

# **ODOT ITS Update- Snowplow Mobile Data Collection Program and Weather Management System**

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# Outline

- Motivation
- Toward Implementation
  - MDCC System Components
  - MDC System Information
- MDCC Driver Interface
- MDCC Configuration:
  - User/cellphone/truck Management
- Real-Time (RT) Monitoring: Dashboard
  - General view.
  - Communication.
  - Locations and routes
- Interactive Data Review and Management
- Reporting
- Future Software Development
- Future Big Data & Research Activities
- Conclusion
- Acknowledgment

# Motivation

- Snowplow trucks are typically the first responders to snow/ice storm-impacted roadways to improve conditions and enable passenger vehicles to freely travel on cleared roadways.
- Unfortunately, snowplow trucks are poorly equipped to *track and report* snow/ice cleared roadways, monitor surface road conditions, or amount of sand dispensed per location, etc.



Implementing a mobile data collection using cellular (MDCC) technology aimed at monitoring and reporting road surface conditions, treatments, and improvements to motorists.

# MDCC System Components

- Non-contact infrared sensor;
- Mobile Weather station
  - Ambient temp
  - Humidity
  - Barometric Pressure
  - Wind strength/direction
  - Dew point and rainfall;
- Cellphone for real-time communication;
- Cellphone accelerometers/Gyroscopes;
- Truck Extensible Embedded Computing Equipment
  - Sand spreader system
  - Plow pressure;
- Real-time website server for monitoring and communication;
- Database server to received and store collected information.



# MDCC System Information

- Cellphone/Tablet:

Speed/Acceleration	Gyroscope
Broadband/Bluetooth wireless	location and routes
Camera images and	incident video recordings

- Mobile RWIS:

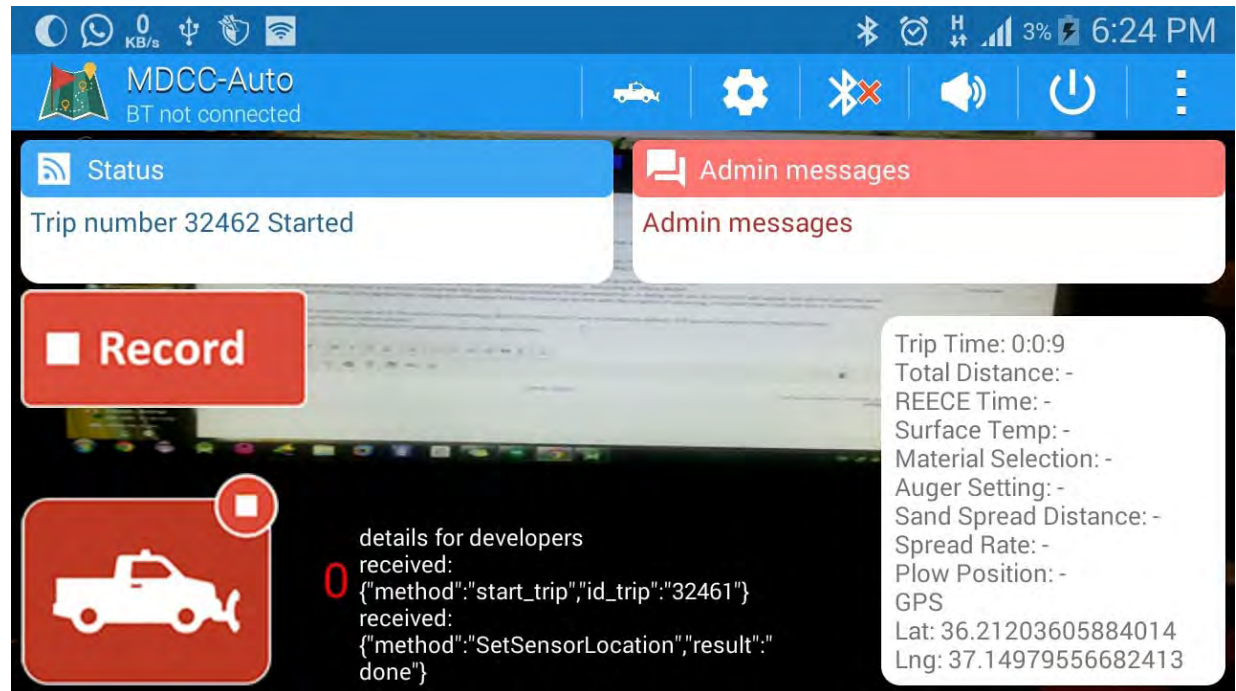
Surface temp	Wind strength/direction
Ambient temp	Humidity
Barometric pressure	Dew-point and rainfall

- Truck Extensible Embedded Computing Equip (TEECE).

