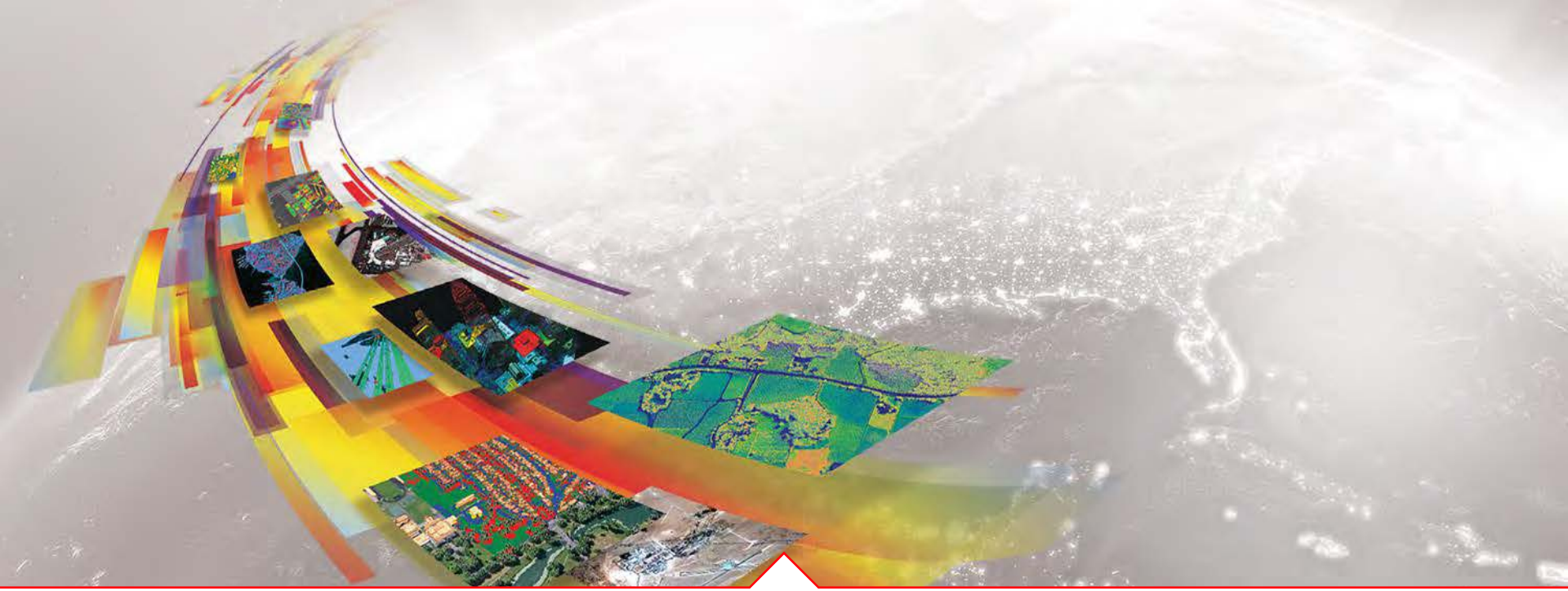


L3HARRIS™

REMOTE SENSING SOLUTIONS FOR UTILITIES AND CRITICAL INFRASTRUCTURES

Leveraging Imagery to automate Asset Management and Planning

September 26th, 2019

JAMES SLATER | Channel Manager EMEA
NICOLAI HOLZER | Sales Engineer EMEA

Agenda

L3Harris / Geospatial

Company Presentation and Value Proposition

Remote Sensing Solutions for Utilities

Challenges, Drivers and Applications

L3Harris Technology Solutions

Conclusion

Summary and Demo

L3Harris / Geospatial

Company Presentation and Value Proposition

L3Harris – Committed to Excellence

L3HARRIS™

L3Harris Technologies is an agile global aerospace and defense technology innovator, delivering end-to-end solutions that meet customers' mission-critical needs.

~400 LOCATIONS

CUSTOMERS IN ~130 COUNTRIES

~50K EMPLOYEES

~20K ENGINEERS

Integrated Mission Systems

$4.9B

Leading technology integrator to U.S. and international militaries for Intelligence, Surveillance and Reconnaissance, airborne and maritime platforms

Space & Airborne Systems

$4.0B

Mission solutions for space and airborne domain with defense, intelligence and commercial applications

Communication Systems

$3.8B

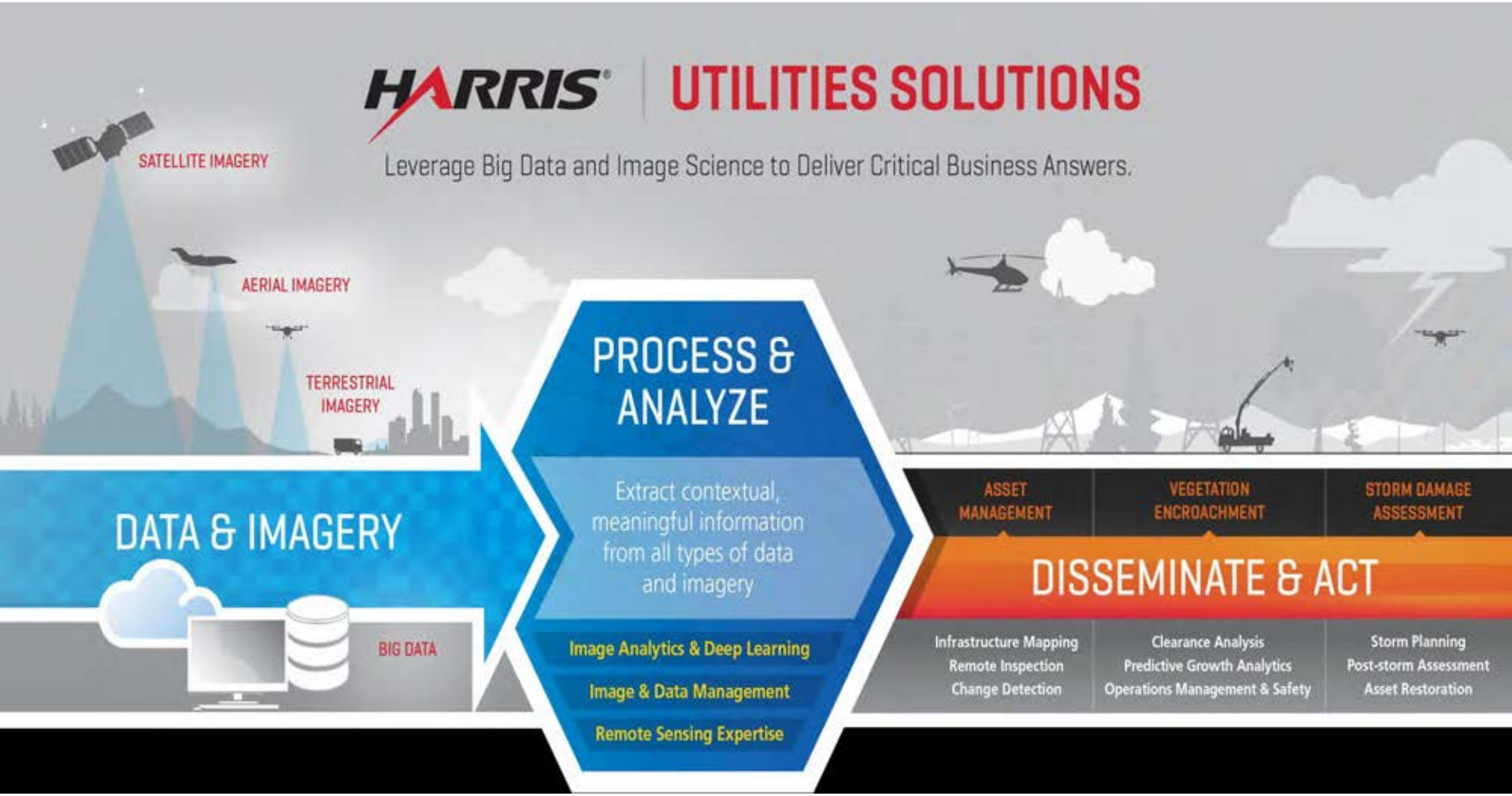
Ground and airborne communications and network systems for U.S./International militaries, and commercial customers

