

HydroConfidence™

Enabling Economically Efficient and Environmentally Sound
Shale Gas Production

HydroConfidence, Inc.
COMPANY PROPRIETARY

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HydroConfidence: Problem & Solution

Problem

- Claims of possible contamination have resulted in multiple class-action lawsuits against natural gas companies, and have prompted state regulators and policy makers to interrupt plans for new drilling operations, order existing wells plugged, and mandate costly remediation services.

Solution

- HydroMonitor directly monitors the aquifer underlying a well pad to detect methane migration as well as monitors the freshwater casing for cement integrity via microseismic.
- Continuous, independent monitoring of groundwater to identify and fingerprint potential contamination at natural gas production sites.
- Detects methane in real-time, allowing well owners to address the source of contamination before it causes a public health hazard and before it affects well productivity.
- A HydroConfidence partner, CTC, will operate a 24/7 Response Center to monitor these networks.

Drivers: Federal & State Regulation

The Secretary of Energy Shale Gas Production Subcommittee 90-Day Report

- Concludes there is a need for shale gas operations to improve “protection of water quality”
 - Recommends that shale gas companies, “measure and publically report the composition of water stocks and flow throughout the fracturing and cleanup process [and] adopt requirements for background quality measurements (e.g., existing methane levels in nearby wells prior to drilling for gas) and report in advance of shale gas production activity.”

Pennsylvania HB 1950 (law signed on Feb. 13, 2012)

- Operator presumed liable for any water contamination that occurs within 2,500 feet and within 12 months after drilling or altering an unconventional well
- Previous limit was 1,000 feet and 6 months after drilling

EPA Investigations

- Increased scrutiny and investigation by the U.S. Environmental Protection Agency
- Multiple federal lawsuits and investigations damaging to producers

Drivers: Private Liability

Cabot Oil & Gas Corp.

- PA DEP investigation concludes Cabot Oil “allowed combustible gas to escape the region’s groundwater supplies.” In April 2010, PA banned Cabot Oil from further drilling in the entire state until it permanently plugged contaminating wells. \$4.1 million settlement to Dimock county plaintiffs and \$500,000 to PA DEP. \$140M loss in shareholder value.

Catalyst Energy, Inc.

- PA DEP determined natural gas extraction had contaminated groundwater supplies at two private properties. Ordered to halt drilling and fracturing at 36 non-Marcellus Shale wells (March 2011).

Southwest Energy Co.

- Thirteen families are alleging Southwest’s fracturing practices have resulted in property damage and personal injury. Claims brought under PA’s Hazardous Sites Cleanup Act, in addition to private nuisance and trespass, negligence, and strict liability claims. Seeking preliminary and permanent injunctions (September 2010).

HydroConfidence System

Sensor unit with a low-power processor and a battery pack

- Converts analog sensor values to digital data and transmits using a common connection
- Correlation of direct methane measurements with microseismic events increases reliability

Data Transmission

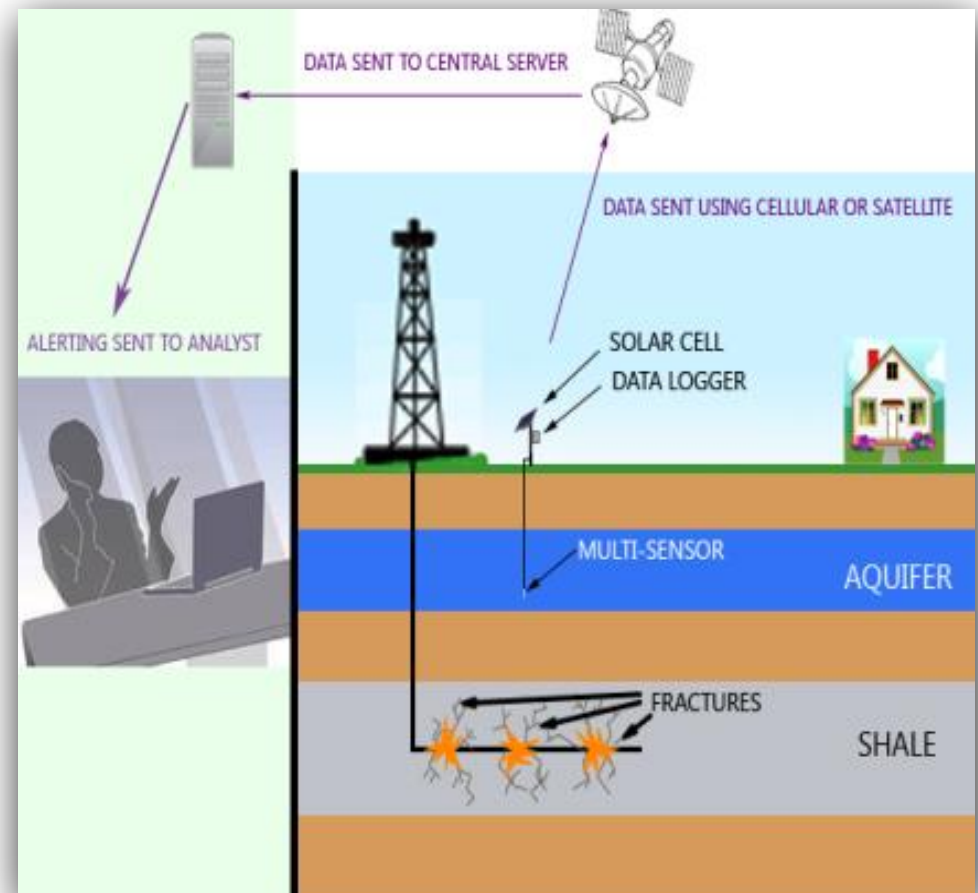
- Tethered cable using open communications standard

