Mandli Communications, Inc.

3D Asset Management

About Mandli

- Established in 1983, Mandli has worked with over 30 State Departments of Transportation in the U.S.
- First integrated pavement data collection in 2002
- First integrated a mobile LiDAR system in 2007
- Offers one of the most advanced datasets in the industry

Data Collection for Florida DOT

- First contract with FDOT was in 1992
- Won additional contracts in 2002, 2006, 2009
- Awarded latest contract in 2013 through 2018
- Collect photolog and GPS data statewide
  - 17,000 miles in 2014
  - 12,000 miles scheduled for 2015

Changing Industry

- New and changing requirements:
  - MAP-21
  - HPMS
  - MIRE
- Many DOTs are scaling back staffing
- Same amount of work with less people
- Limited budgets mean every dollar needs to be justified

Mandli’s Response

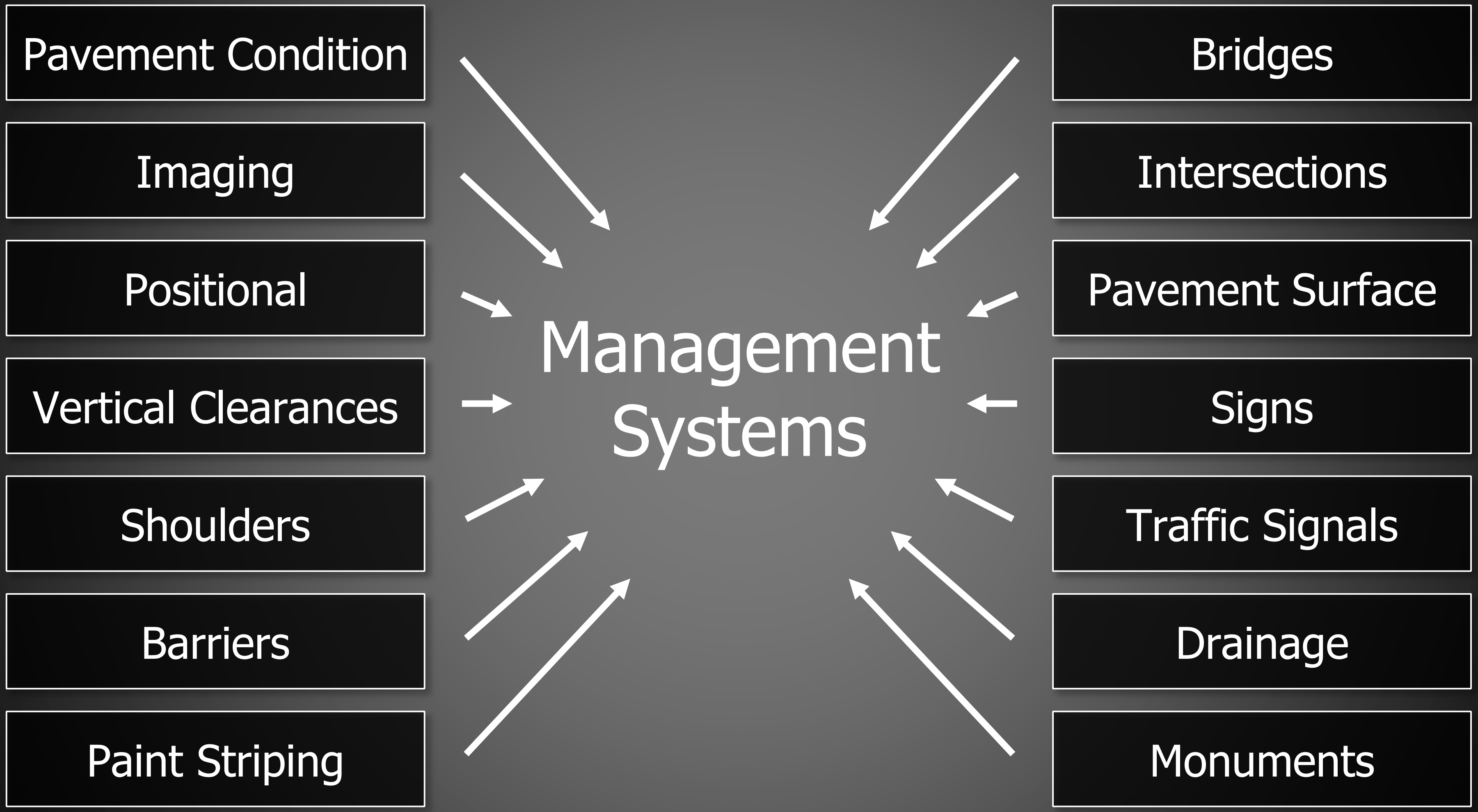
- Multi-functional vehicle:
  - High-Resolution Imaging, 3D Pavement Profiling, Mobile LiDAR, Positional
- One pass collection at highway speeds
- Latest technology
- Most accurate, highest resolution 3D data set
- More assets capable of extraction
- Greater return on investment

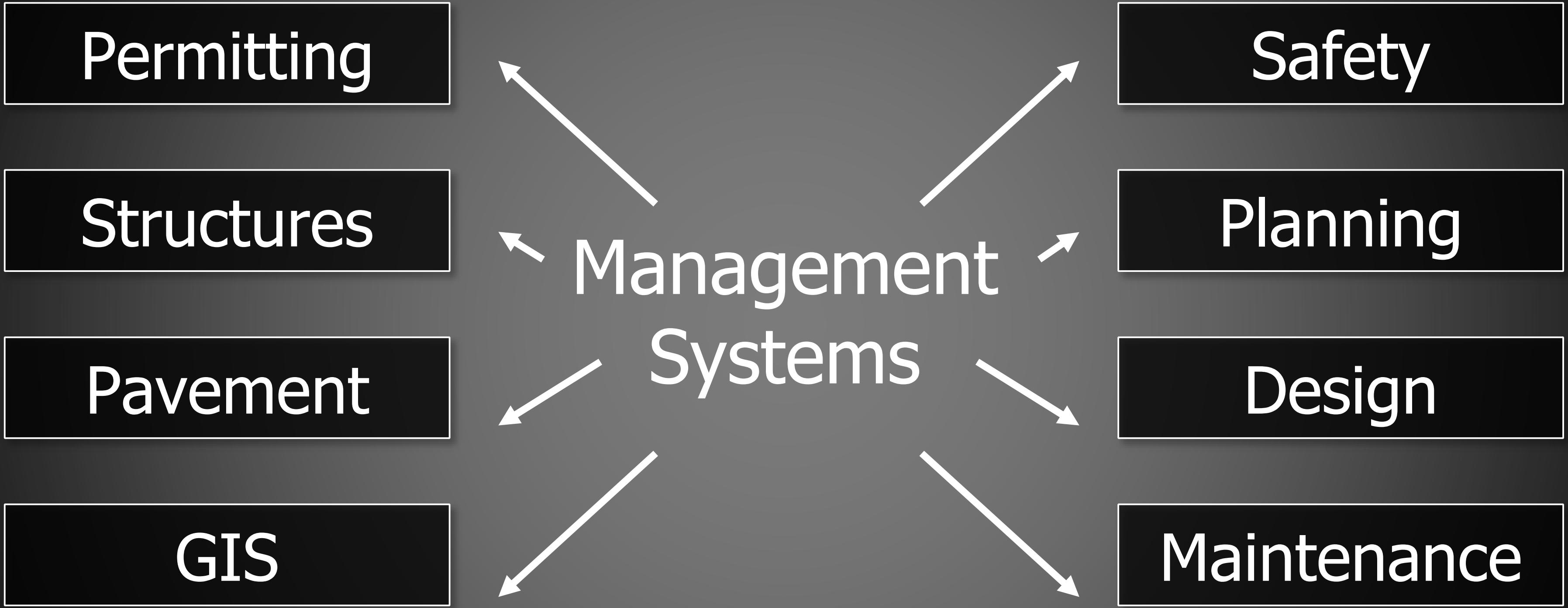
Mandli's Solution

- Comprehensive data collection
- Integration with leading vendors in the industry
- Added value for multiple divisions in DOTs
- All data collected at posted highway speeds
- Data then processed back in the office

