DOCKETED

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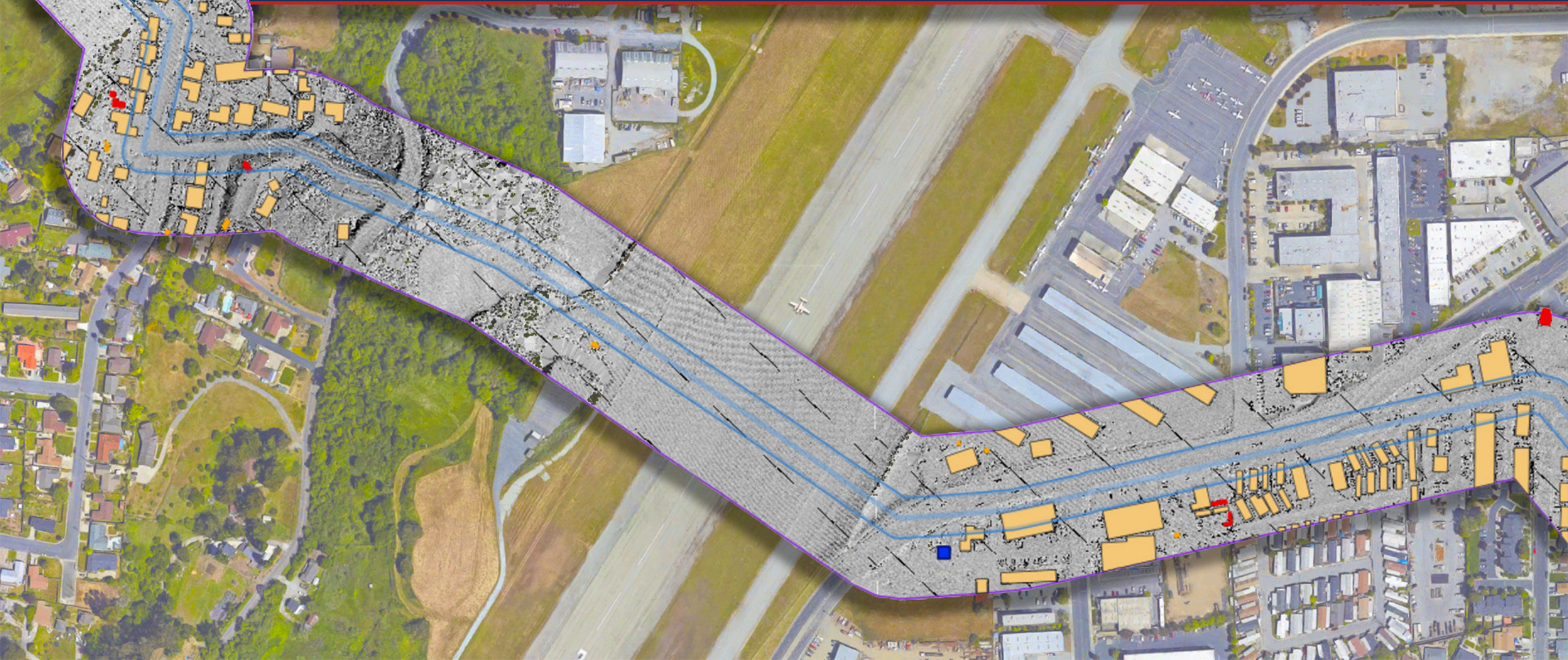
Geospatial Data Analytics to Protect Energy Infrastructure



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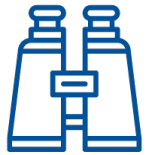
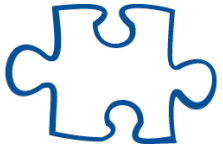
Overview

Enview turns massive datasets into operational insights to support pipeline operational safety and reliability



Computer Vision

See the Invisible



Machine Learning

Predictive Insights

Data Visualization

Actionable Results

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Pipeline Capabilities

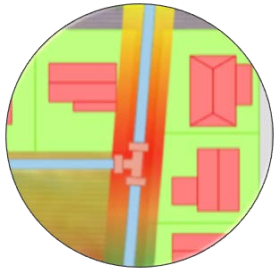
Vegetative Obscuration
49 CFR 192.701 & 705
NERC FAC-003-3

3rd Party Dig-Ins
49 CFR 192.614

Depth of Cover
49 CFR 192.620

Structure Count
49 CFR 192.5, 613 & 905

ROW Encroachment
CPUC GO 112-F (143.6)