Data Logging System

- COTS data logger system such as the Nexsens iSIC

Communications

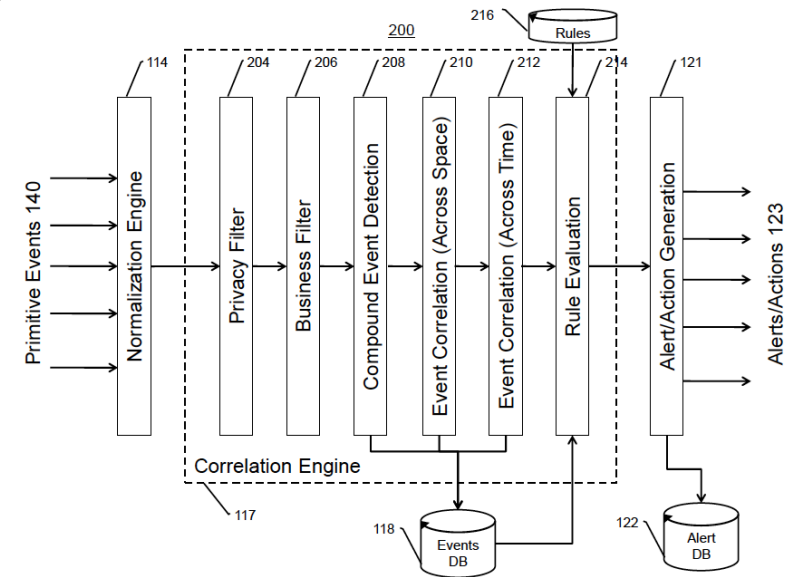
- Cellular, Satellite, or Wi-Fi



HydroConfidence Software Architecture

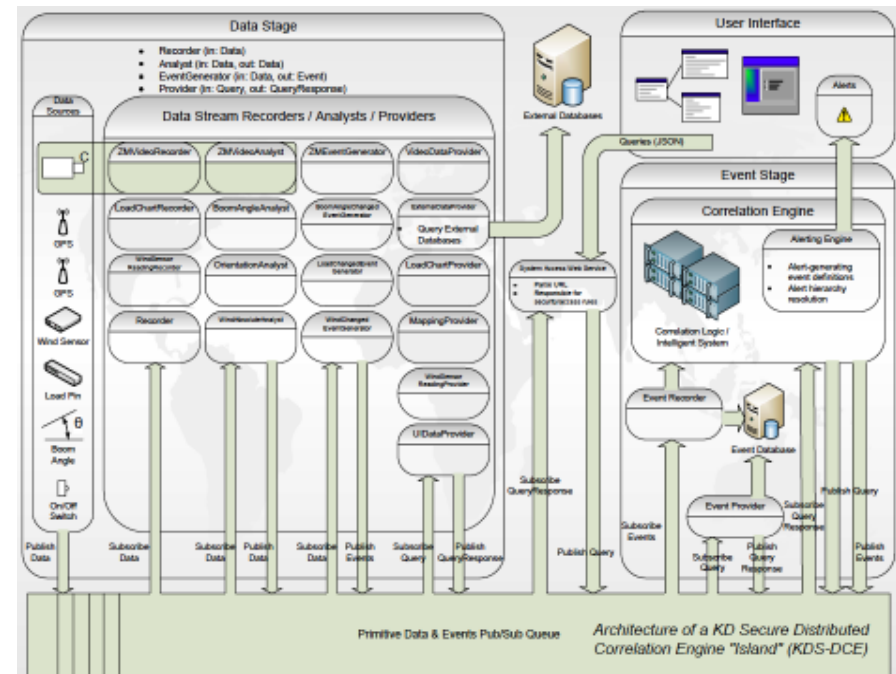
- **Correlation Engine**

- Correlates events from direct methane sensing with microseismic monitoring to build a probabilistic model of casing failure, leakage, and methane migration from a pad into nearby water aquifers



- **Alerting Engine**

- Alerting engine processes data from correlation engine, including weights associated with