Aviation Systems

$3.8B

Commercial and military aviation solutions, systems, networks and pilot training

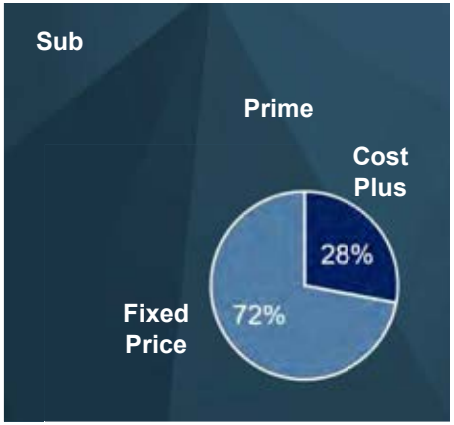
L3Harris Geospatial Utilities Solutions



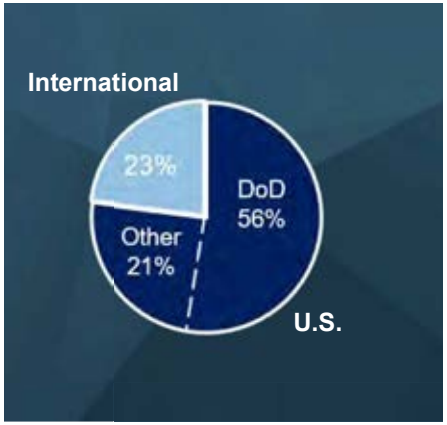
L3Harris Value Proposition for Utilities

- Large, stable, U.S. based company with a solid balance sheet
- Trusted vendor to U.S./European Governments with track record for delivering complex projects with high security.
- Recognized as industry leader in image science. Years of success in defense/intelligence with >30 years of experience in the remote sensing.
- Ability to integrate core analytic and data management into existing operational systems.

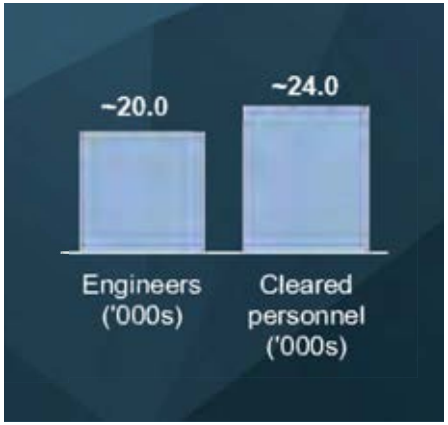
Diversified business mix[1]



Strong customer relationships[1]



Talent and culture of innovation



Global scale in ~130 countries

1 CY18 financials. 2 EBIT excluding discontinued operations is defined as net income plus interest expense and income taxes. 3 Net cash from continued operations less net capex

Remote Sensing Solutions for Utilities

Challenges, Drivers and Applications

Challenges and Drivers in Utilities

Challenges

- With ever tightening margins, there are needs in optimizing costs, improving safety, and ensuring reliability and customer satisfaction.
- Inspecting and maintaining infrastructure with traditional methods is a time consuming and dangerous task
- Comprehensive picture of as-built infrastructure and current state of equipment is often unknown, despite increasingly consuming remotely sensed data
- Often separate, disparate systems and company records, with the need to establish a centralized data management system
- Unmanned Aircraft Systems (UAS) are still maturing and regulatory uncertainty remains, but policies and technology standards are gradually taking shape

Drivers

- Remote sensing technology combined with geospatial analytics is becoming a safe, accurate, and low-cost approach that can provide critical insights faster and more affordably then traditional inspections
  - Optimize Costs and Efficiency: Cost control / lower costs of inspections and vegetation management, aggregate data in central repository and workflows
  - Improve Safety: Improve overall safety of workers, reduce risks from changing network conditions that could impact the public
  - Maintain Reliability: Increase inspection intervals for less downtime and better awareness, avoid penalties, increase customer satisfaction

Asset Detection / Update / Conflation

Challenges

- Maintaining an accurate asset database, as actual construction often differs from the original design.
- Network record database may be registered to older, inaccurate base maps
- Consolidations and acquisitions create challenges in merging databases.

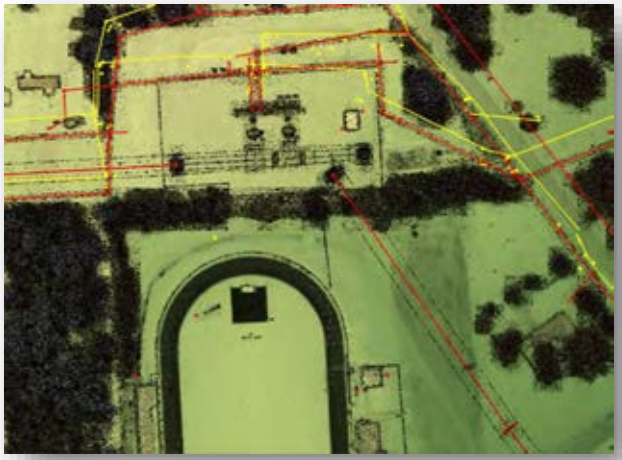
Solution

- Remotely sensed data collection (LiDAR, imagery) to identify current asset configurations (machine learning analytics) and to provide accurate location information
- Change analytics to identify where change has occurred. Conflation methods merging overlapping vector datasets to update and insert new records
- Flow results to downstream operational systems

Benefits

- Reduce costs by having a better asset register, making routine inspections, outage management, and break/fix work more efficient by knowing exactly what components are in place
- Increase reliability by understanding the current state of the network infrastructure, detecting anomalies more accurately and frequently, anticipate outages

Automatic component identification of transmission infrastructure with LiDAR, imagery, and machine learning analytics



Red linework indicates new improved asset locations after conflation

Asset Inspection Automation

Challenges

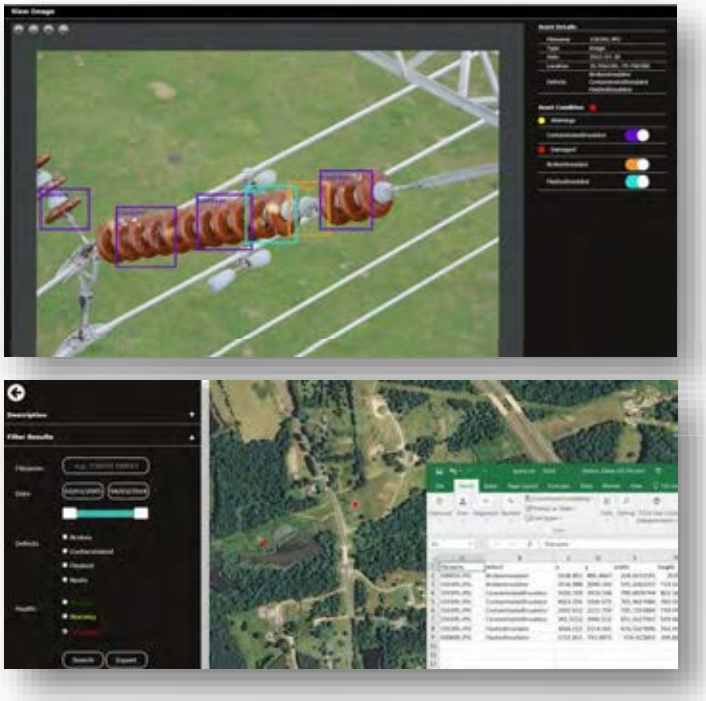
- Many inspections still performed only visually with helicopter or inspectors on the ground which are costly
- Field employees / pilots are put at risk during the inspection process
- Inspections occur infrequently based on regulation and results can vary by inspector

Solution

- Automated analysis of remote sensing data (LiDAR, imagery, thermal, etc.) to automate inspections
- Provide scalable data management tools for all types of input data
- Deliver accurate and timely analytics that assess infrastructure
- Flow results to downstream operational systems

Benefits

- Improve safety by reducing trips to the field, climbing
- Reduce costs by automating inspection operations with analytics (faster, more accurate, focused work management orders)
- Increase reliability by detecting anomalies more accurately and frequently, anticipate outages



Automatic defect identification of insulator with machine learning analytics applied to UAS imagery data

Vegetation Management / Risk Mitigation

Challenges

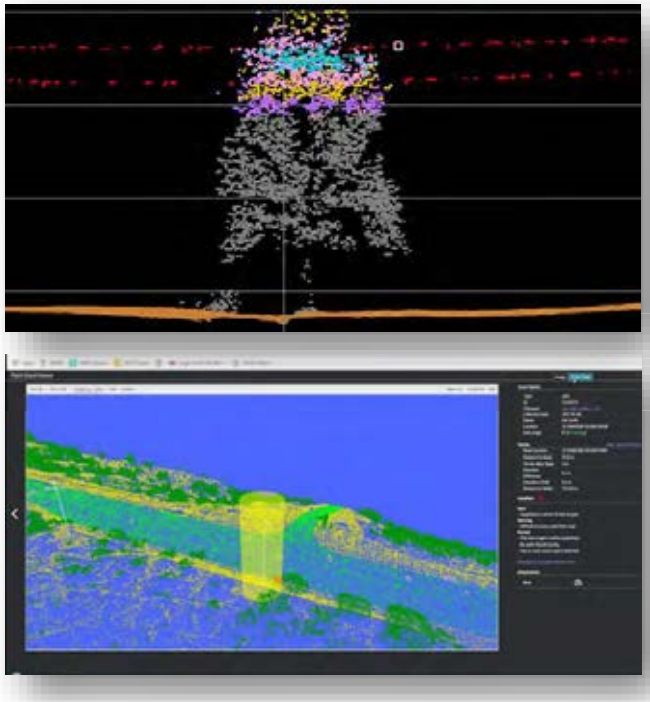
- Vegetation is a leading cause of power outages that impact system reliability as well as public and utility staff safety
- Vegetation management typically makes up the largest portion of annual T&D maintenance costs
- Utilities often use a fixed-time-based approach – regular schedule with routine inspection and cutting in pre-defined areas

