Mechanizing Industrial Asset Inspections and Integrity Assessments

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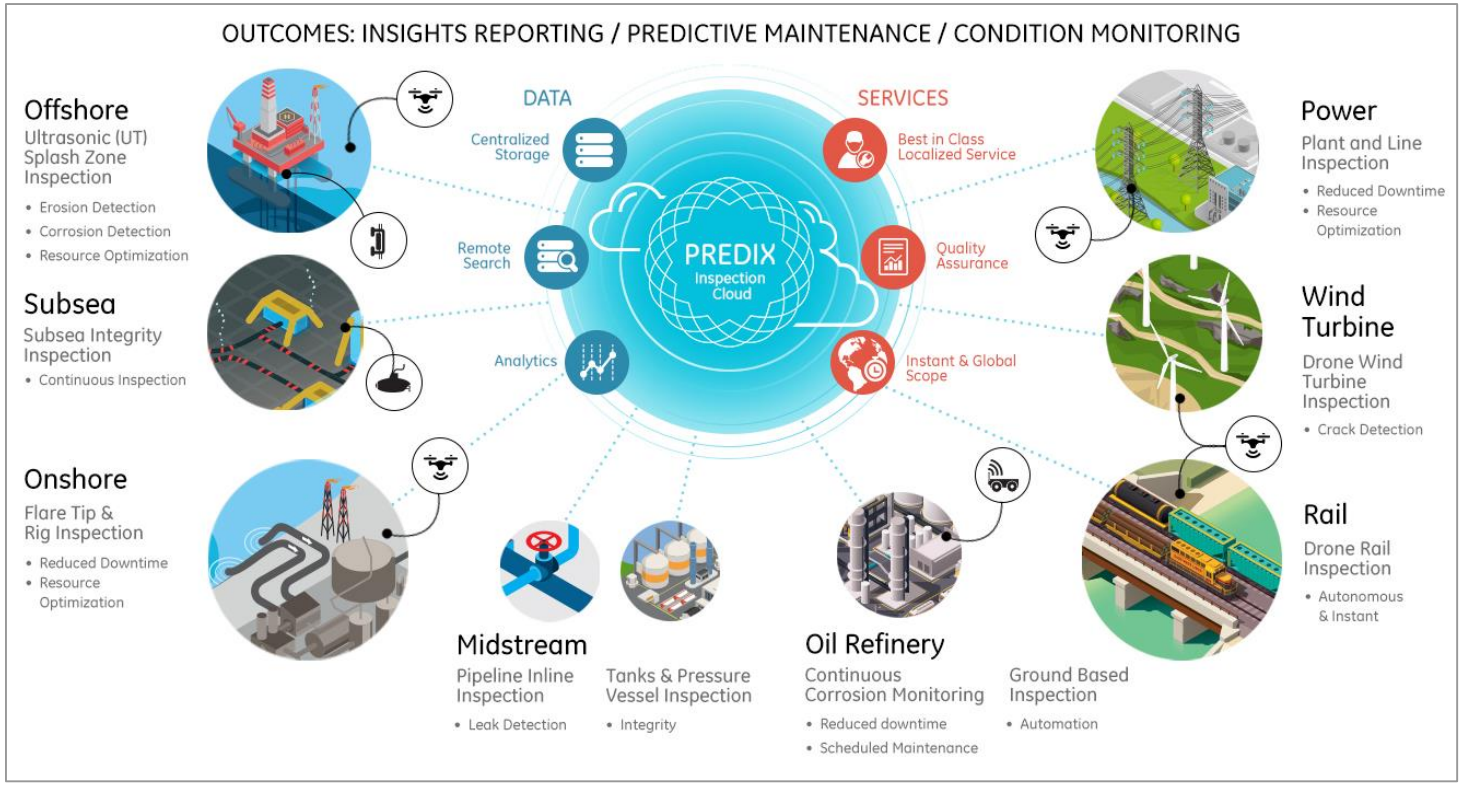
Avitas Systems
a GE venture

Managing outcomes with multi-sensor source data integration and inspection capabilities