input data, and generates alerts which are sent to field personnel, safety personnel, and third-party monitoring center



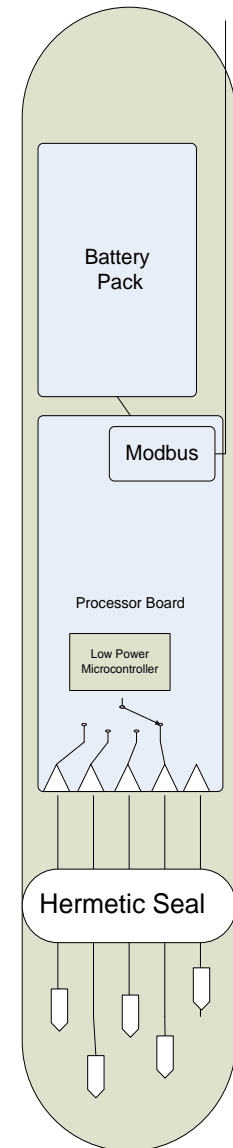
HydroConfidence Sensors

Short-term: partner's existing sensors

- Volatile organic compounds (VOCs), primarily methane
- Geophones to detect microseismic events
- Both water and air emissions monitoring available
- Additional contaminants monitoring available

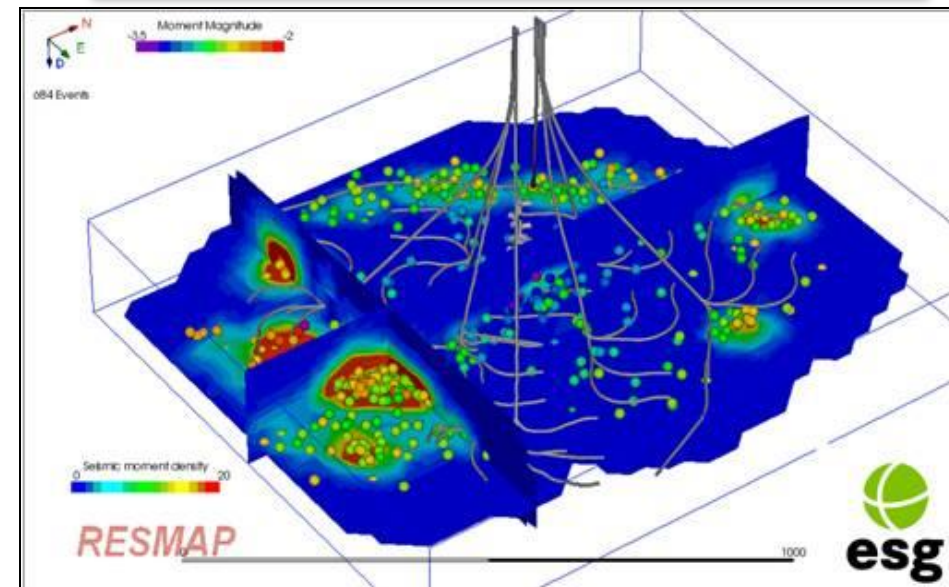
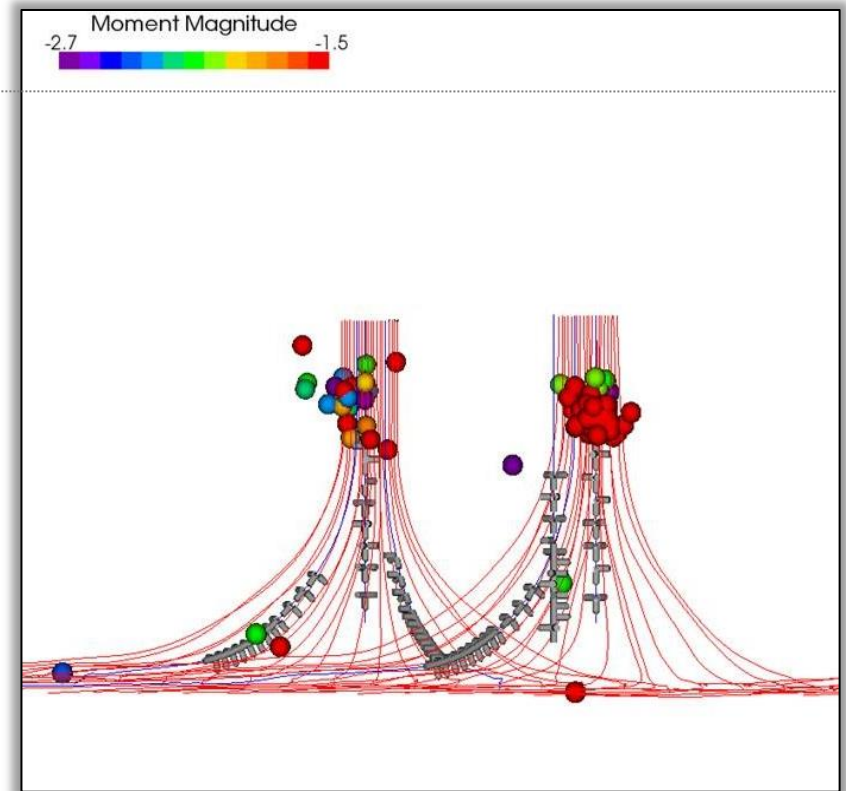
Intermediate to long-term: custom sensors developed with research partners