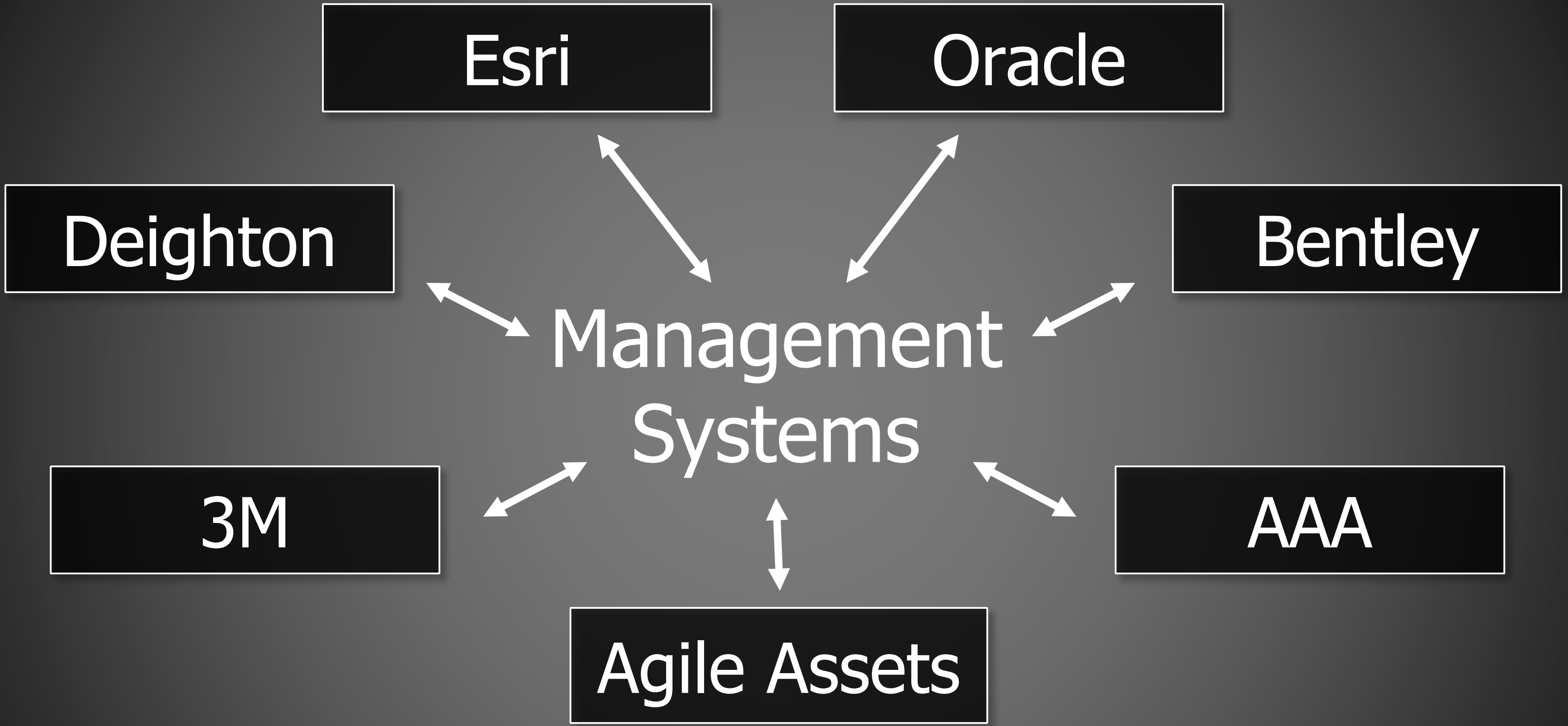
Mandli’s Solution

- SAFER
- MORE EFFICIENT
- MORE ACCURATE
- CREATE AN ARCHIVED 3D DATA INVENTORY


Pavement Condition
Imaging
Positional
Vertical Clearances
Shoulders
Barriers
Paint Striping
Management Systems
Bridges
Intersections
Pavement Surface
Signs
Traffic Signals
Drainage
Monuments



Permitting
Structures
Pavement
GIS
Management Systems
Safety
Planning
Design
Maintenance



Mandli works with all of these organizations to develop software specifically designed around our dataset. For the Utah DOT project we have come together to form a committee, UTIBS, to share information and ideas.

Mandli’s Technology

- High-Resolution Imaging
- 3D Point Cloud
- 3D Pavement Profile
- Robust Positional System

In order to create the most advanced dataset available Mandli is constantly researching, testing, and integrating new hardware to keep at the forefront of the industry.

High-Resolution Imaging

- Multiple right-of-way camera configurations
- Resolutions up to 3296 x 2472 per camera
- Frame rate ranging from 100 to 500 images per mile
- Optional 360º imaging
- Images are referenced to linear distance traveled and DGPS data
- JPEG compression format
- Real-time monitoring of image collection

This is a sample of Mandli's standard three-camera view. Many of our clients request this setup as it provides a good view of the right-of-way as well as the assets to the side of the roadway.

The high-resolution cameras allow for the capture of detailed images. Note how the sign installation date (05) in the lower-left corner is clearly visible.

Image Configuration Changes

2003 – 2 Cameras
1280 x 1024

2006 – 2 Cameras
1600 x 1200

2007 – 3 Cameras
1600 x 1200

2009 – 3 Cameras
2048 x 1152

2010 – 2048 x 1152 (Same as 2009)