Material/Liquid Selection	Plow state (up/Down)
Auger setting	Plow height above ground (Potential)
Blast distance	Blast Quantity
Liquid volume	Spreading distance

# MDCC Driver Interface

- Simple Design
- Auto login
- Auto software upgrade
- Minimize Driver interaction
- Local Configuration:
  - Image size
  - Data type
  - Collection frequency
- Connection status update:
  - Online- Connected
  - Offline- No coverage
  - GPS location Acquired
  - Bluetooth connected to TEECE.



- Admin/driver communication messages:
  - Text and audible messages.
  - Video and voice recordings.
- Trip/deployment Type:
  - Construction Vs Snowplow
- System information:
  - Trip time
  - Total Distance
  - Surface Temp
  - Plow position
  - Material Selection
  - Auger setting
  - Sand spread distance
  - Spread rate

# MDCC Settings: User Management

- User setup:
  - ID
  - Password
  - Privileges

**Mobile Data Collection using Cellphones**

## Manage Users

- Users
  - Hazem
    - Create
    - Rename
    - Remove
    - Settings
    - Privileges

**User Name : Hazem**

New Password:

Repeat Password:

## Manage Users

- Users
  - Hazem
  - Jared Schwennesen
    - Rename
    - Remove
    - Settings
    - Privileges

**User Name : Jared Schwennesen**

**Privileges:**

- ☒ Location
- ☒ Data
- ☒ Plow position
- ☒ Sand Spreader
- ☒ Pictures
- ☒ Events
- ☒ Message Push to Vehicle
- ☒ Truck info
- ☒ User info
- ☒ User Privileges
- ☒ Tablet/phone Info
- ☒ Manage Cellphone Updates

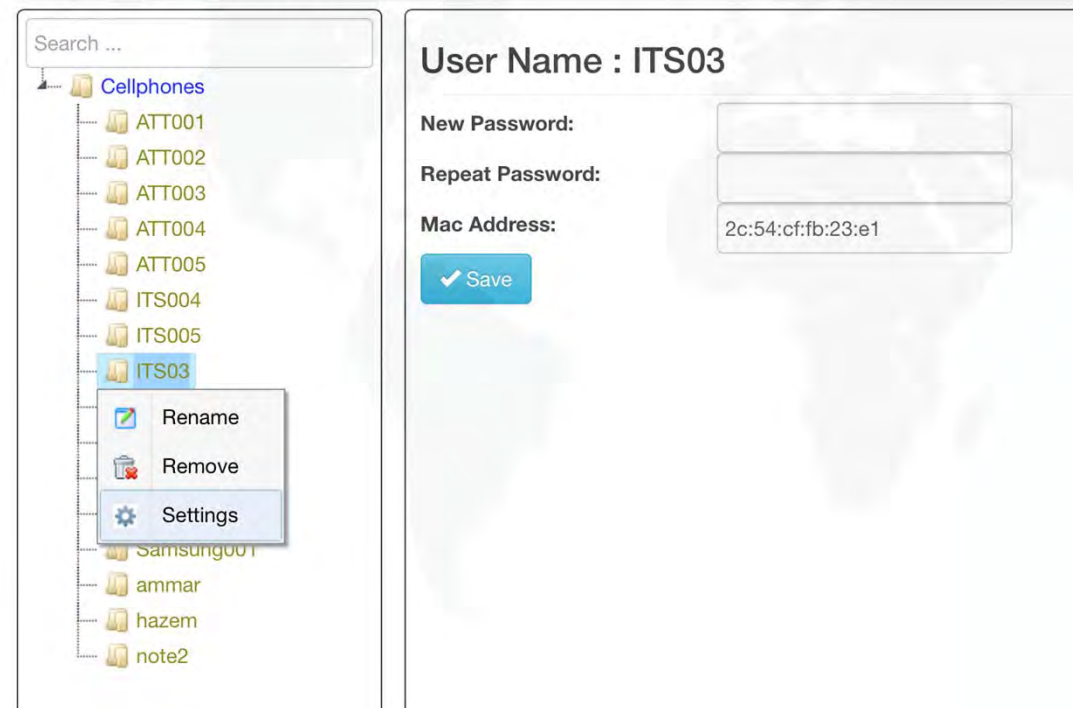
← **Messaging**



# MDCC Settings: Cellphone/Tablet Management

- Simple cellphone/tablet setup
- Cellphone addition/removal
- Search feature
- Simple tree view
- Cellphone authentication
  - ID
  - Password
  - Unique MAC address

## Manage Cellphones



Search ...

Cellphones

- ATT001
- ATT002
- ATT003
- ATT004
- ATT005
- ITS004
- ITS005
- ITS03
- Samsung001
- ammam
- hazem
- note2

Rename

Remove

Settings

User Name : ITS03

New Password:

Repeat Password:

Mac Address: 2c:54:cf:fb:23:e1

Save



# MDCC Settings: Snowplow Truck Management

- Simple truck/cellphone association
- Additional level of potential authentication

## Manage Trucks Structure

Search ...