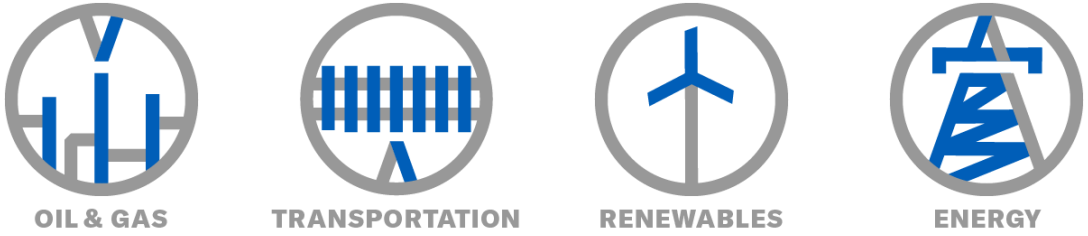
THE FUTURE OF INSPECTION: CROSS-INDUSTRY ANALYTICS PLATFORM



WHAT IS NEEDED?

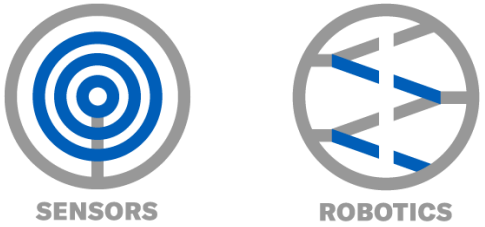
- Domain expertise
- Technical expertise
  - > Sensors
  - > Analytics
  - > Robotics and automation
  - > Software development and systems design
- Delivery and process expertise
- Customer and market focus

Mechanized inspections can drive value across industries



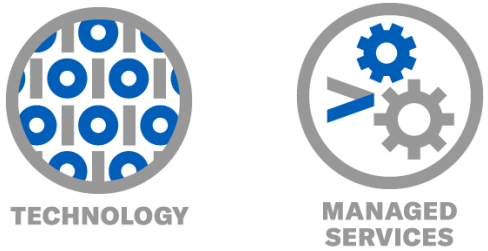
> Decrease facility inspection costs up to 25% annually
> Increased equipment uptime up to 10-15% with optimized Capex replacement schedules
> Increased human safety

HARDWARE



SOFTWARE

DELIVERY



Automating and augmenting manual inspection processes

AUTONOMY & ROBOTICS

UAVs for remote vision, IR, and fugitive methane detection

Robotic crawlers for UT

Autonomous underwater vehicles

HANDHELD & INSTALLED SENSORS

GE's connected advanced inspection tools

Persistent corrosion monitoring via installed sensors

Remote visual and infrared aerial inspection

A SAFER, MORE EFFICIENT APPROACH TO ASSET INSPECTION

Current inspection approach

> Camera/video mounted on helicopter
> Rope access
> Scaffold
> Crane and man baskets

TECHNOLOGY

> Safer operation; eliminates dull, dirty, dangerous tasks
> Controlled flight and inspection plan
> Better visibility, more thorough asset inspection
> Higher quality data with the ability to mount RGB and IR cameras
> Faster, more reliable process

SOFTWARE

> Real-time data analysis
> Repeatable process for longitudinal and autonomous data collection
> Risk-based strategy (vs time-based)
> Cloud-based storage and reporting

BENEFITS

> Increase inspection safety
> More efficient, higher quality inspections with more comprehensive data collection
> Reduce manual inspection labor
> Decrease in inspection costs

Fugitive emissions inspection

COST-EFFICIENT SOLUTION FOR IDENTIFYING LARGE AND SMALL FUGITIVE EMISSIONS

Current inspection approach

> Intermittent, labor intensive, and time consuming inspection without leak rate or volume
> Today's detection technologies are either sensitive or cheap, but not both

TECHNOLOGY

> Reduced inspection time (when compared with currently used OGI practices)
> Enhanced data quality; provides both qualitative and quantitative analysis of leakage
> Increased sensitivity for identification of small-scale leakage