Solution

- Remote sensing data collection (LiDAR, imagery, hyperspectral) to obtain accurate relationship of vegetation to network infrastructure
- Advanced analytics to automate current vegetation encroachment detection and anticipate future impacts
- Flow results to downstream operational systems

Benefits

- Move away from fixed-priced management strategy to a risk-informed, condition-based treatment cycle
- Improve utility measures across safety, reliability, and cost
- Impact customer satisfaction, reduce risk, meet regulatory requirements, and lower environmental impacts



Automatic detection of vegetation encroachment to conductor and to pole with specific area of encroachment identified (3m)

SAR Land Displacement Monitoring

Challenges

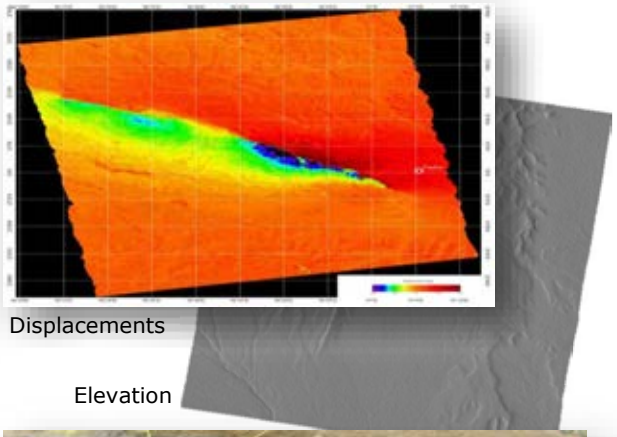
- Continuous structural health monitoring of critical assets (power plants, transformers, dams etc.) and linear infrastructures (transmission lines, pipelines, etc.)
- Prevent potential risks of structure failure as result of land displacements

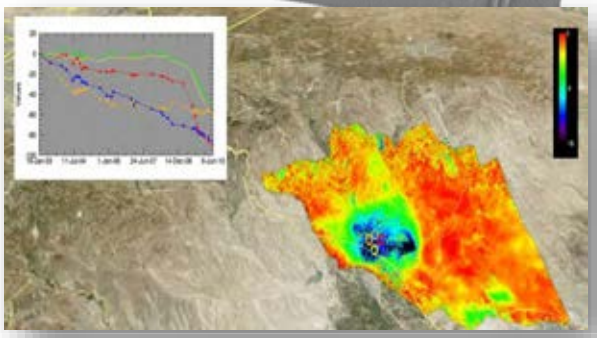
Solution

- Interferometric processing of remote sensing Synthetic Aperture Radar (SAR) data for analytical and operational land displacement and infrastructure monitoring
- Ad-hoc disaster land shift analysis and long-term multi-temporal displacement monitoring

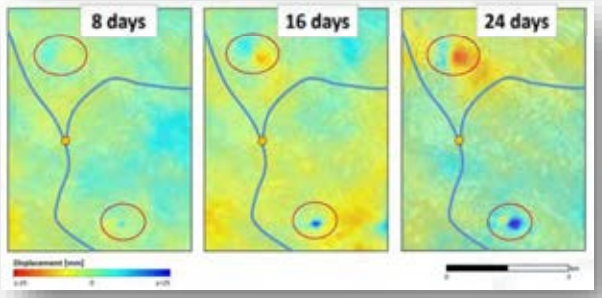
Benefits

- Obtain improved situational awareness of land displacement activities to keep assets structurally secure
- Reduce costs by remote data capture, achieve high density of information, precision and accuracy, an wide area coverage
- Increase reliability with continuous monitoring and alert areas where land is moving





Multi-temporal analysis of Displacements



Remote Sensing Solutions for Utilities

L3Harris Technology Solutions

Amplify – L3Harris Utilities Analytics Platform

End-to-end advanced asset data management solution for asset inspection and maintenance operations

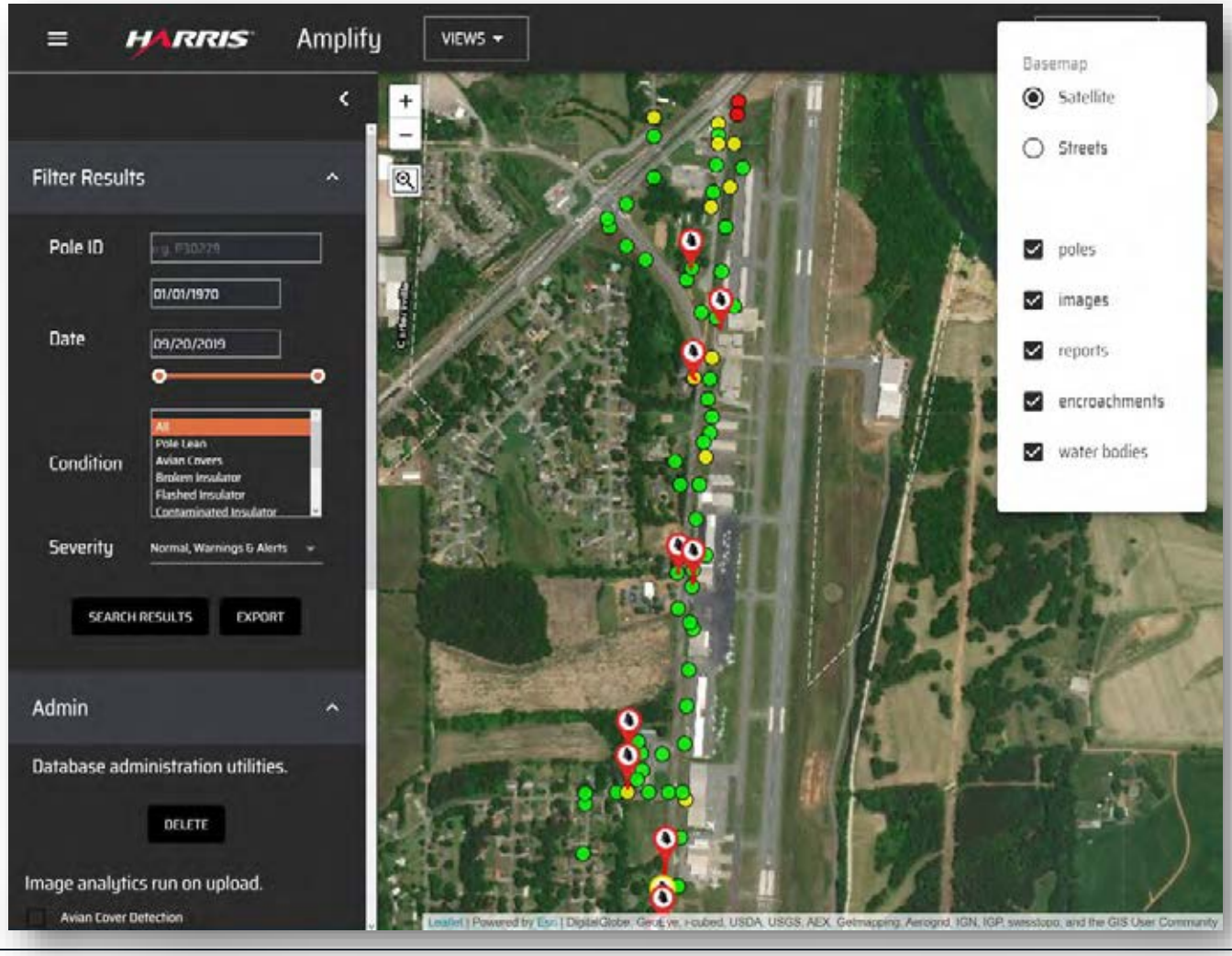
- Manages, processes, and analyzes geospatial imagery to automate, scale, and optimize asset management operations
- Integrates in operational systems (GIS, work management, asset management)