Divisions

- Division 1
- Division 2
- Division 3
- Division 4
  - 411-A NOBLE COUNT
  - 411-B GARFELD COI
  - 411-C PAYNE COUNT
  - 411-F LOGAN COUNT
  - 411-H KAY COUNTY
  - 411-K KINGFISHER C
  - 411-L GRANT COUNT
  - 412-A DIVISION WIDE
  - 413-B GUTHRIE INTE
    - 864311
    - 864722
    - 864748
    - 865214
    - 865263
    - 865264
  - 413-C TONKAWA INT
  - 414-A SIGN CREW
- Division 5
- Division 6
- Division 7
- Division 8

Search ...

Divisions

- Division 1
- Division 2
- Division 3
- Division 4
  - 411-A NOBLE COUNT
    - 864747
    - 865135
    - 865162

### Manage Truck : 864747

Description:

2001 INT Tandem Axle

Cellphone:

ITS006

Commissioned:

Inactive

✓ Active

Surplussed

✓ Save

Search ...

Divisions

- Division 1
- Division 2
- Division 3
- Division 4
  - 411-A NOBLE COUNT
    - 864747
    - 865135
    - 865162

### Manage Truck : 864747

Description:

2001 INT Tandem Axle

Cellphone:

ITS006

Commissioned:

Active

✓ Save



# MDCC Settings: Data collection

- Remote data settings
- Data collection setting per truck/county/division/all.
- Image size
- Several counters
  - Image
  - Location
  - Sand spreader info
  - Plow position
  - Weather parameters
  - Surface temp
  - Acceleration
  - Gyroscope

## Manage Trucks Structure

Search ...

Divisions

Division 1

Division 2

Division 3

Division 4

Create

Rename

Remove

Settings

Search

412-A DIVISION WIDE I

413-B GUTHRIE INTER

864311

864722

864748

865214

865263

865264

Manage Division : Division 4

Picture X:

680

Picture Y:

480

Capturing interval:

300

Data interval:

60

Location interval:

30

BBB interval:

0

BWS interval:

0

Save

# Video Processing and Viewing: Event

- Driver communicates back to dispatch via Video recording including voice.
- Recordings are kept in private DB until published by ODOT

The screenshot displays a mobile application interface for managing sensor events. At the top, there's a 'Trip Date' selector set to '2015-10-01'. Below it, a calendar view shows the month of September 2015, with the 1st highlighted. A search bar is visible on the left. The main area is titled 'Manage Sensors Event' and contains a table with columns: Division, County, Truck ID, Longitude, Latitude, Datetime, Event, and Viewed. The table lists various events, mostly from Division 8 and Craig County, with truck IDs like 864981 and 865141. A 'Confirm Dialog' is overlaid on the table, showing the text 'Accident with injury' and a priority selection (Low, Mid, High) with 'High' selected. The dialog has 'Confirm' and 'Cancel' buttons. The background interface also shows a list of divisions on the left and a 'Mobile Data' header.