SOFTWARE

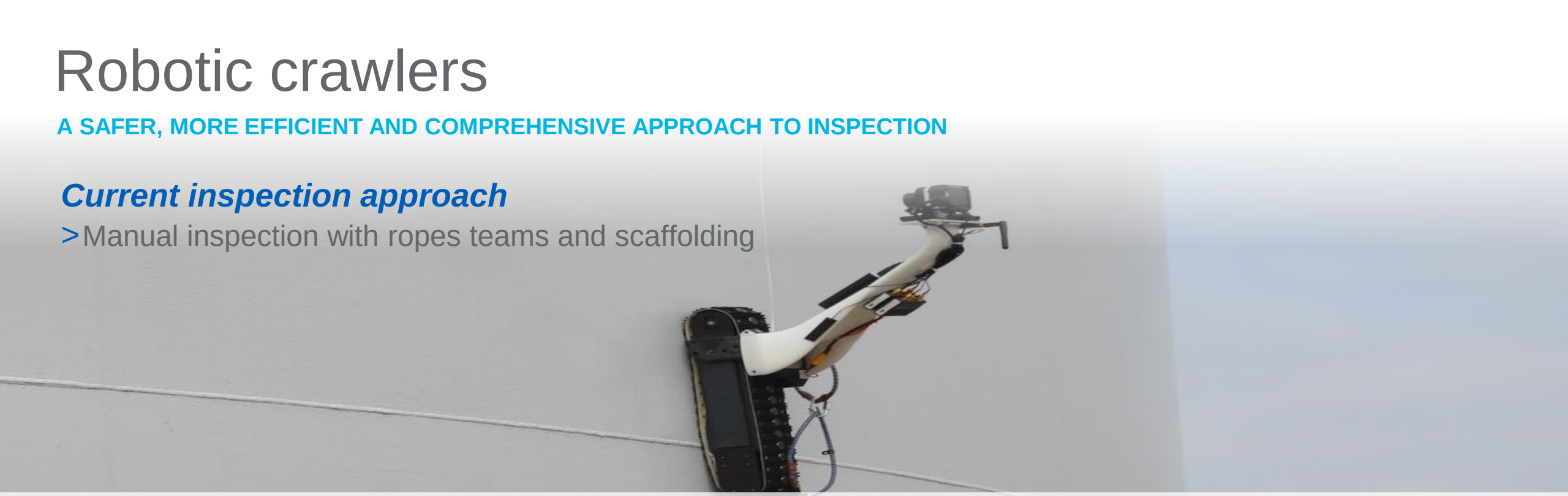
> Autonomous inspections
> Automated, customizable reporting and uploading to cloud-connected database

BENEFITS

> Reduced cost per inspection/site
> Reduced time per inspection/site
> Reactive leak mitigation strategy

Robotic crawlers

A SAFER, MORE EFFICIENT AND COMPREHENSIVE APPROACH TO INSPECTION



Current inspection approach

> Manual inspection with ropes teams and scaffolding

TECHNOLOGY

> Safer operation
> Controlled, precise, repeatable inspection plan
> Better visibility, more consistent and thorough asset inspection
> Higher quality data with the ability to mount RGB and IR cameras, stereo, structured light, PEC and UT
> Faster, more reliable process

SOFTWARE

> Real-time data analysis
> Repeatable process for longitudinal and autonomous data collection
> Risk-based strategy (vs time-based)
> Cloud-based storage and reporting

BENEFITS

> Increase inspection safety
> More efficient, higher quality inspections with more comprehensive data collection
> Reduction in manual inspection labor
> Decrease in inspection costs

Subsea inspection

INCREASING DATA QUALITY WHILE REDUCING COSTS

Current inspection approach

> Work class ROVs with high cost 10 man crew and support vessel
> Inspections are slow with manual navigation and tether restrictions
> Data quantity is low (e.g., annually) and quality can be limited

TECHNOLOGY

> Autonomous underwater vehicles
> Precision navigation to points of interest
> 3D field models and topographical mapping
> Laser and high definition imaging
> Host of NDE instruments
> Localization, collision avoidance and auto defect recognition

SOFTWARE

> 3D and topological data fusion with direct and indirect associated signatures
> Object perception and classification for significance
> Probability map and statistics for identifying areas to explore based on supporting sensor info

BENEFITS

> Increase the quality and quantity of actionable inspection data to enable better operational decisions
> Reduce the operational costs for performing subsea inspections
> Reduce the non-productive time of subsea operations
> Extend the life of subsea assets