Amplify – T&D Utility Workflow Analytics

- Application
  - Remote sensing data management infrastructure integrated with machine learning technology to analyze utility T&D network assets
    - Data Management
    - Identifying/locating assets
    - Finding defects/damage/anomalies
    - Identifying vegetation encroachment/ clearance issues
    - Monitoring change over time
- Feature Summary
  - Simple dashboard of anomalies/defects per asset across all analyses
  - Automated algorithms to classify vegetation and determine distance and size of vegetation encroachment
  - Filters and search criteria to focus on issues of interest
  - Streamlined remote sensing data ingest, cataloging, and management
  - SaaS or on-premise deployment
  - Interactive system to train deep learning models

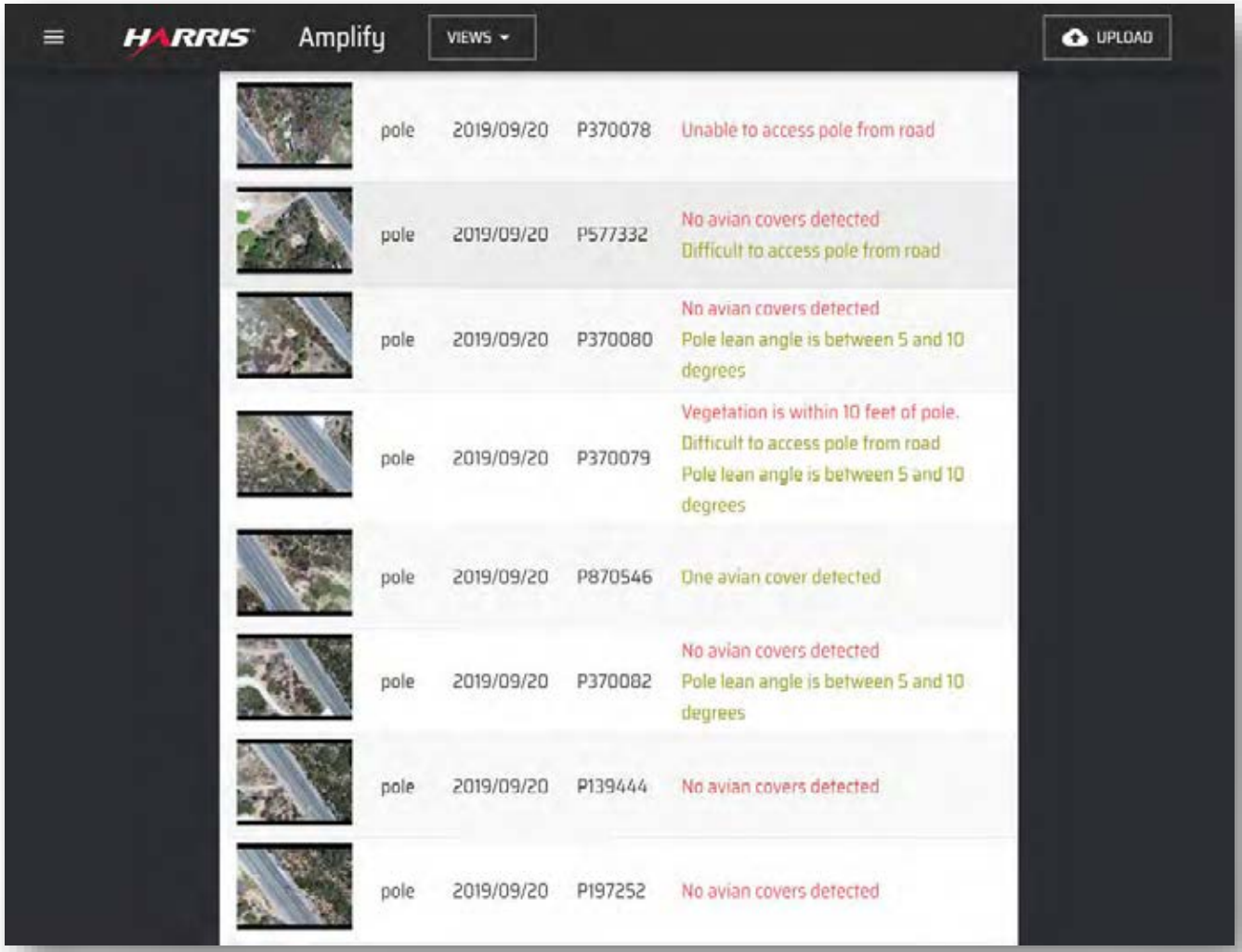
Amplify – Map View

- Real-time automated analyses based on a wide range of data types



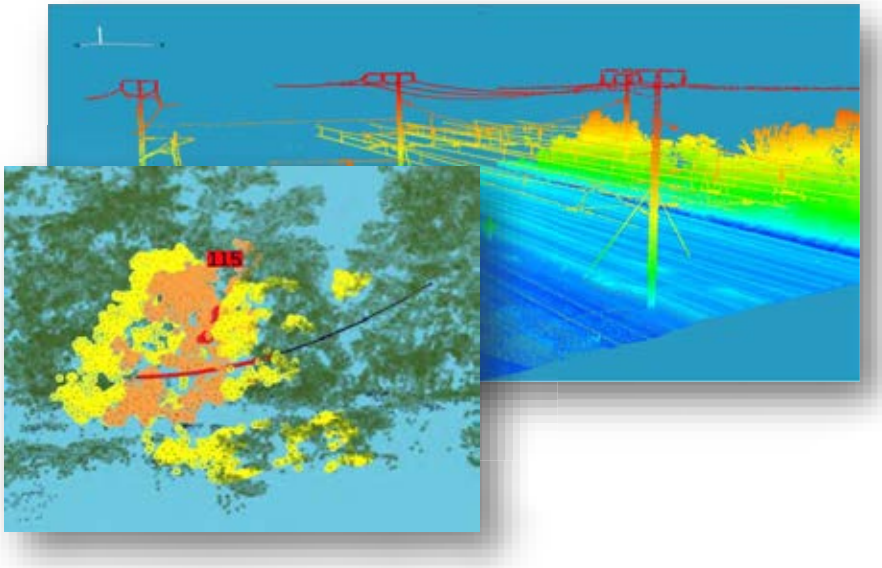
Amplify – Catalog View

- Generate inspection reports for remediate work orders



ENVI Imagery Analytics & Deep Learning

- ENVI - Market leading product in remote sensing analytics across many data types
  - Optical – Multispectral – Hyperspectral – Infrared – LiDAR – SAR
  - Examples
    - Vegetation identification from hyperspectral imagery
    - Locate and quantify vegetation encroaching close powerlines and poles
    - LiDAR feature extraction of utility assets