- Biogenic vs. thermogenic
- "Fingerprinting" contamination
- Downhole flow monitoring sensors for measuring three-phase flow in real-time and optimizing fracturing and production



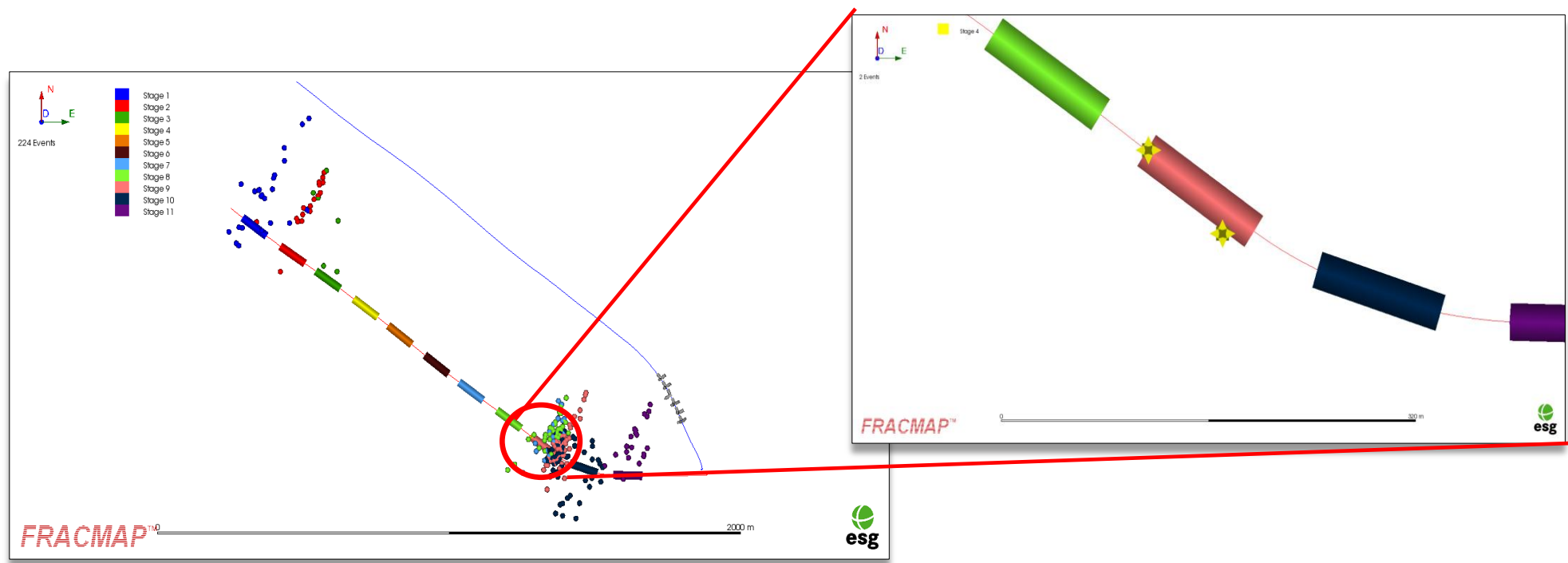
Partnership with ESG for Caprock Integrity Monitoring