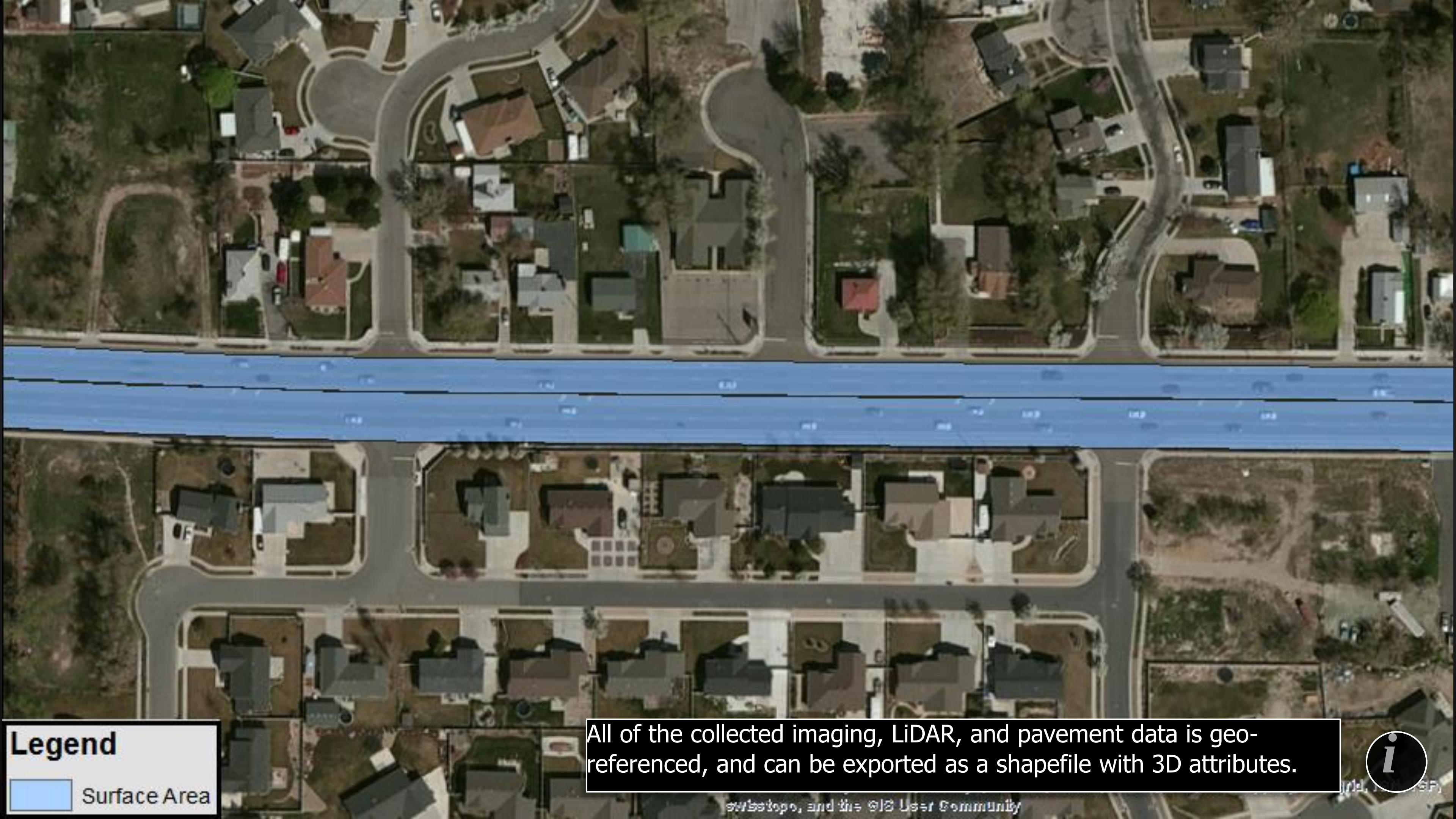
2011 – 3296 x 2472

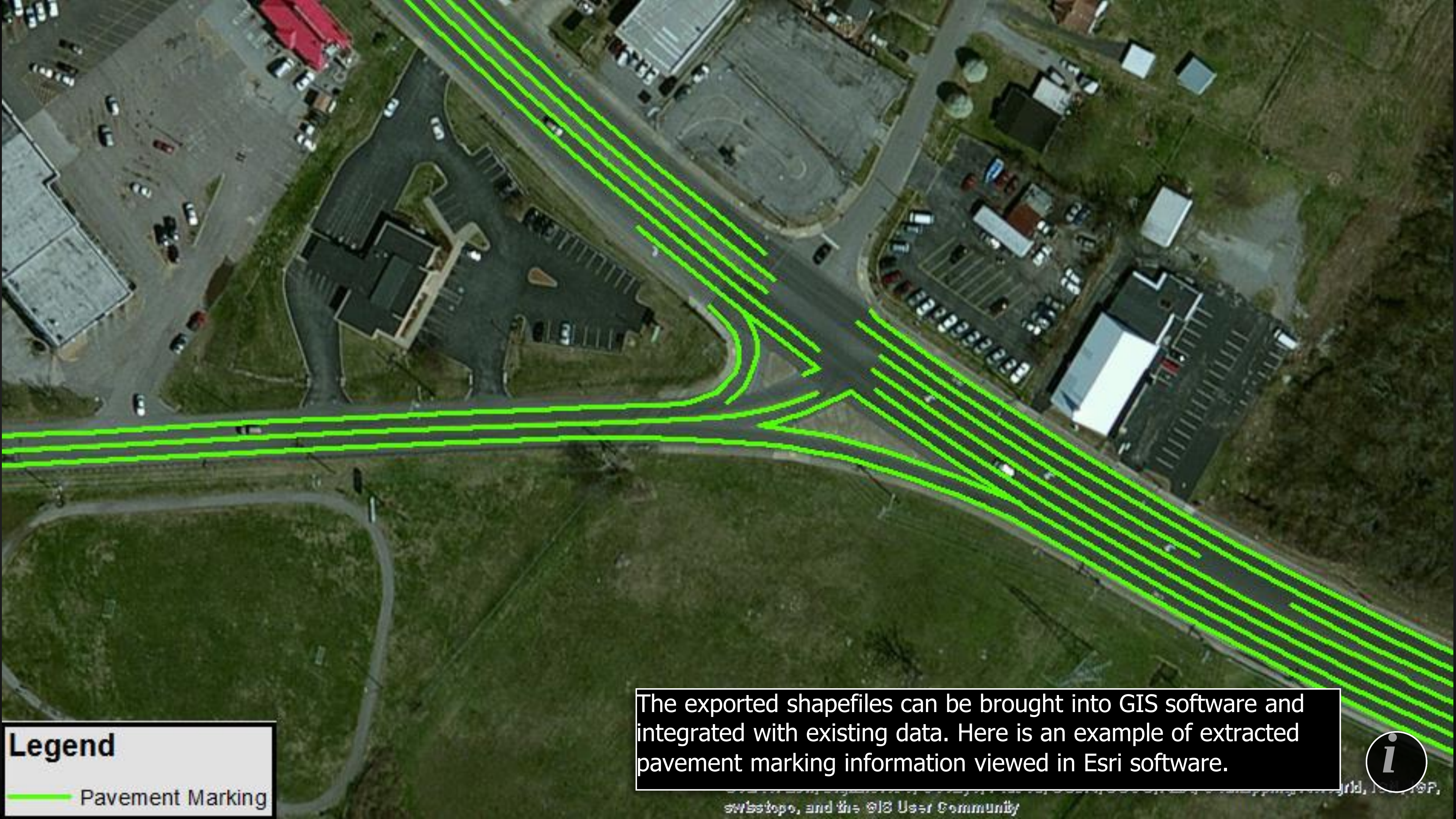
Increased Field Of View

Increased Resolution

Robust Positional System

- Applanix POS LV 220 with dual antennas, inertial measurement unit (IMU), and wheel-encoder distance measurement unit (DMI)
- Collects GPS information, geometrics, and linear reference data
- Monitors vehicle dynamics in real time
- 100% of the positional data is post-processed using the POSPac Mobile Mapping Suite from Applanix
- Real-time differential allows for the accurate collection of positional data during long periods of GPS outage


Legend
Surface Area
All of the collected imaging, LiDAR, and pavement data is geo-referenced, and can be exported as a shapefile with 3D attributes.
swisstopo, and the GIS User Community



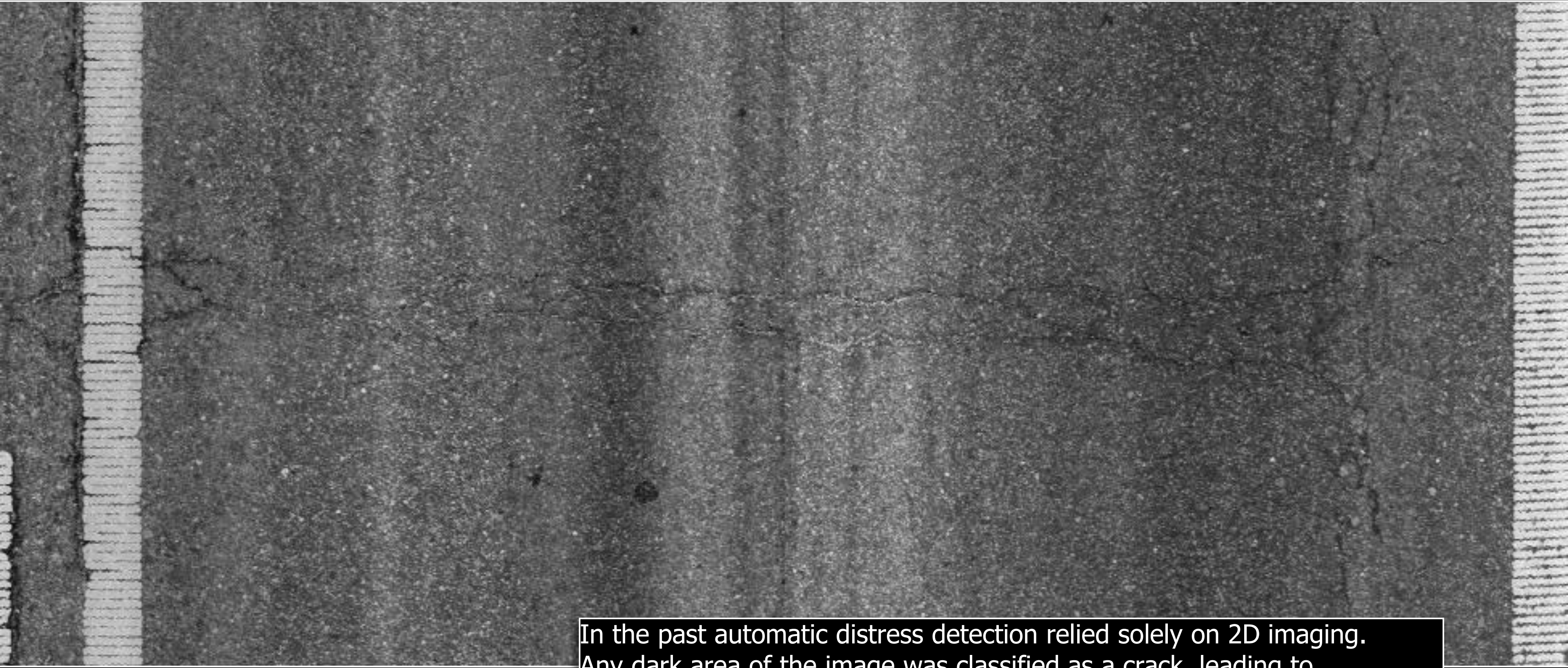
The exported shapefiles can be brought into GIS software and integrated with existing data. Here is an example of extracted pavement marking information viewed in Esri software.