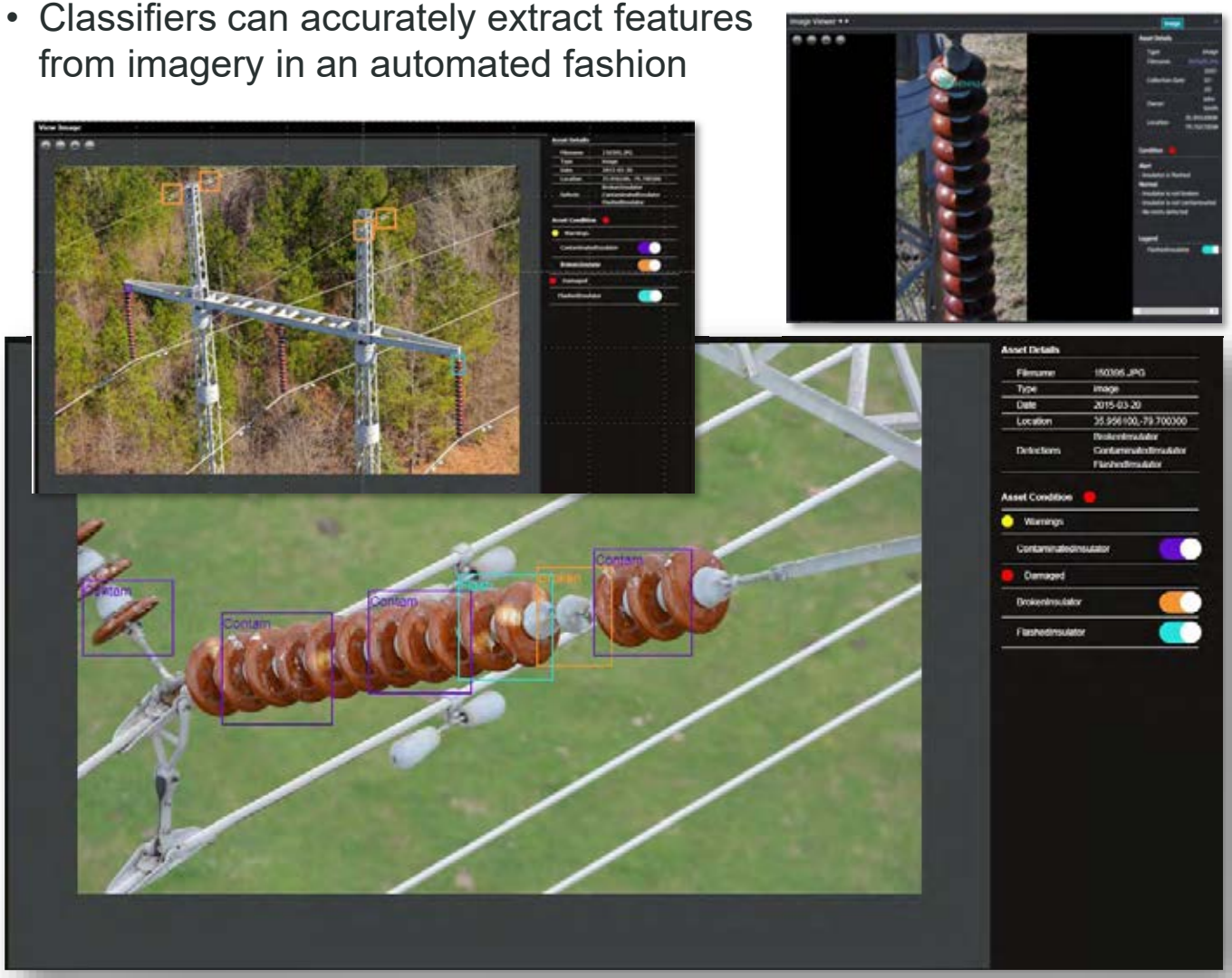


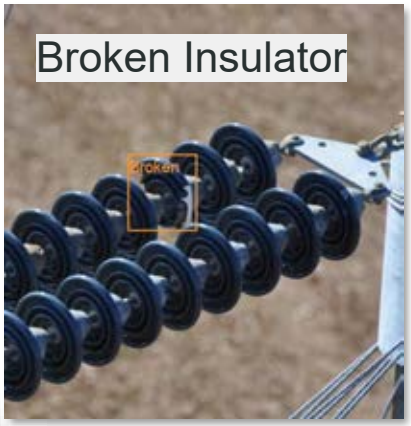
- State-of-the-art L3Harris-developed Deep Learning technology
  - Applied R&D to remote sensing and geospatial intelligence problems

  - Examples
    - Asset identification and location
    - Asset anomalies and defects
    - Change detection over time

Amplify Deep Learning Analytics - Examples

- Classifiers can accurately extract features from imagery in an automated fashion





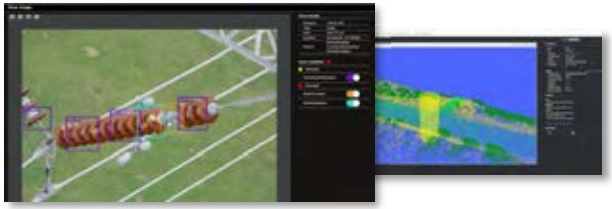
Amplify – Automatic Workflows

1. Collect and Ingest

- Collect data and upload in content management system
- Extract information from **all type of data modality**: optical, LiDAR, spectral (multi- / hyperspectral), SAR, infrared, thermal, etc.
- Ingest data and imagery from **all type of acquisition platforms**: UAV, helicopter, satellite, terrestrial, etc.
- Subscribe for **satellite based web monitoring services**

2. Process and Analyze

- **Image and Data Management**
  - Store, catalogue, search, discover and exploit the right data for critical insights
- **Image Analytics and Deep Learning:**
  - Asset location improvement and as-built update
  - Asset damage inspection and anomaly detection
  - Vegetation encroachment analysis
- **Infrastructure Monitoring**:
  - Satellite based macro-scale vegetation monitoring
  - SAR based land displacement monitoring
  - CCTV camera based real time weather monitoring



3. Disseminate and Act

- **Optimize Asset Management and Planning Operations**
  - Infrastructure mapping
  - Remote inspection
  - Change detection
- **Manage Vegetation Encroachment and Mitigate Risks**
  - Clearance analysis
  - Predictive growth analytics
  - Operations management & safety
- **Respond to a Weather Event / Damage Assessment**
  - Storm planning
  - Post-storm assessment
  - Asset restoration

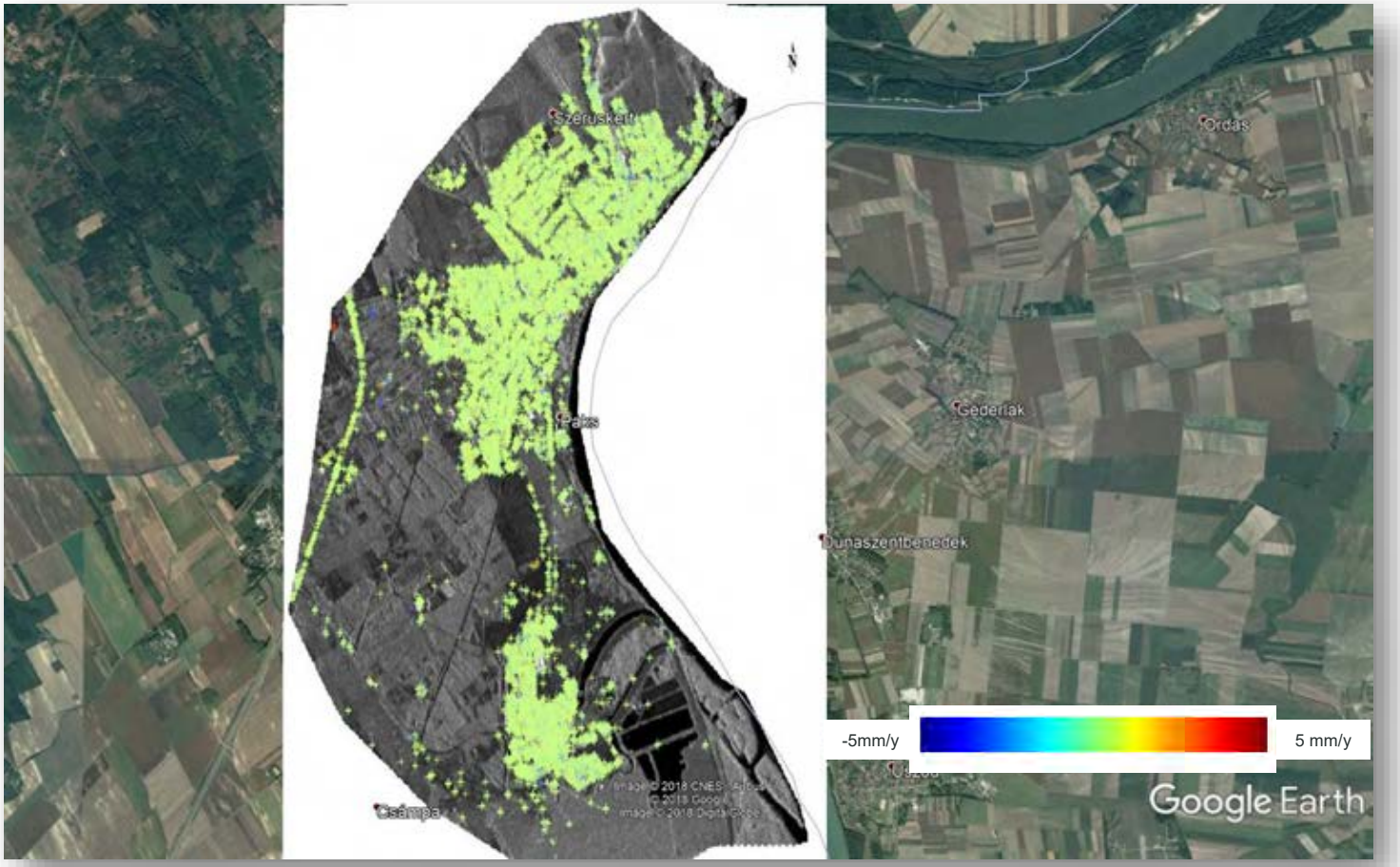
Satellite based Macro Scale Vegetation Monitoring along Linear Infrastructures

- Continuous automated vegetation hazard monitoring along linear infrastructures (rail, utilities or pipeline corridors)
  - Vegetation encroachment
  - Vegetation health
- Vegetation hazard workflow
  - Based on multi-temporal Sentinel-2 collects and ENVI's spectral analysis tools
  - Continually running to analyze anomalies and send alerts when a region has results of concern
- Cost effective approach to optimize preventative maintenance operations
  - Monitoring at a macro scale to then focus maintenance efforts on a micro level faster
  - Using time series analysis to validate the risk has been mitigated and the maintenance completed
  - UAV and maintenance teams can put together a tipping and cuing system to focus efforts