- **Example: Coal seam above the reservoir**
 - Observed to shrink and swell with the development of a large steam chamber in the wells
- **Advanced microseismic warning**
 - Large number of events triggered near the surface
 - Able to reduce the pressures in the steam chamber and successfully avoid breakthrough to the surface



Example: Casing Failure Detection

- Two casing failures identified during Stage 3 of an 11-stage fracture stimulation
- Casing failure occurred near to Stage 9 zone



Completed field test in Ligonier, PA

Field test system

- Funded by Foundation for PA Watersheds grant
- Custom software and UI developed
- Measured background methane levels of 0.2-0.5 mg/L (ppm) in Ligonier, PA
- Measurements validated by third-party laboratory analysis
- Consistent with background methane levels reported by industry (Range Resources)
- Sensor accuracy validated down to 10^{-4} mg/L (0.1 ppb)



Sensor Development Partners

Franatech

- The Franatech team has 14 years of experience in underwater gas detection, supported by patents, technology awards, participation in international projects and numerous publications
- Sensors used worldwide for offshore oil and gas exploration activities and groundwater quality monitoring

Engineering Seismology Group (ESG)

- Inventor of microseismic monitoring technology
- Bi-modal correlation of direct methane sensors and microseismic monitoring improves reliability and accuracy

Carnegie Mellon University

- Expertise with environmental management and monitoring for methane and other potential contaminants

Dublin City University

- CLARITY Center for Sensor Web Technologies focuses on adaptive sensing and information discovery

Benefits to Producers

Mitigate Liability

- Dispute inaccurate claims of contamination; address legitimate claims quickly and minimize negative impact

Assist with obtaining drilling rights on private/public lands

- Allay concerns of environmental contamination
- Distinguish early-adopters in competitive grants

Improved Reservoir Understanding

- Understanding the reservoir response and optimizing fracture treatments and their associated producible volumes

Project a positive image

- Advertise a commitment to public well-being and environmental protection

Assist with permitting

- Component of a Preparedness, Prevention and Contingency (PPC) plan for accident monitoring and mitigation of any detrimental effects due to drilling

Third-party service

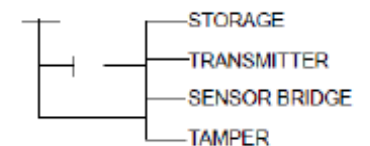
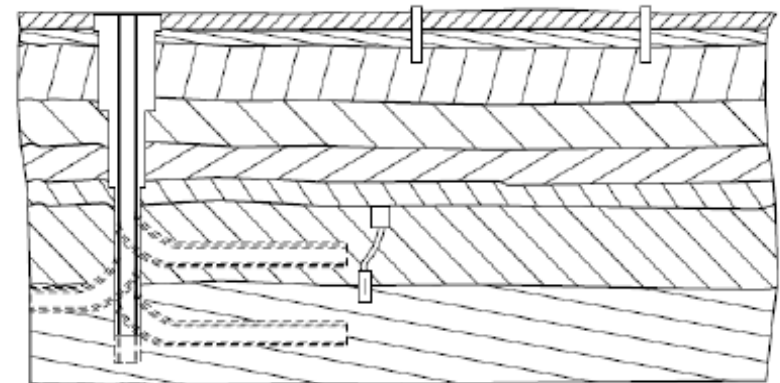
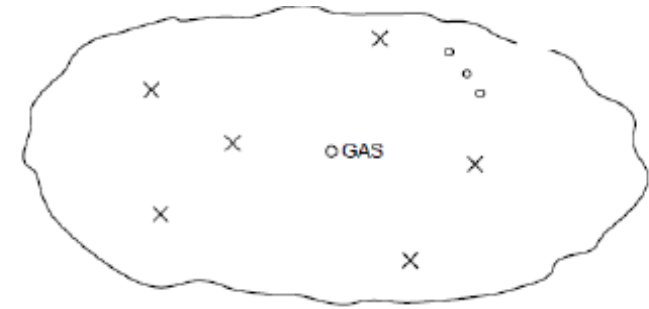
- Allay concerns of bias; focus on primary business