Predictive Analytics

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2003 Northeast Blackout

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Outcomes

- Regulations
  - NERC FAC-003-3 Yearly vegetation-related inspections
  - NERC FAC-008 Thermal rating of powerlines
- Previous manual solutions did not scale to new regulations
- Industry turned to powerful new technology: LiDAR

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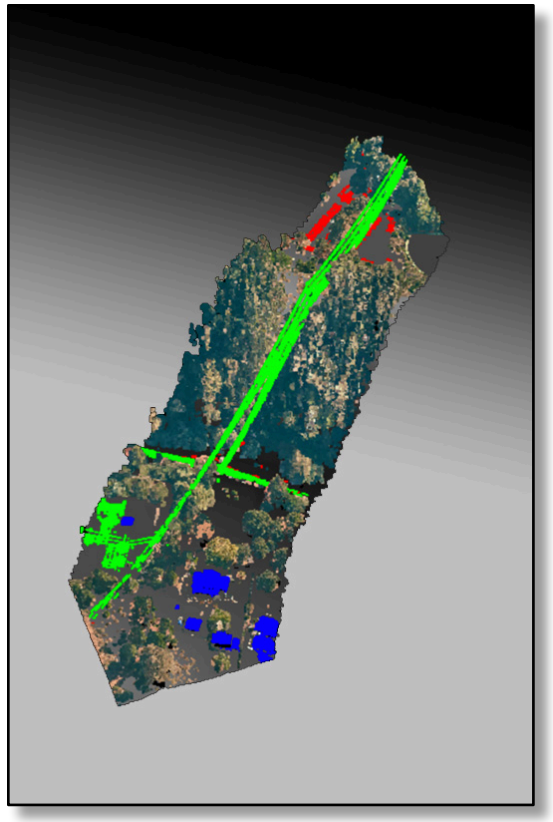
Big Data Consequences

- LiDAR data is massive (GB per mile, PB per operator)
- Response pushed entire ecosystem into big data:
  - Regulators
  - Electric transmission operators
  - LiDAR surveyors
  - LiDAR sensor vendors
- Many painful operational lessons



1 mile. 19M points. 5 GB.

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Methane and Big Data

- Methane leak assessment will have same impact on pipeline operators
- Methane big data challenge is enormous
  - Area: 303k mi transmission, 1.26M mi distribution
  - Frequency: Continuous time history vs one-time surveys
  - Complexity: Gas dispersion, fluid dynamics, environmental factors, etc.
  - Quantity: To be fully determined…
- Methane remote sensing big data is the future for the industry
- Pipeline operators can benefit from electric transmission experiences

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Lesson 1: Data Rights

- Problem
  - Inability to process big data led electric co's to depend on 3rd party vendors for analysis
  - Many vendors use proprietary data formats to lock operators into their platform
  - Operators can't get access to their own data

- Lesson: Don't get locked out of your own data
  - Make sure deliverables include results AND raw data in open format

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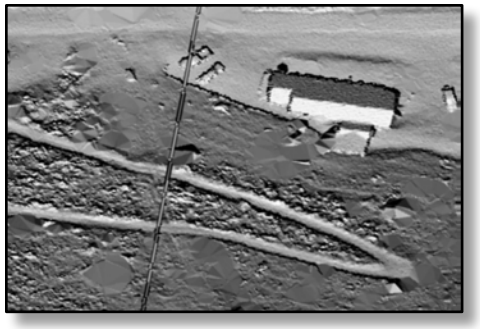
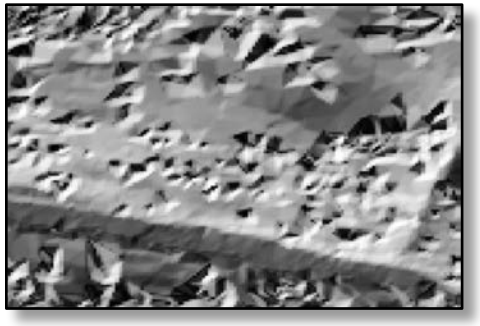
Lesson 2: Data Retention

- Problem
  - Vendors were unprepared for massive amounts of data
  - Vendors stored big data like “small data” (~$2,000/TB/yr)
  - Threw out “non-essential” data to ease storage
  - Caused major loss of value for future compliance activities



Original LiDAR Data

- Lesson: Don’t throw out your own data
  - Data collection is expensive; retain ALL raw data as a baseline and for future analyses
  - Store big data using modern techniques (<$400/TB/yr)