Sensor mesh networks for continuous VOC monitoring

COST EFFECTIVE CONTINUOUS QUANTITATIVE MONITORING VS. INTERMITTENT QUALITATIVE INSPECTION

Current inspection approach

- Man + pickup + OGI device
- Qualitative output
- Manual review and reporting
- Intermittent

TECHNOLOGY

- 24/7 self contained and self powering
- Ruggedized and intrinsically safe
- PPM sensitivity
- Multispecies sensing… C1 – C4
- Multi-nodal distributed network
- Cost competitive to semiannual inspection

SOFTWARE

- Cloud-based leak source localization
- Mobile-enabled leak notification and analysis
- Leak rate calculation
- Cloud-based storage and automated reporting
- Advanced sampling automation

BENEFITS

- Scalable to large dispersed operations
- Simple upkeep and maintenance
- Risk-based strategy (vs time-based)
- Safer operation; less miles driven by personnel to remote locations

Predictive corrosion management

REAL-TIME, CONTINUOUS VISIBILITY OF THERMAL AND THICKNESS INSPECTIONS

Current inspection approach

> Expensive operation
> Scaffolding required on semi-permanent basis
> Insulation removal is a MOC
> Impact on population in vicinity

TECHNOLOGY

> RightTrax installed UT sensors; collect corrosion and temperature data
> Repeatable, accurate corrosion measurement
> Reduce manual corrosion-based inspection labor
> Designed for safety; ATEX certified

SOFTWARE

> Repeatable, accurate corrosion measurement
> Continuous data across multiple inspection points
> Trend and predict failures and schedule maintenance

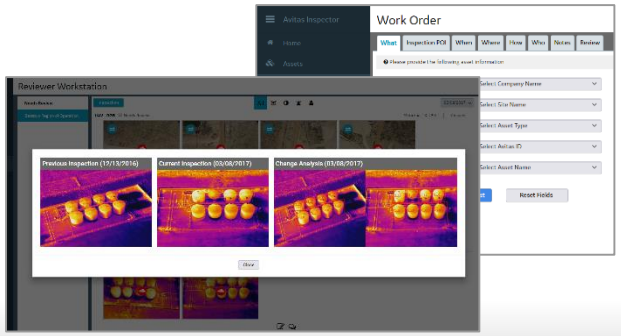
BENEFITS

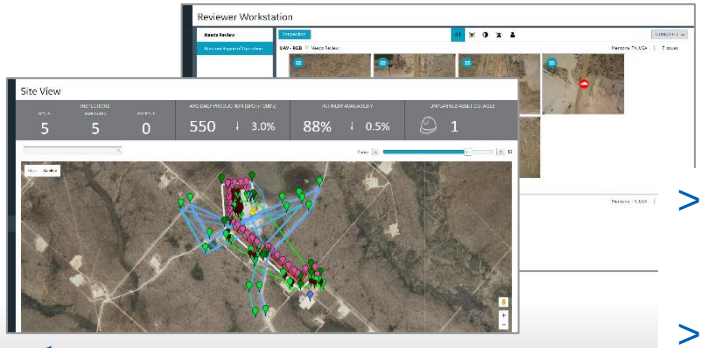
> Conduct inspections in-service vs. shut down
> Eliminate or reduce manual inspection labor
> Eliminate costly scaffolding, rigging, and insulation removal

The Avitas Systems solution

WORKFLOW MANAGEMENT

> Risk-based inspection and maintenance workflow optimization





INTERACTIVE DASHBOARDS

> Synthesized operations, maintenance, and inspection data

> Alerts and live, interpreted results

DATA FUSION

Store and structure
Normalization
Integration with APM

PREDIX

RISK-BASED ANALYTICS

Predictive analytics
Automated defect recognition

AUTONOMY AND ROBOTICS

Aerial

Surface

Subsea

AUTOMATED INSPECTION AND SENSOR ANALYTICS

Ultrasonic

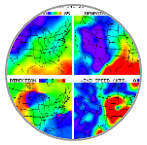
Persistent corrosion monitors

Fugitive emissions

NATIVE SYSTEMS

Operational systems

EXISTING DATA SOURCES



Environmental data

Inspection planning maturity curve

Time-based
Base maturity

- Common current method of operations
- Limited to no digitization
- Reactive with no analytics