Competitive Analysis

No similar solution available commercially

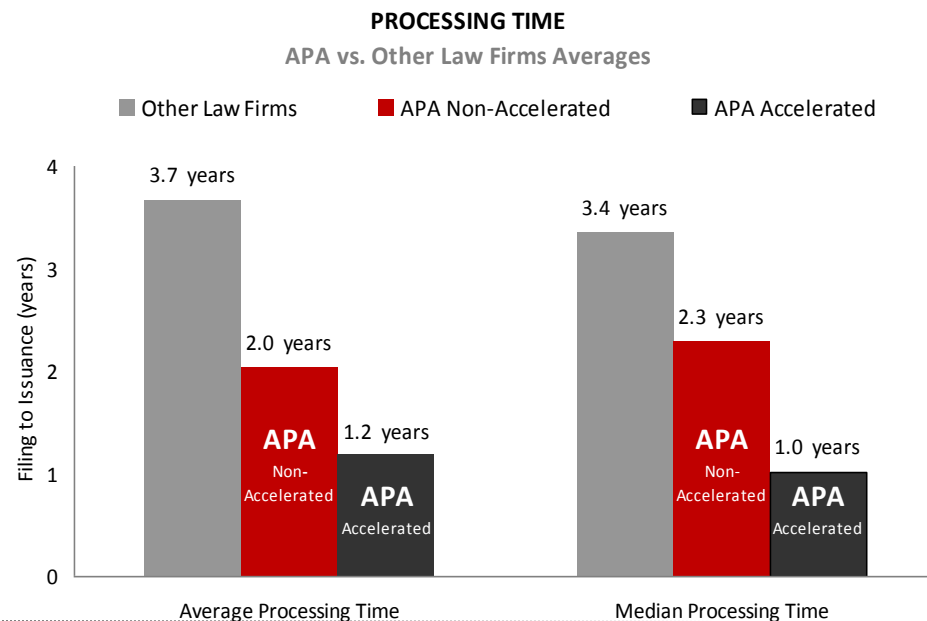
Laboratory analysis

- No real-time information
- No pro-active response possible
- No time-series data available
- No finger-print capability
- Time consuming and labor intensive
- Potentially costly



Intellectual Property

- **Accelerated non-provisional patent application verbally approved by Examiner**
 - “Systems and methods for monitoring groundwater, rock, and casing for production flow and leakage of hydrocarbon fluids”
 - Claims cover shale safety utilizing downhole and surface monitoring
- **U.S. Patent No. 8, 130,098, issued on March 6, 2012 (Dan Hussain, inventor; licensed from KD Secure LLC)**
 - “Systems and methods for safety and business productivity”
 - Broad coverage of safety applications utilizing a correlation engine
- **U.S. Trademark Approved for Publication**



Management Team

- **Dan Hussain**, Entrepreneur ▶ CEO
 - MIT Graduate in Electrical & Biomedical Engineering, PhD Candidate in Civil & Environmental Engineering at Carnegie Mellon
- **Ryan Abbott**, MD, JD ▶ President/COO
 - Graduate of Yale Law School and University of California, San Diego School of Medicine
- **Steven Malliaris**, Entrepreneur ▶ Vice President
 - MIT Graduate in Mathematics, PhD Candidate in Finance at Yale
- **Lou Crocco**, Esq., Attorney ▶ Chief Strategy Officer
 - Decades of experience with PA legislation and industry contacts
- **James Miller**, PhD, Chemical Engineer ▶ CTO
 - Associate Research Professor at Carnegie Mellon's Chemical Engineering Department
- **Vincent DeVito**, Esq. ▶ General Counsel
 - Former Acting U.S. Assistant Secretary of Energy for Policy and International Affairs
- **J. Scott Roberts**, PG ▶ Chief Geologist
 - Former Deputy Secretary of the Pennsylvania Department of Environmental Protection
- **Frank Cooper**, PE ▶ Corporate Board Member
 - Chief Technical Officer of Concurrent Technologies Corporation (