Source: "Utilizing free satellite imagery to focus maintenance efforts in rail corridors" using Sentinel-2 imagery:
https://www.harrisgeospatial.com/Learn/Blogs/Blog-Details/ArtMID/10198/ArticleID/23544/Utilizing-free-satellite-imagery-to-focus-maintenance-efforts-in-rail-corridors

Land Displacement – Nuclear Power Plant

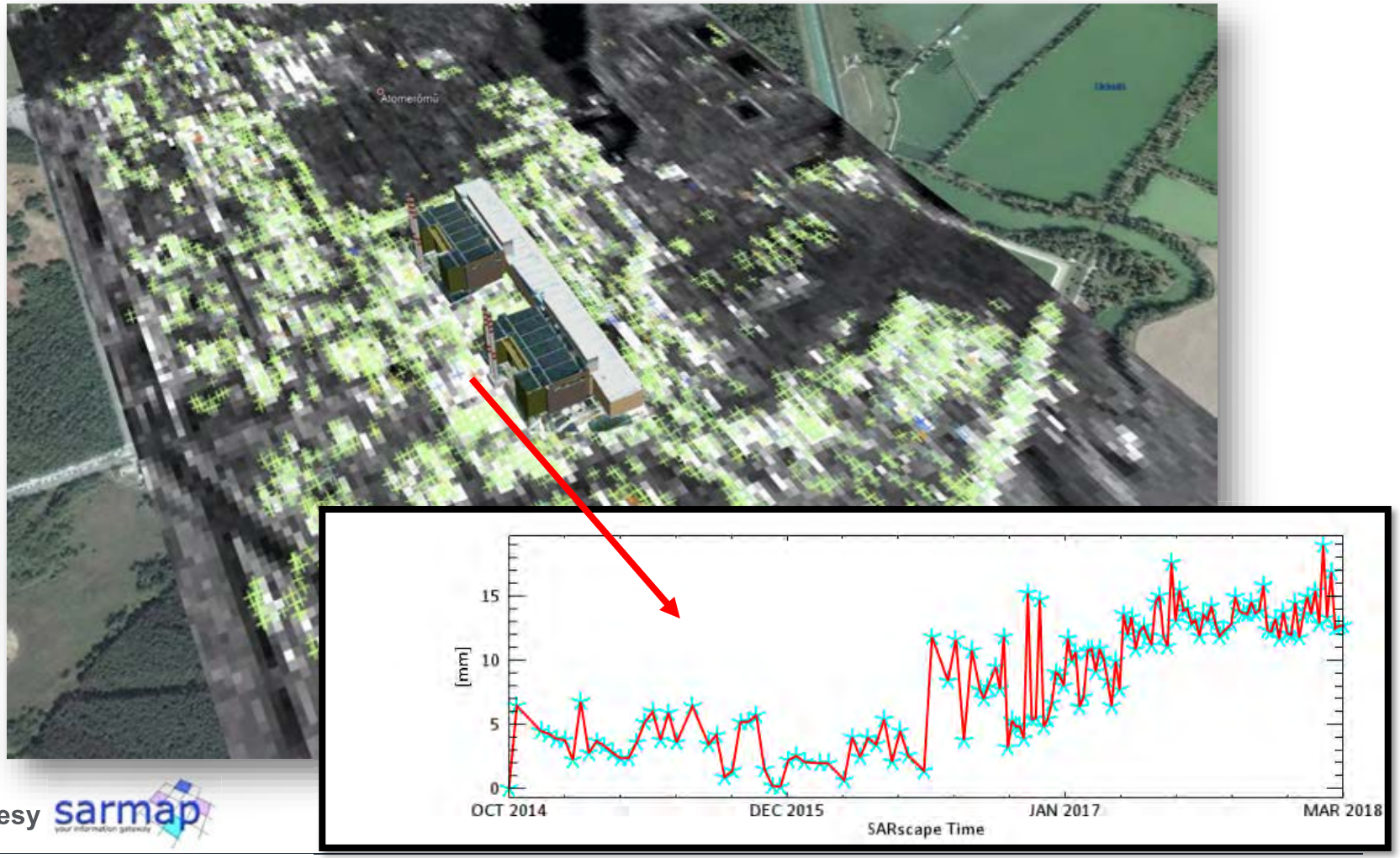
- Persistent Scatterers: determine displacements from time series of Sentinel-1.



Data courtesy sarmap

Land Displacement – Nuclear Power Plant

- Sentinel-1 time series analysis indicates land uplift at nuclear plant site.