3D Pavement Profile

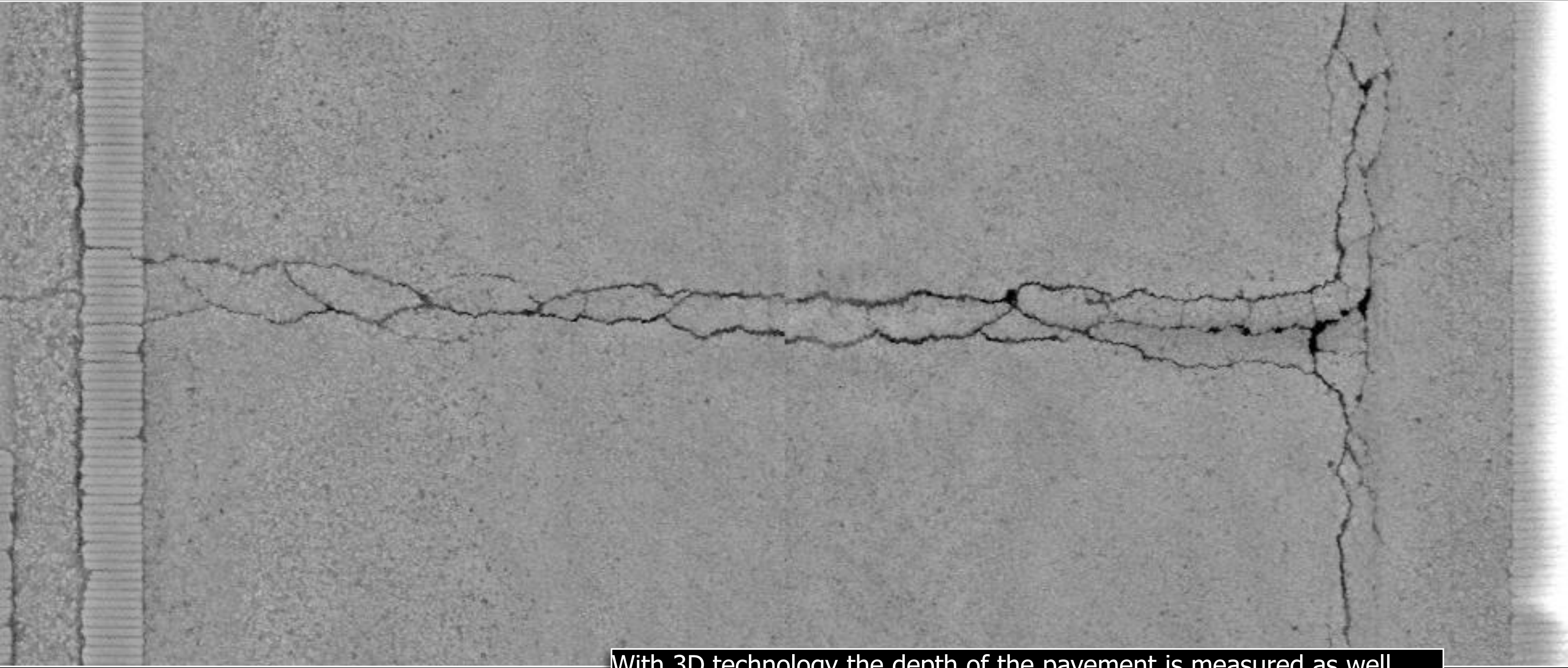
- Laser Crack Measurement System (LCMS) from Pavemetrics
- Automatic distress detection
- Collection of rutting and transverse profiles, distress, and pavement imaging
- Collects both 2D images and high-resolution 3D profiles of the road
- Detection of pavement type
- 4,000 point rutting
- Highly accurate and repeatable results

3D Pavement Profile Customers

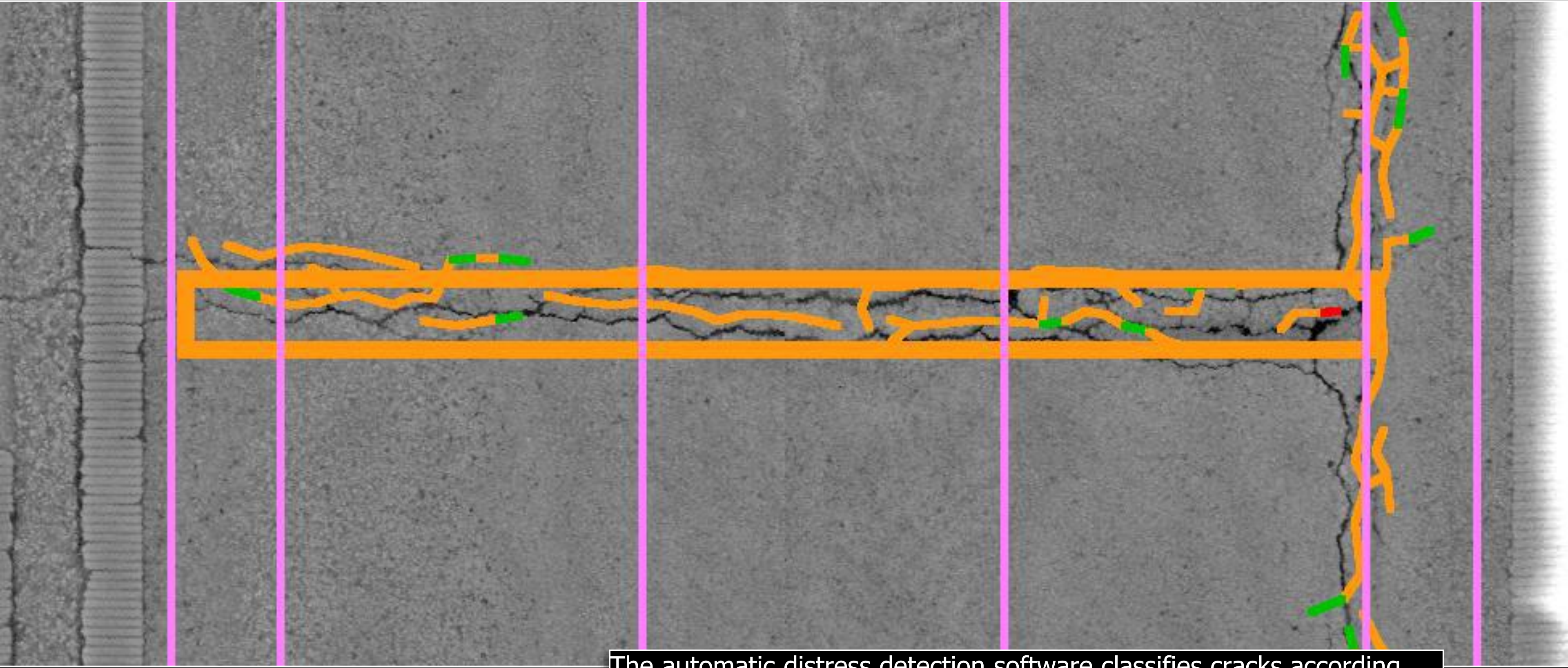
- Utah DOT
- Tennessee DOT
- Oklahoma DOT
- Nevada DOT
- Hawaii DOT
- Alaska DOT & PF
- Rhode Island DOT
- Illinois DOT
- Caltrans
- Kentucky Transportation Cabinet (3 vehicles)
- Kansas DOT (vehicle)
- Various Cities and municipalities
- Exclusive subs for APT and AECOM for military and airport projects



