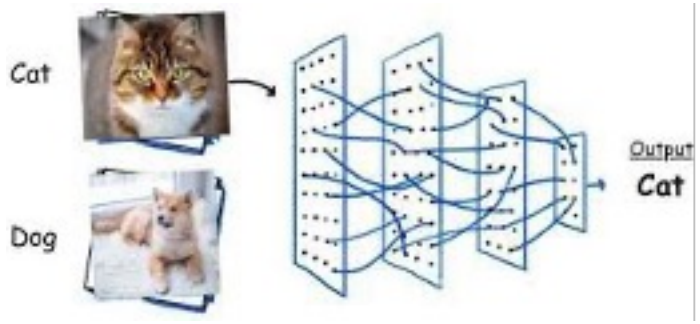
1. Stream or load to S3
2. Index and reformat
3. Continuous record formation
4. Noise removal and differentiation
5. Multi-scale decomposition
6. Compression

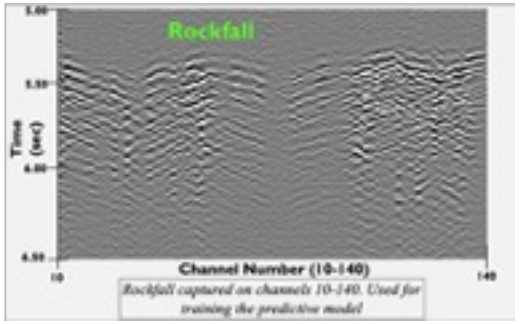


What goes to the cloud, stays in the cloud

- The data is in the cloud in a public domain format
- With proper credentials, it can be accessed from anywhere
- Any vendor with a cloud presence can participate in processing
- We bring the data closer to data science







Environmental Monitoring with DAS

- Distributed Acoustic Sensing provides a wealth of opportunities for environmental monitoring
- MoMacMo participated in the initial development and use of DAS in the energy industry
- We provide a full range of services for:
  - Planning DAS projects
  - Acquiring data in the field
  - Full life cycle DAS data management
  - Processing and interpretation of results
- Contact us if you have a project where we can help !