Decimated LiDAR Data

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Lesson 3: Insight Generation

- Problem
  - Extracting insight from remote sensing data is a multidisciplinary effort

- Lesson: Ensure solution covers all components, including big data
  - Sensor experts: Develop novel sensor tech
  - Gas ops teams: Inform operationalization of new tech
  - Data collectors: Obtain properly georegistered & open data
  - Big data firms: Analyze and store big data, deliver results

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Lesson 4: Big Data Analysis

- Problem
  - Data science for its own sake doesn't benefit operations
  - Machine learning /big data analytics is a specialized skill set

- Lesson: Machine learning is not a magic cure-all
  - Solutions must be custom-tailored for the energy industry
  - Algorithms inform expert operators, does NOT replace people
  - Vet vendor for analytical AND operational capability

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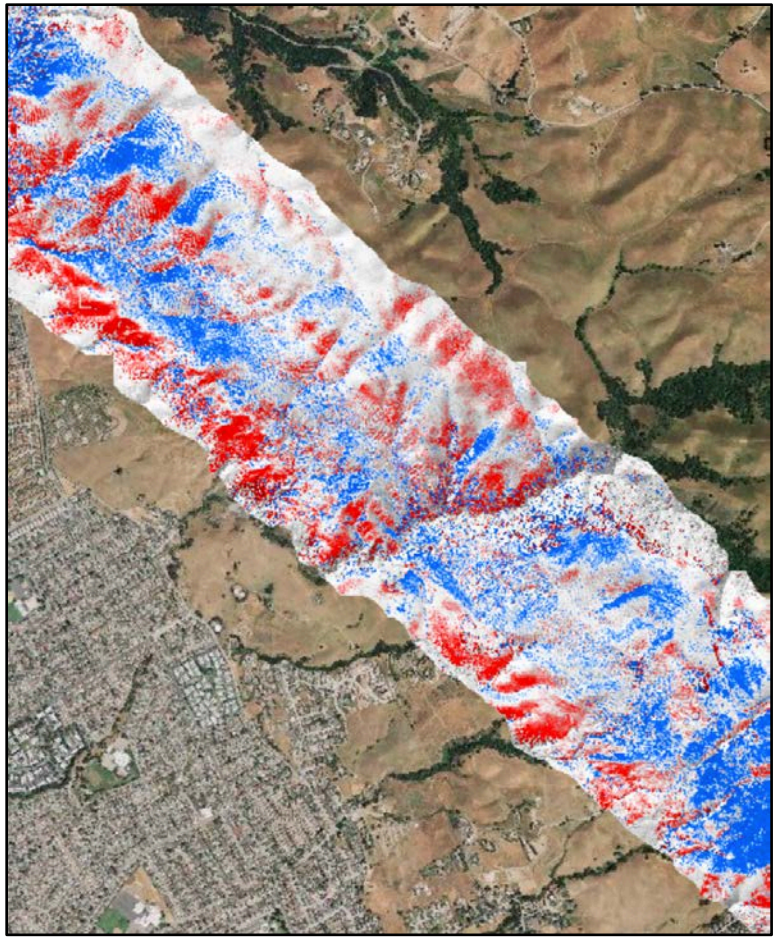
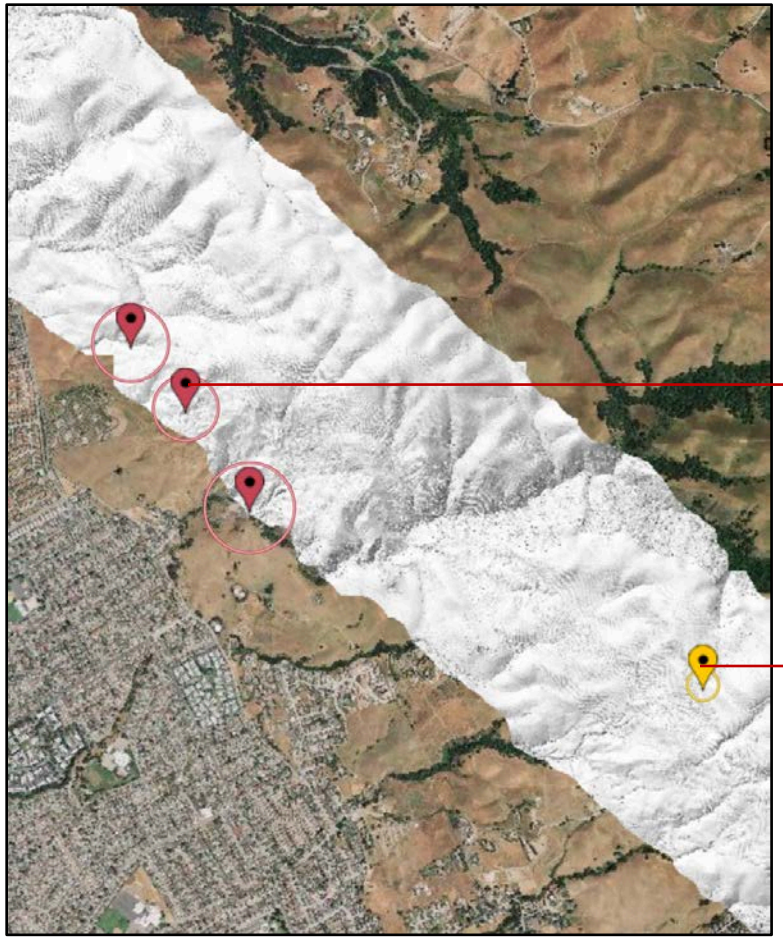
Meaningful Big Data Analysis