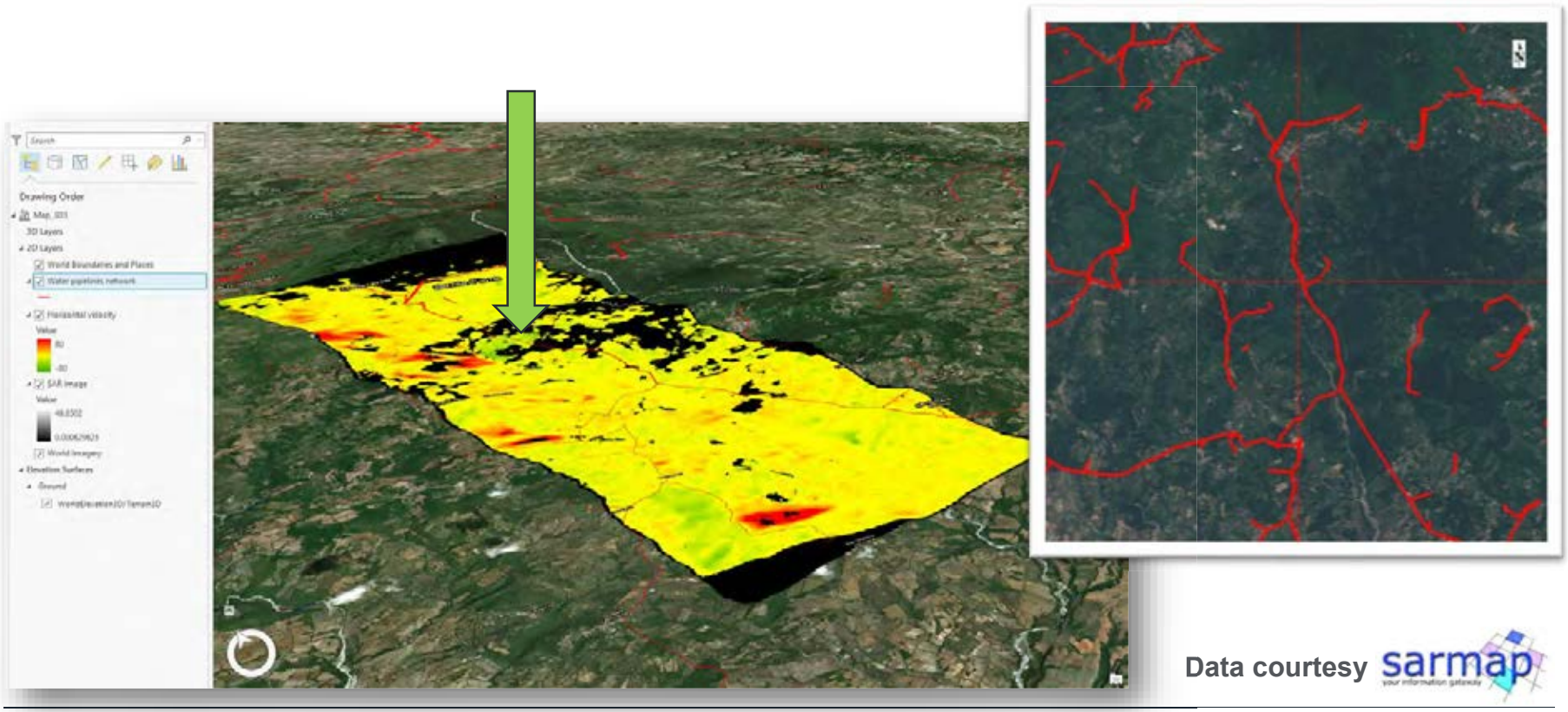


Data courtesy sarmap

Land Displacement – Pipeline Monitoring

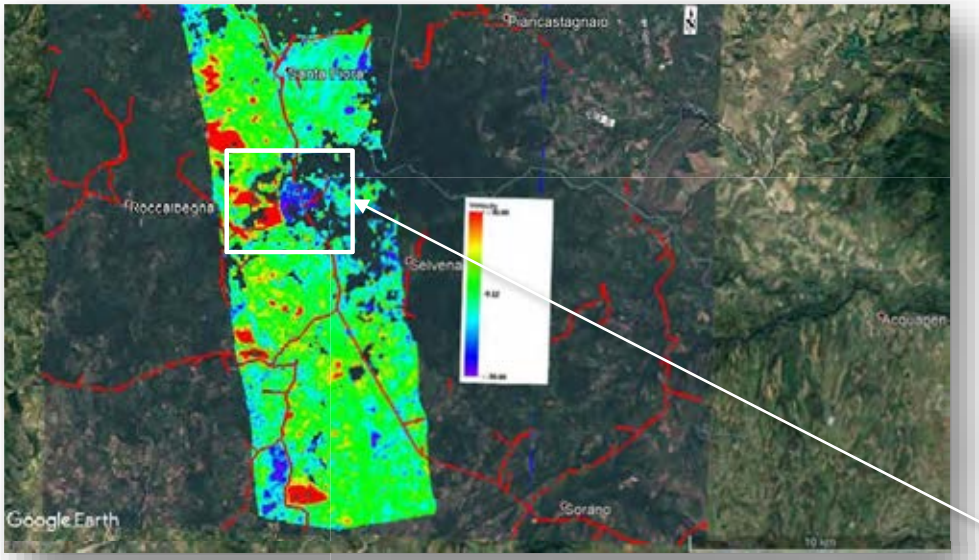
Identify interaction between landslides and pipelines based on SAR analysis (Toscana, Italy)

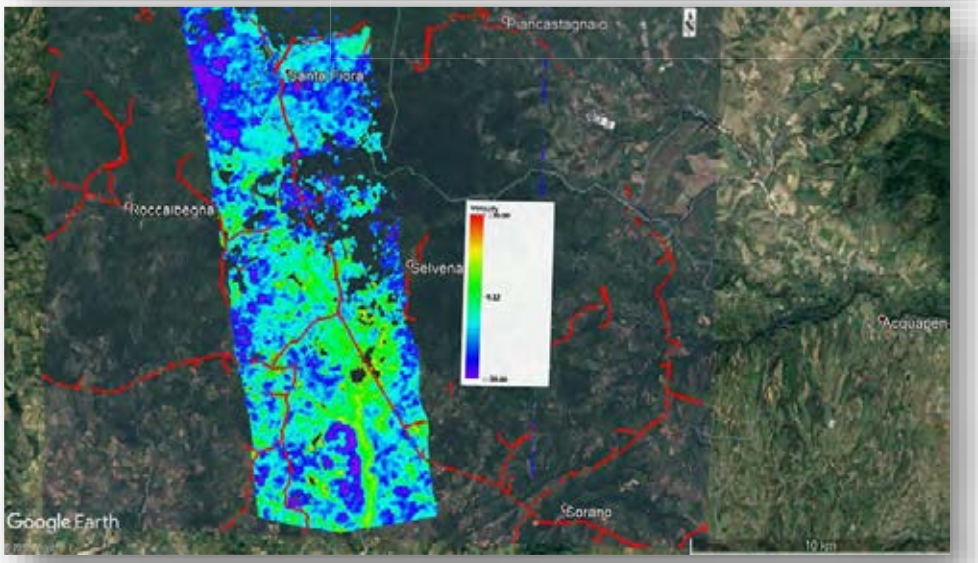
- >270 SAR Sentinel-1 images, revisit time 6 days, ascending and descending (October 2014 – March 2018)



Data courtesy sarmap

Land Displacement – Pipeline Monitoring





Map of average displacement

(Scale: +/- 30 [mm / y])

- Horizontal (east-west direction) – Slope movements
  - Positive values (red) correspond to an eastward shift
  - Negative values (blue) correspond to a westward shift

Active landslide event in the center of the image that overlaps with critical infrastructure

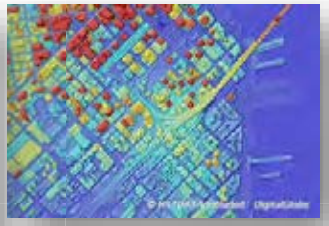
- Vertical (up-down) – Subsidence
  - Positive values (red) correspond to an upward shift
  - Negative values (blue) correspond to a downward shift

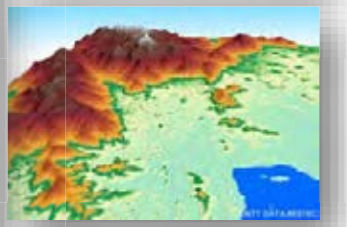
Data courtesy sarmap

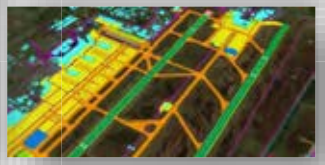
L3Harris Geospatial Data & Imagery

L3Harris Geospatial Marketplace

L3Harris offers a large selection of geospatial products worldwide including satellite imagery, aerial maps, digital elevation model (DEM) data, vector and lidar data, topographic maps, and more.