In the past automatic distress detection relied solely on 2D imaging. Any dark area of the image was classified as a crack, leading to improper identification and poor repeatability results. This intensity image produced by the LCMS shows what a 2D view looks like by itself.

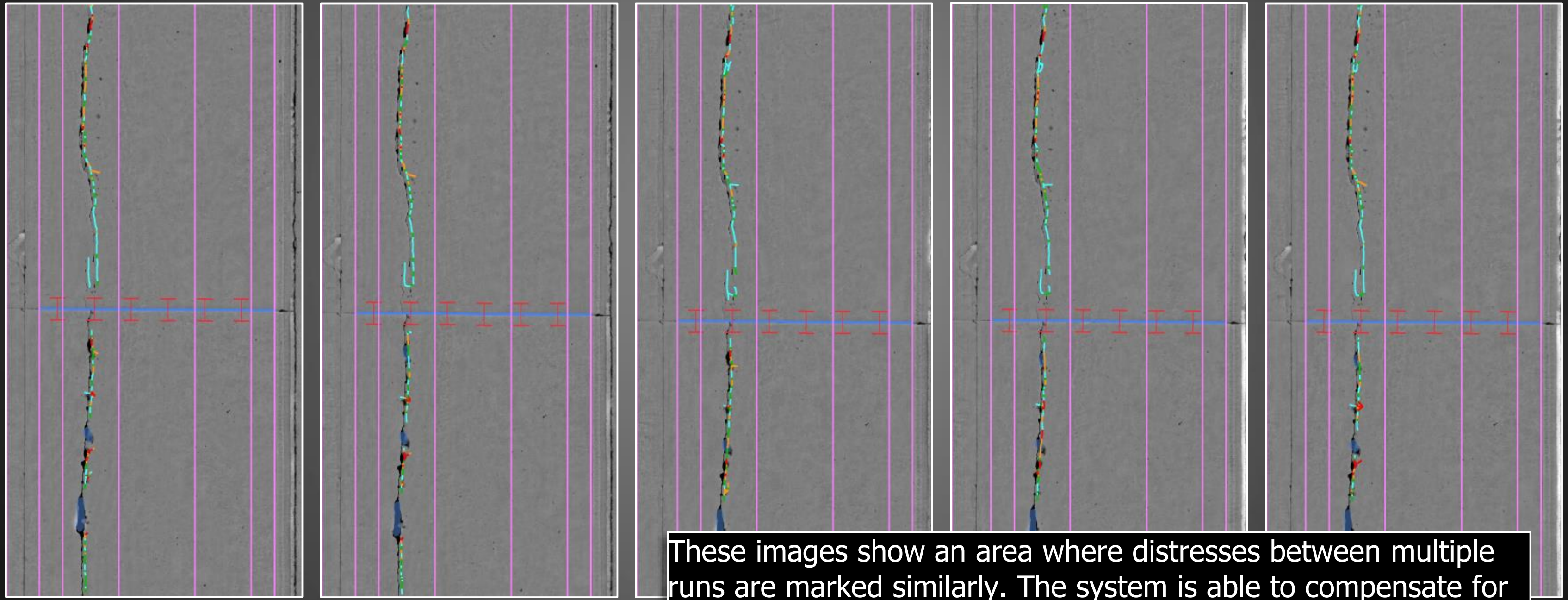


With 3D technology the depth of the pavement is measured as well. Here is an example of a range image captured by the LCMS. Note the differences when comparing the 3D image to the 2D image.



The automatic distress detection software classifies cracks according to type and severity, and produces an overlay image highlighting the results. The overlay is offset in order to still see the individual cracks.

LCMS Repeatability



Run 1

Run 2

These images show an area where distresses between multiple runs are marked similarly. The system is able to compensate for driver wander during collection. Note how the wheel paths are correctly identified in the five separate images.

Asphalt Distress Ratings

Automated	Manual
Alligator	Depression
Block Cracking	Edge Cracking
Longitudinal	Patching
Transverse	Shoving
Potholes	Weathering and Raveling

Concrete Distress Ratings

Linear (automated)
Joint seal damage
Polished aggregate
Joint Spalling
Corner break
Pumping

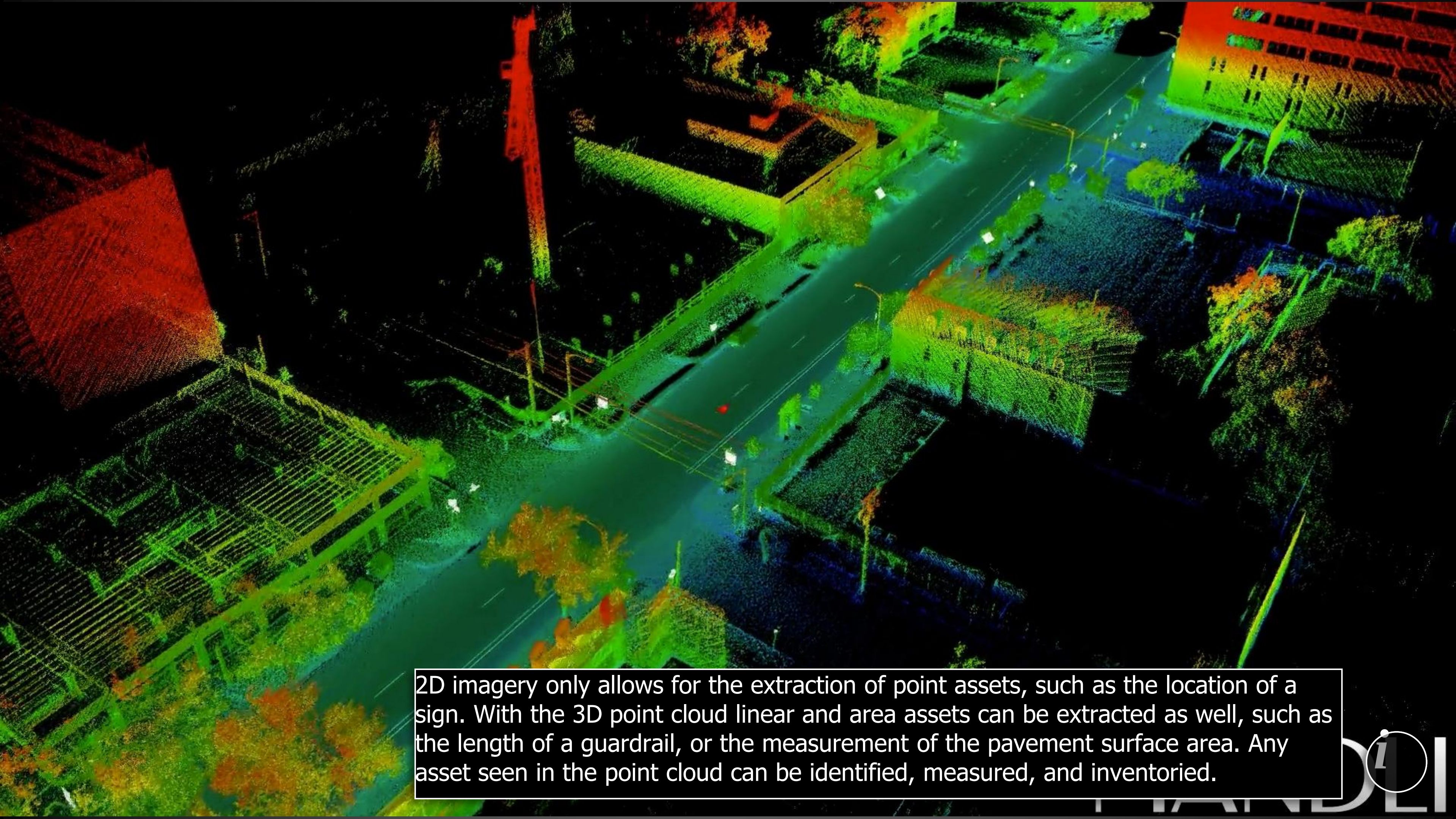
Blowup/buckling
Large patching
Popouts
Durability cracking
Small patching
Scaling, map cracking