Raw change detection – not operationally useful



Automated anomaly detection – operationally useful

Landslide Detection

New Structure Detection

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Lesson 5: Data Visualization

- Problem
  - Big data analytics supports, not supplants, people
  - Gas ops teams work in ArcGIS
  - Also have non-Arc users that need to see results
  - Data scientists abstract geospatial data away from GIS

- Lesson: Ensure big data results are easily accessible to everyone
  - Big data methods must accept your GIS as input
  - Arc Users: Big data outputs must integrate seamlessly with current workflow
  - Non-Arc Users: need intuitive, 4D data visualization tool

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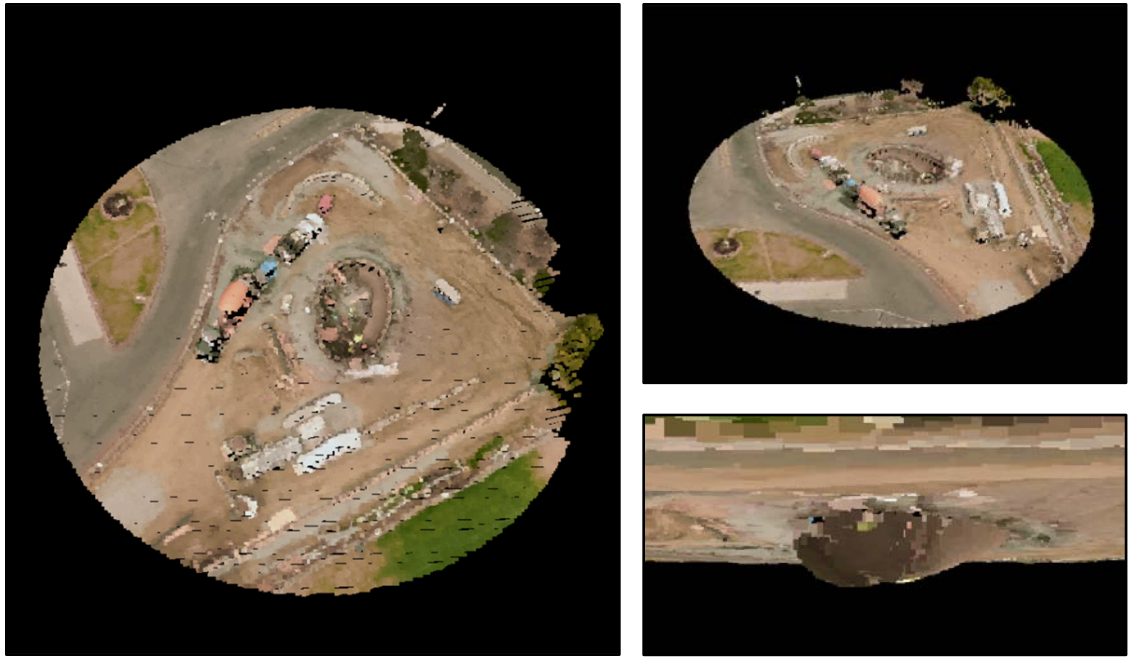
3D Data Visualization

Excavation near pipeline ROW – Top View



Views of same excavation in an interactive, 3D data viewer

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