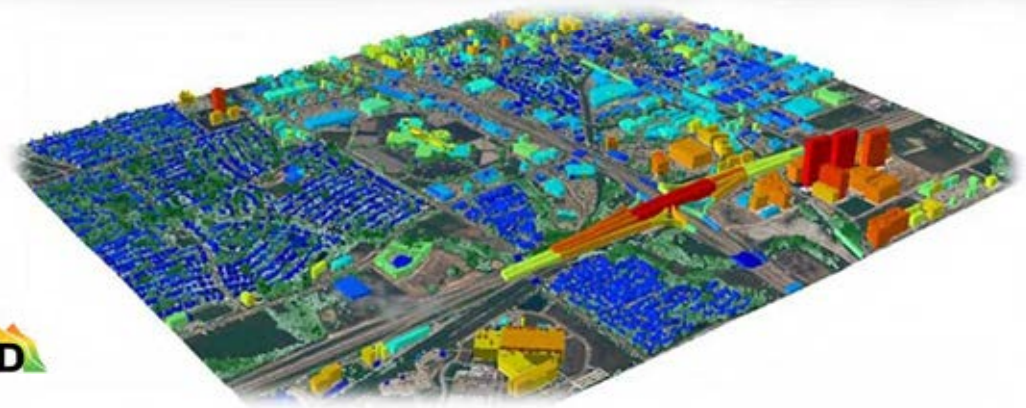






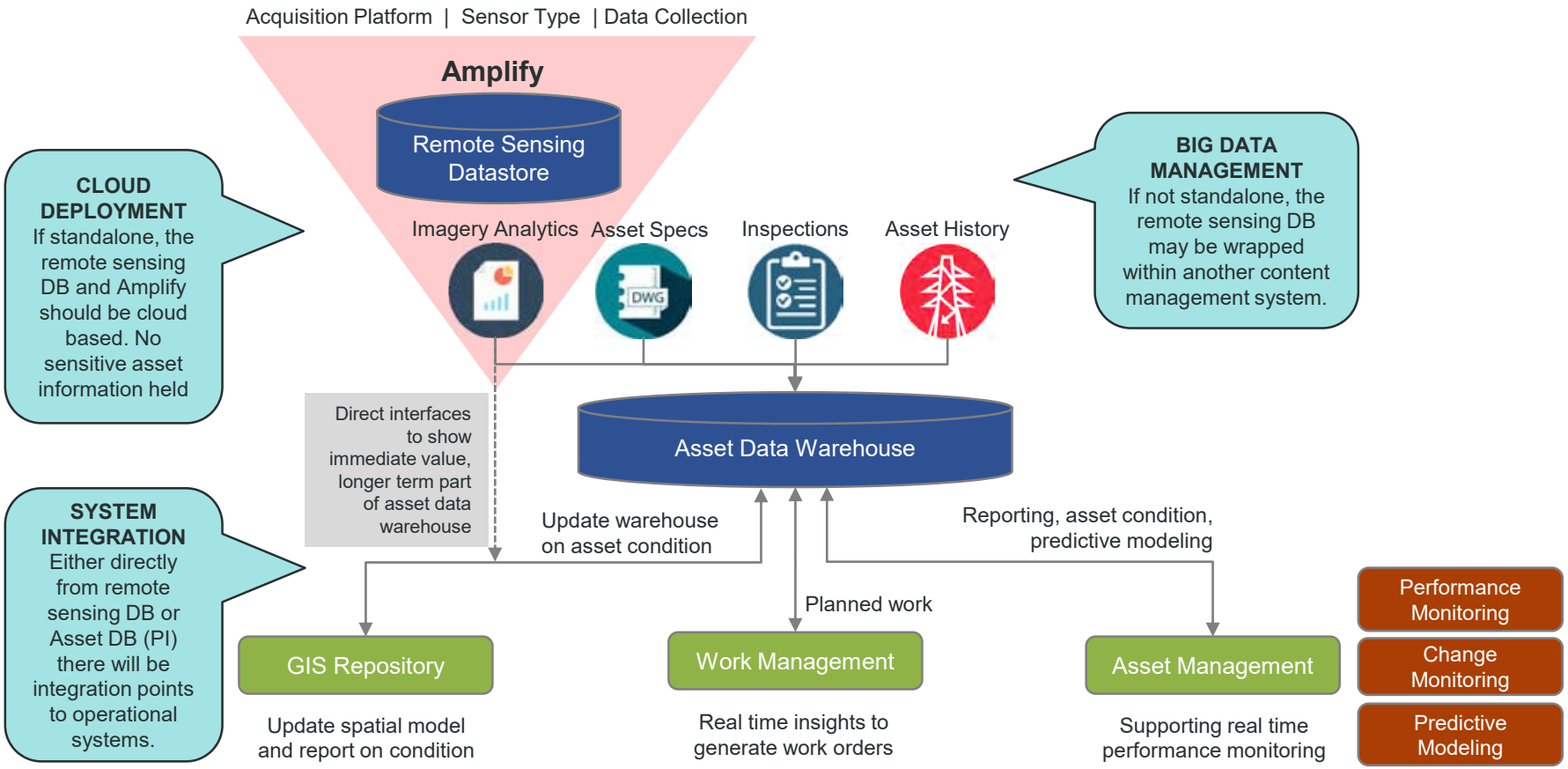
Geospatial services

Creation of custom solutions for highly automated information extraction supported by a broad portfolio of professional software technologies and knowledge transfer.



DigitalGlobe
A MAXAR COMPANY
AIRBUS
planet.
AW3D

Amplify – Integration with Utility Operations



Conclusion

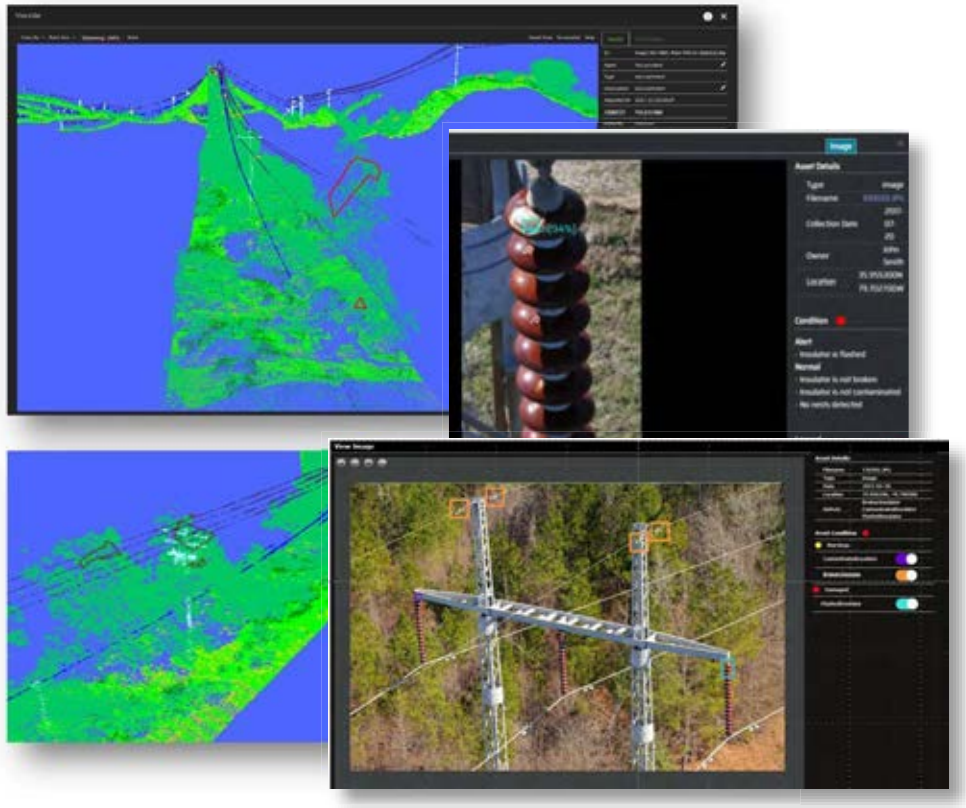
Summary and Demo

Amplify – Summary / Value Proposition

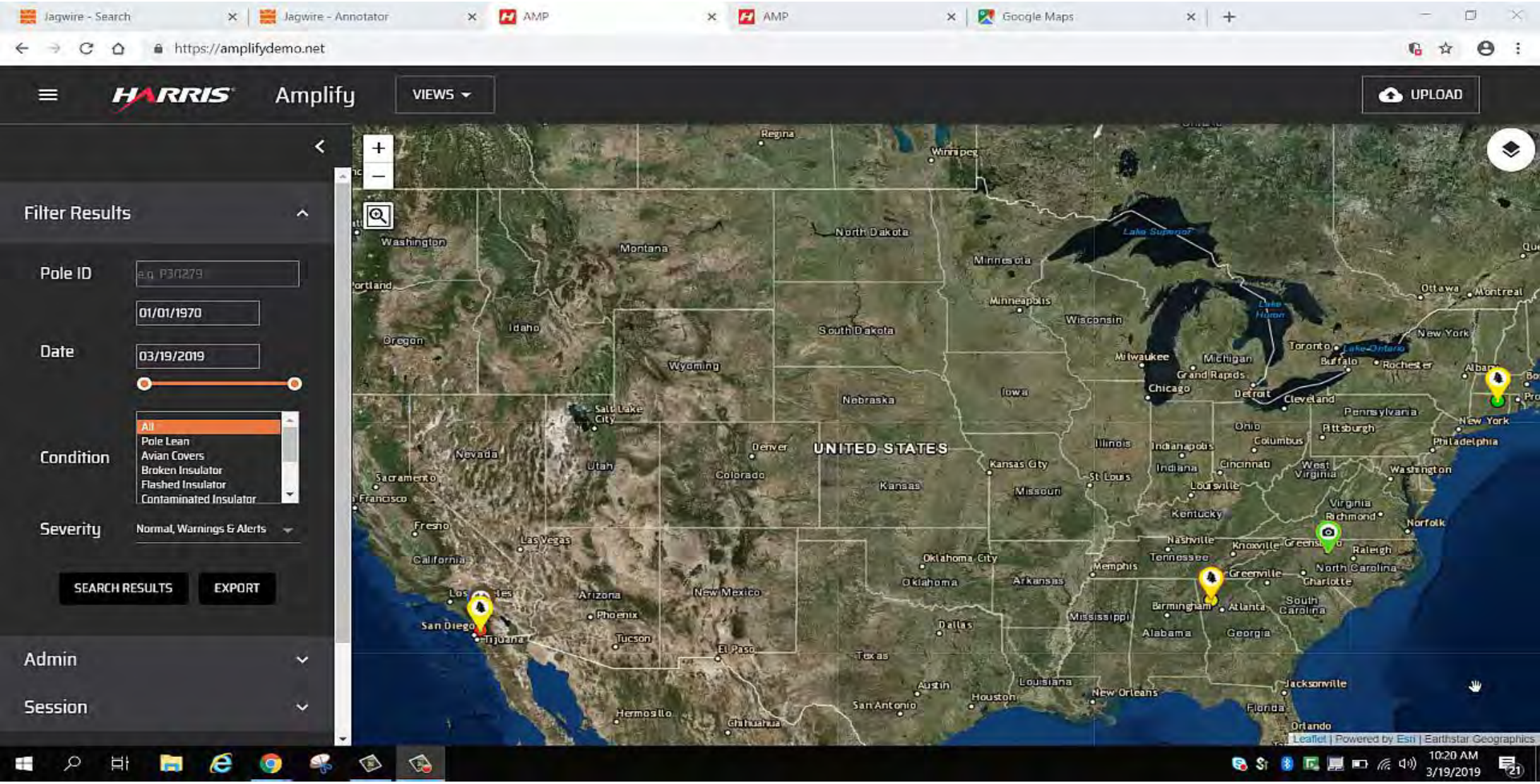
- Significant potential in the use of remote sensing data and analytics to automate utility asset management operations
  - Make utilities inspections more efficient and safer
- Key applications
  - Remote sensing data management
  - Asset detection / inventory as-built update
  - Asset location improvement (conflation)
  - Asset inspection automation
  - Vegetation management
  - Land Displacement Monitoring
  - Pre/post disaster management
- Operational considerations
  - Data collection methodology
  - Machine learning models
  - Data management and archive for access and change monitoring
  - Systems integration – GIS, asset management, and performance monitoring

KEY BENEFITS OF AMPLIFY

- OPTIMIZE COSTS
- ENSURE RELIABILITY
- IMPROVE SAFETY
- CUSTOMER SATISFACTION



Demo Amplify



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