Mark IV Road Surface Profiler

- Collects longitudinal profile elevations, International Roughness Index (IRI), and slab faulting
- Operator able to view real-time profile data in both wheel paths for verification of data collection
- Measurements are referenced to linear distance traveled (DMI) and Differential Geographical Positions System (DGPS) information
- System meets the Class I precision and bias specifications as defined by ASTM E-950 and the Texas Transportation Institute (TTI) certification

3D Point Cloud

- Multi-sensor Velodyne LiDAR data collection
- Relative accuracy (point-to-point) of ± 4 cm @ 2 sigma
- 100+ meter range
- 1.4 millions points per second
- Realistic view of collected environment
- Data can be used for the extraction of roadway assets and vertical and horizontal clearances, as well as advanced design and modeling applications



2D imagery only allows for the extraction of point assets, such as the location of a sign. With the 3D point cloud linear and area assets can be extracted as well, such as the length of a guardrail, or the measurement of the pavement surface area. Any asset seen in the point cloud can be identified, measured, and inventoried.

Sample Extractable Assets

- Intersections
- Signs
- Bridges
- Road Surface
- Lane Report
- Paved Shoulder Width
- Through Lanes
- HOV Operations Type
- HOV Lanes
- Right Turn Lanes
- Left Turn Lanes
- Speed Limit
- Toll Charged
- Toll Type
- Lane Width

- Median Type
- Shoulder Type
- Right Shoulder Width
- Left Shoulder Width
- Terrain Type
- Surface Type
- Median Width
- Paved Shoulder Width
- Accel./Decel. Lanes
- Guardrails
- Number of Lanes
- Passing Lanes
- Pavement Width
- Speed Zones
- Turn Lanes

- Culverts
- Luminaires
- MUTCD Sign Inventory
- Paved Turnouts
- Paved Unpaved
- Railroad Crossings
- Rest Areas
- Rumble Strips
- Scenic Overlooks
- Traffic Signals
- Trail Heads
- Barriers
- Control Fence
- Curb and Gutter
- Signal Poles

- Signal Cabinets
- Power Pedestals
- Attenuators
- Delineators
- Specialty Markings
- Tunnel
- Ditch
- Mowable Acres
- Landscaping/Wildflowers
- One/Two Way Operations
- Driveways
- Ramps
- Raised Pavement Markers