Usage-based
Maturity level I

- Common current method of operations
- Digitization of business data
- Reactive with simple analytics

Condition-based
Maturity level II

- Desired method of operation
- Digitization of business and operations data
- Pro-active with advanced analytics

Risk-based
Maturity level III

- Target method of operation
- Complete digitization, including risk strategy
- Strategic, with advanced analytics

INDUSTRIAL IOT KILLER USE CASE:

Automating inspections data collection and embedding intelligent decision support systems for managing risk and optimizing inspection resources

Avitas Systems Industrial Image Analytics at Scale

Generic algorithms

A library of common methods that can be used as part of a workbench to fine-tune a customer-specific deployment

> Parameterized solutions
> Horizontal capabilities such as intelligent change analysis, subcomponent/region identification, and intelligent searches

Customer workbench

Toolkit to be used by a group of Image Analysts/Setup Engineers to perfect algorithms

> Rapid training using tools and documented methodology
> Test, evaluation, and deployment of new models

Image repository

Create repository of tagged images

> Image Net for industrial images
> Meta-data standards
> Predix-based

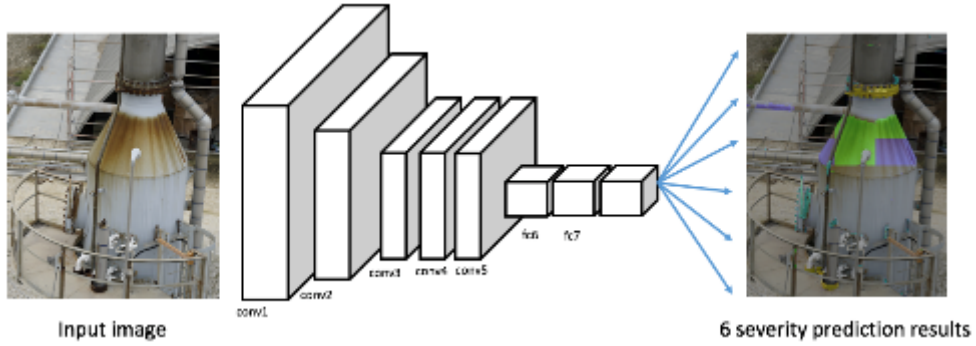
Best-of-breed deep learning algorithms and utilities for intelligent analysis of industrial images

Ability to scale for multiple assets/sites/vertical using site-devoted field image analysts

Image database creates metadata- searchable archival record for visual records

Image analytics for automated defect recognition

DEEP LEARNING NETWORK



Families of deep learning algorithms, such as fully convolutional networks

- **Training phase**: Image with ground truth used to set the right weights (W) by a process called back-propagation that used the difference between the result and ground truth to change the W
- **Run time**: trained network now is able to ingest an image and return the desired result