Asset Inventory

Asset Inventory

Bike Lanes

Asset Inventory

Clearances

Asset Inventory

Drainage

Asset Inventory

Edge Types

Asset Inventory

Intersections

Asset Inventory

Lane Types

Asset Inventory

Luminaires

Asset Inventory

Medians

Asset Inventory

Mile Post Markers

Asset Inventory

Monuments

Asset Inventory

Pavement Messages

Asset Inventory

Pedestrian Crossings

Asset Inventory

Pedestrian Ramps

Asset Inventory

Power Pedestals

Asset Inventory

Sidewalks

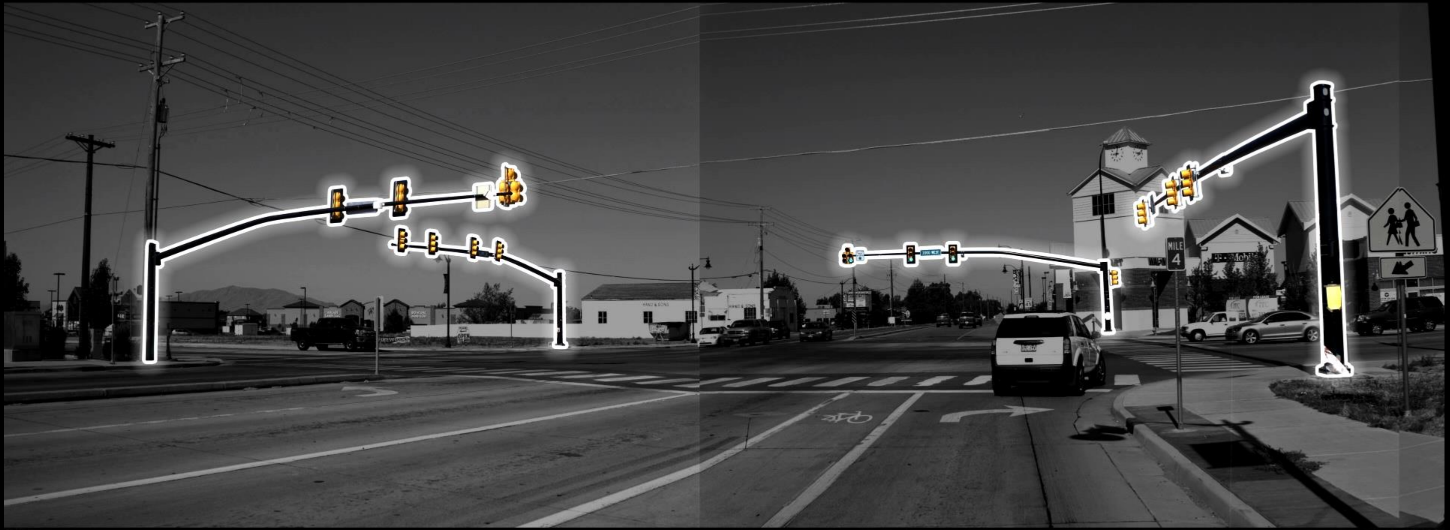
Asset Inventory

Sign Assembly

Asset Inventory

Sign Faces

Asset Inventory



Signal Assembly

Asset Inventory

Signal Cabinets

Asset Inventory

Signal Poles

Asset Inventory

Traffic Lights

Asset Inventory

Utility Lines

Asset Inventory

Utility Poles

Asset Inventory

Comprehensive Asset Inventory

Asset Inventory

Asset Inventory

Concrete Barrier Walls

Asset Inventory

Delineators

Asset Inventory

Guardrails

Asset Inventory

Lanes

Asset Inventory

Paint Striping

Asset Inventory

Pavement Surface Area

Asset Inventory

Rumblestrips

Asset Inventory

Shoulders

Asset Inventory

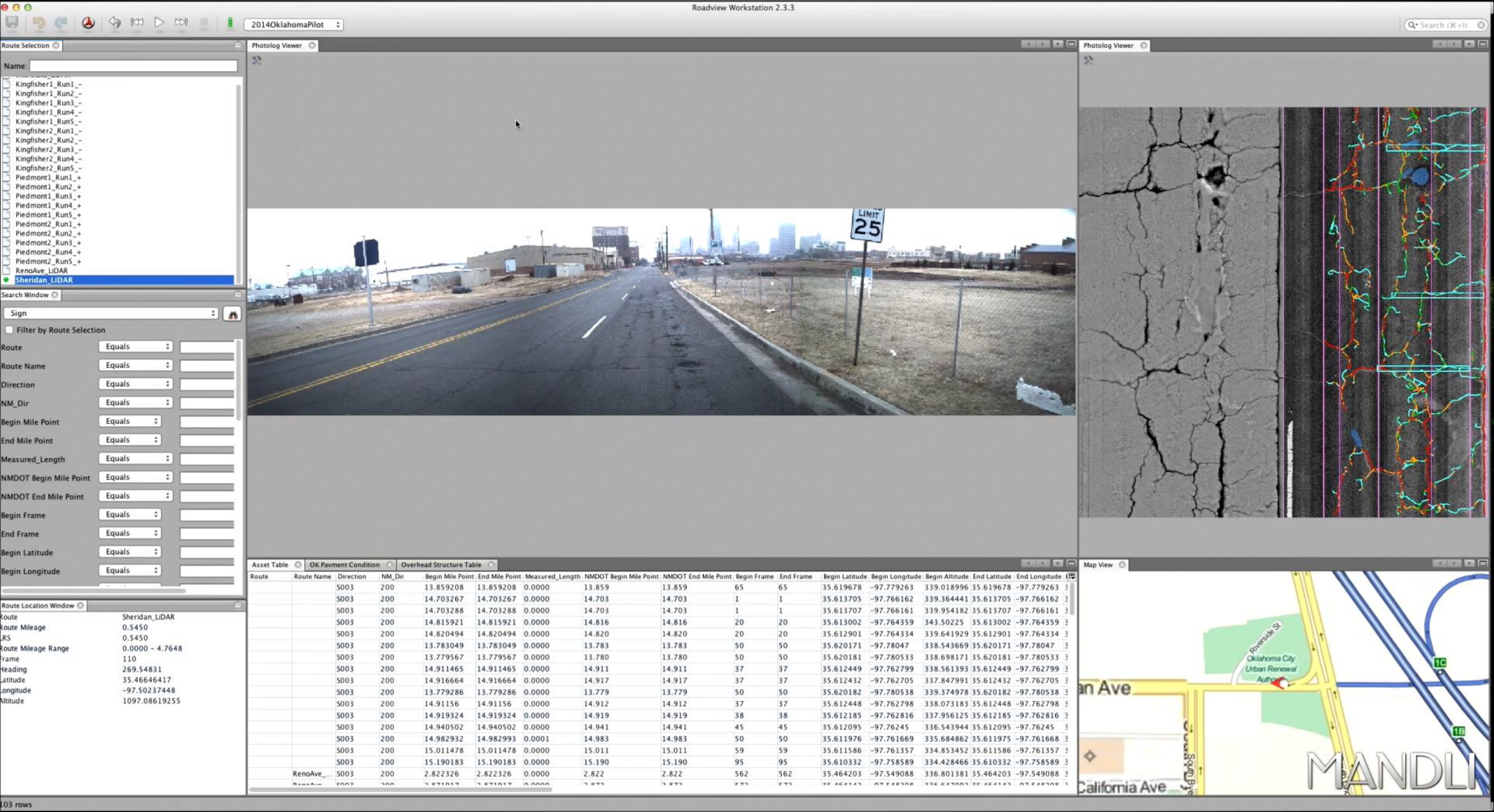
Sign Faces

Asset Inventory

Sign Supports

Asset Inventory

Comprehensive Asset Inventory



Roadview Workstation 2.3.3
2014OklahomaPilot
Route Selection
Name:
Kingfisher1_Run1_-
Kingfisher1_Run2_-
Kingfisher1_Run3_-
Kingfisher1_Run4_-
Kingfisher1_Run5_-
Kingfisher2_Run1_-
Kingfisher2_Run2_-
Kingfisher2_Run3_-
Kingfisher2_Run4_-
Kingfisher2_Run5_-
Piedmont1_Run1_+
Piedmont1_Run2_+
Piedmont1_Run3_+
Piedmont1_Run4_+
Piedmont1_Run5_+
Piedmont2_Run1_+
Piedmont2_Run2_+
Piedmont2_Run3_+
Piedmont2_Run4_+
Piedmont2_Run5_+
RenoAve_LiDAR
Sheridan_LiDAR
Search Window
Sign
Filter by Route Selection
Route Equals
Route Name Equals
Direction Equals
NM_Dir Equals
Begin Mile Point Equals
End Mile Point Equals
Measured_Length Equals
NMDOT Begin Mile Point Equals
NMDOT End Mile Point Equals
Begin Frame Equals
End Frame Equals
Begin Latitude Equals
Begin Longitude Equals
Route Location Window
Route Sheridan_LiDAR
Route Mileage 0.5450
LRS 0.5450
Route Mileage Range 0.0000 - 4.7648
Frame 110
Heading 269.54831
Latitude 35.46646417
Longitude -97.50237448
Altitude 1097.08619255
Photolog Viewer
LIMIT 25
Photolog Viewer
Asset Table
OK Pavment Condition
Overhead Structure Table
Route | Route Name | Direction | NM_Dir | Begin Mile Point | End Mile Point | Measured_Length | NMDOT Begin Mile Point | NMDOT End Mile Point | Begin Frame | End Frame | Begin Latitude | Begin Longitude | Begin Altitude | End Latitude | End Longitude
S003 200 13.859208 13.859208 0.0000 13.859 13.859 65 65 35.619678 -97.779263 339.018996 35.619678 -97.779263
S003 200 14.703267 14.703267 0.0000 14.703 14.703 1 1 35.613705 -97.766162 339.364441 35.613705 -97.766162
S003 200 14.703288 14.703288 0.0000 14.703 14.703 1 1 35.613707 -97.766161 339.954182 35.613707 -97.766161
S003 200 14.815921 14.815921 0.0000 14.816 14.816 20 20 35.613002 -97.764359 343.50225 35.613002 -97.764359
S003 200 14.820494 14.820494 0.0000 14.820 14.820 20 20 35.612901 -97.764334 339.641929 35.612901 -97.764334
S003 200 13.783049 13.783049 0.0000 13.783 13.783 50 50 35.620171 -97.78047 338.543669 35.620171 -97.78047
S003 200 13.779567 13.779567 0.0000 13.780 13.780 50 50 35.620181 -97.780533 338.698171 35.620181 -97.780533
S003 200 14.911465 14.911465 0.0000 14.911 14.911 37 37 35.612449 -97.762799 338.561393 35.612449 -97.762799
S003 200 14.916664 14.916664 0.0000 14.917 14.917 37 37 35.612432 -97.762705 337.847991 35.612432 -97.762705
S003 200 13.779286 13.779286 0.0000 13.779 13.779 50 50 35.620182 -97.780538 339.374978 35.620182 -97.780538
S003 200 14.91156 14.91156 0.0000 14.912 14.912 37 37 35.612448 -97.762798 338.073183 35.612448 -97.762798
S003 200 14.919324 14.919324 0.0000 14.919 14.919 38 38 35.612185 -97.762816 337.956125 35.612185 -97.762816
S003 200 14.940502 14.940502 0.0000 14.941 14.941 45 45 35.612095 -97.76245 336.543944 35.612095 -97.76245
S003 200 14.982932 14.982993 0.0001 14.983 14.983 50 50 35.611976 -97.761669 335.684862 35.611975 -97.761668
S003 200 15.011478 15.011478 0.0000 15.011 15.011 59 59 35.611586 -97.761357 334.853452 35.611586 -97.761357
S003 200 15.190183 15.190183 0.0000 15.190 15.190 95 95 35.610332 -97.758589 334.428466 35.610332 -97.758589
RenoAve_... S003 200 2.822326 2.822326 0.0000 2.822 2.822 562 562 35.464203 -97.549088 336.801381 35.464203 -97.549088
103 rows
Map View
Riverside St
Oklahoma City Urban Renewal Authority
1C
1B
an Ave
California Ave
MANDLI

Mobile LiDAR Asset Projects

- Utah DOT
- Tennessee DOT
- New Mexico DOT
- Nevada DOT
- Hawaii DOT
- Alaska DOT
- County of Hawaii
- City of Peoria, IL

Utah DOT - 12,000 lane miles

Signs	98,785	Medians	69,384
Sign Assembly	66,294	Shoulders	442,713
Barriers	10,783	Lane Count	35,991
Walls	1,416	Pavement Surface Area	
Drainage	14,211		35,991
Signal Pole	6,631	Vertical Clearance Measurement	
Intersection	10,555		1,662
Signal Cabinet	1,265		
Power Pedestal	848	**Total Assets:**	**796,529**

New Mexico DOT - 27,000 lane miles

Signs	280,577
Sign Assembly	212,957
Intersection	31,456
Retaining Walls	467
Bridge Deck	3,150
Rumble Strips	269,789
Lane Surface Area	76,551
Shoulders	184,496
Median	67,250

Tennessee DOT - 13,500 lane miles

Signs	160,825
Curb & Gutter	15,828
Delineator	22,145
Guardrail	20,094
Ditch	73,336
Drain	51,643
Pavement Markings	39,682
Mowable Acres	71,771

Nevada DOT - 11,000 lane miles

Signs	74,536
Sign Assembly	56,766
Medians	12,837
Shoulders	102,235
Operation Way	12,837
Rumble Strip	190,258
Intersection	6,431
Driveway	10,000
Ramps	987

County of Hawaii

Streetlights	8,731 (extracted in 2014 from 2011 LiDAR data)

City of Peoria, IL

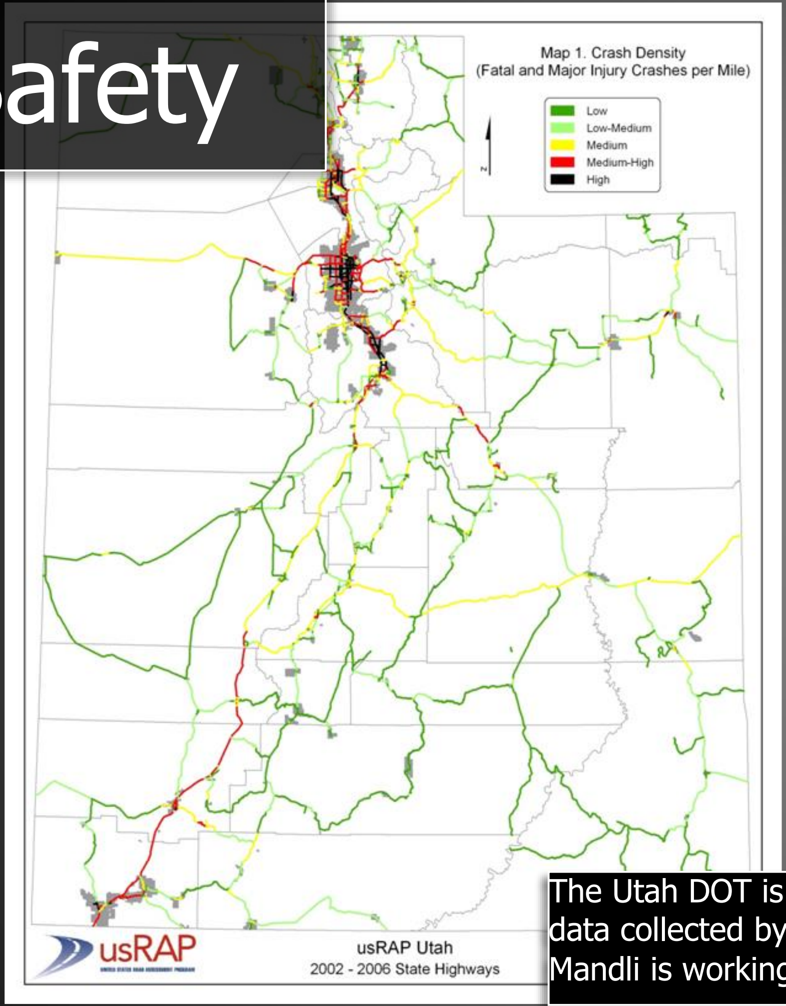
Signs	55,000
Streetlights	15,000

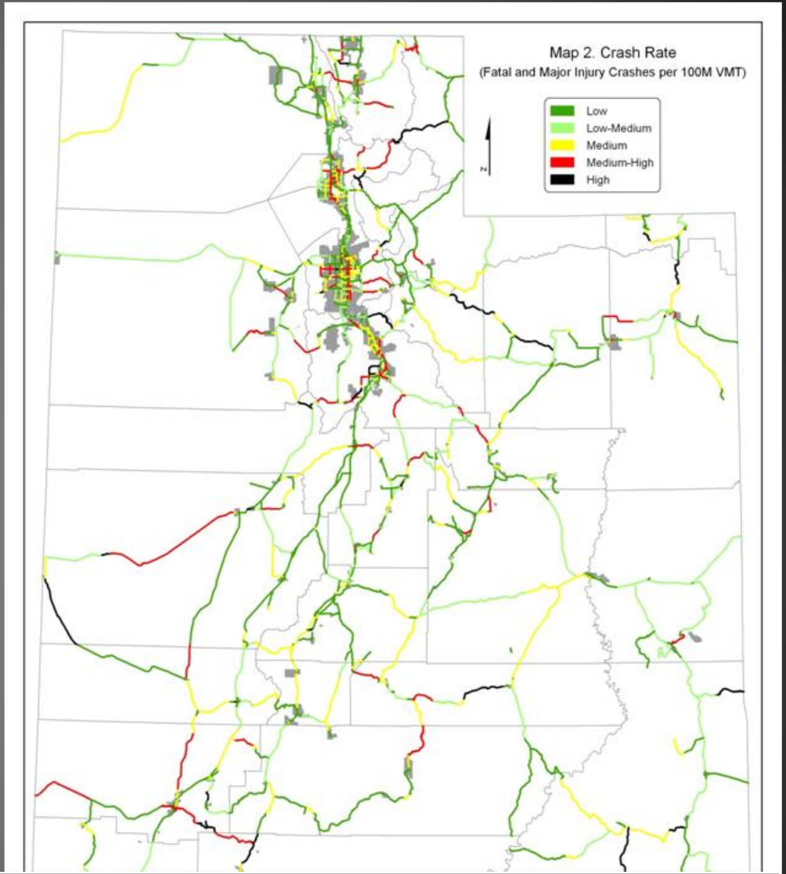
Multiple Client Approaches

- These three categories of influence are Mandli's main selling points for approaching projects:

    - ***Safety***: utilize dataset for safety analysis
    - ***Asset***: wide range of asset inventory services
    - ***Road Condition***: detailed pavement analysis

Safety





The Utah DOT is using the pavement, positional, and road geometric data collected by Mandli to assign usRAP safety star ratings to roadways. Mandli is working closely with both Utah and usRAP to support this effort.

usRAP Objectives

- Reduce death and serious injury
- Strategic decisions on route improvements, crash protection and standards of safety mgt based on assessment of risk
- Forge partnerships with local agencies
- Empower agencies to make decisions based on video-log of roadway features known to be associated with crashes

usRAP Data Elements - Mandli

- Number of through lanes
- Speed limit
- Lane width
- Paved shoulder width
- Rumble strips
- Curvature
- Grade
- Road condition
- Sidewalk
- Curb parking
- Pedestrian crossing
- Bicycle lane
- Property access points
- Intersection
- Medians
- Street lighting
- Differential speed limits
- Roadside severity

usRAP for Utah DOT

- As part of Mandli's statewide contract with Utah DOT, Mandli is delivering usRAP data elements on their network
- Data elements are derived from video-log imagery
- Mandli already is collecting video-log images on Florida roadways
- No LiDAR data is used to process the usRAP data elements

Mandli Communications, Inc.

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