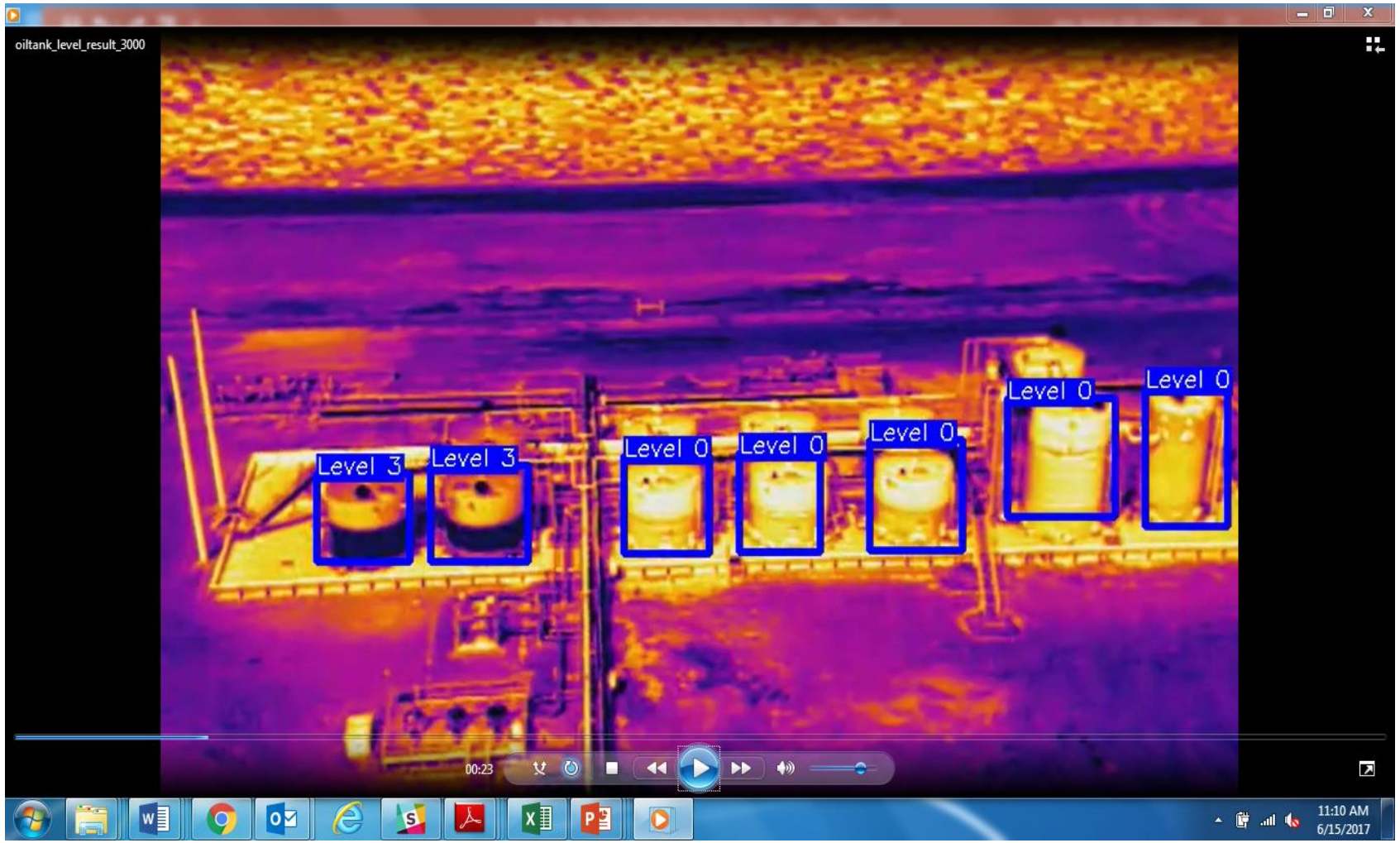
DEEP-LEARNED DEFECTS

- Paint breakdown
- Insulation breakdown
- Loose, cracked, broken, or missing bolts
- Cracking
- Corrosion
- Concrete spalling
- Heat distortion
- Numerous other that are asset and part specific (blocked drain, blocked nozzle, kinking, loose ignitor tubing, damaged support/guides, water logging)

Detect and classify

- Deep model that detects corrosion
- Deep models that determine level of severity
- Transfer learning from existing pretrained deep models

Detect and classify



- Object detection and tracking on the edge
- Volumetric analytics on the edge
- Cloud analytics for change and integrity assessment

Analytics lifecycle

DIGITIZE

On completion of initial inspection (On-site & in the Cloud)

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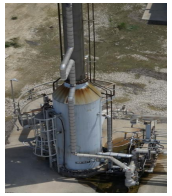

Baseline

ANALYZE

Online

(On-site & in the Cloud)

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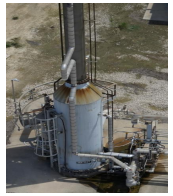
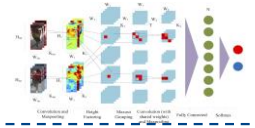


Deep learning

Baseline

Current



ANOMALY AND DEFECT DETECTION

OPTIMIZE

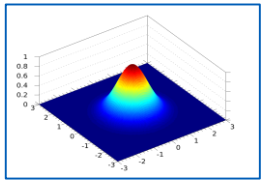
On demand (In the Cloud)

Anomaly and defects

Process history

Advanced data analytics

Rules-based reasoning



Asset risk maps

RISK-BASED INSPECTION PLANNING AND RECOMMENDATIONS