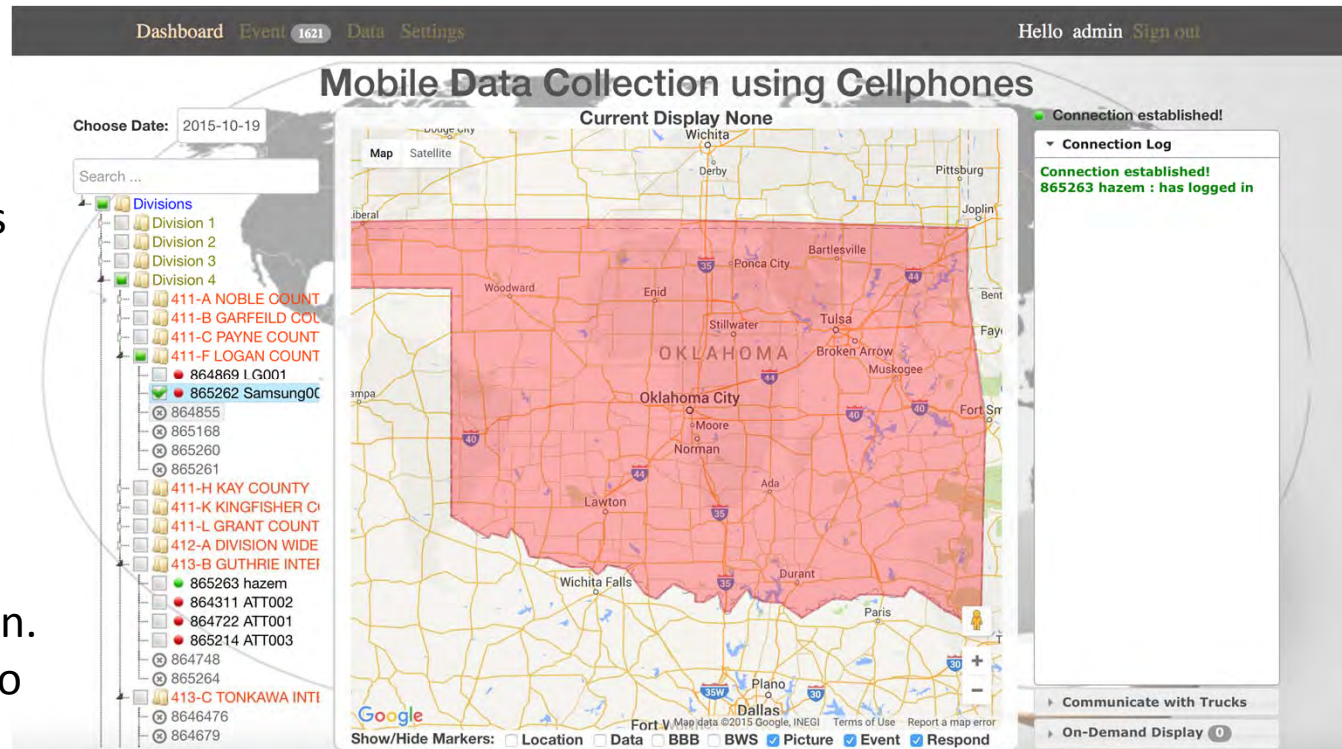
Division	County	Truck ID	Longitude	Latitude	Datetime	Event	Viewed
Division 8	811-A CRAIG COUNTY	864981	37.1467035	36.210933	2015-10-07 17:53:45		
Division 8	811-A CRAIG COUNTY	864981	37.150174	36.2113817	2015-10-07 17:53:38		
Division 8	811-A CRAIG COUNTY	864981	37.1500323	36.2143582	2015-10-07 17:53:33		
Division 8	811-A CRAIG COUNTY	864981	37.1500615	36.2121949	2015-10-07 17:53:10		
Division 8	811-A CRAIG COUNTY	864981	37.1526653	36.2082073	2015-10-07 17:52:27		
Division 8	811-A CRAIG COUNTY	865141	37.3621355	37.0592386	2015-10-02 07:40:52		
Division 8	811-A CRAIG COUNTY	865141	37.361852	37.0591984	2015-10-02 01:25:13		
Division 8	811-A CRAIG COUNTY	865141	37.3617875	37.0591587	2015-10-01 21:51:27		
Division 8	811-A CRAIG COUNTY	865141	37.3618835	37.059255	2015-10-01 21:29:02		
Division 8	811-A CRAIG COUNTY	865141	37.3618766	37.0592762	2015-10-01 21:28:42		
Division 8	811-A CRAIG COUNTY	865141	37.3618512	37.0593115	2015-10-01 21:28:30		
Division 8	811-A CRAIG COUNTY	865141	37.3618076	37.0592943	2015-10-01 21:28:05		
Division 8	811-A CRAIG COUNTY	865141	37.361851	37.0592608	2015-10-01 21:27:51		
Division 8	811-A CRAIG COUNTY	865141	37.3618877	37.0592509	2015-10-01 21:27:26		
Division 8	811-A CRAIG COUNTY	865141	37.3618676	37.0592888	2015-10-01 21:27:07		
Division 8	811-A CRAIG COUNTY	865141	37.3618437	37.0592462	2015-10-01 21:26:57		
Division 8	811-A CRAIG COUNTY	865141	37.3618074	37.0592294	2015-10-01 21:26:46		
Division 8	811-A CRAIG COUNTY	865141	37.361859	37.0592825	2015-10-01 21:26:33		
Division 8	811-A CRAIG COUNTY	865141	37.3618735	37.0592621	2015-10-01 21:26:10		
Division 8	811-A CRAIG COUNTY	865141	37.3618597	37.059227	2015-10-01 21:25:51		

- Search feature per division, county, truck



# Real-Time (RT) Monitoring: Dashboard

- List/search trucks in tree format (All/Divisions/Counties/truck) for ease of accessibility
- Display truck state: Active (green), Inactive (red), and not configured (x).
- Information are updated as it arrives from truck (Pseudo - RT)
- Special display windows: Connection, Communication, and On-Demand.
- Connection shows trucks/cellphone activities.
- Communication allows operator to transmit instructions in text, or request additional information.
- Flexibility of marker display selection.
- Truck status information.
- Automatic map zoom to selected trucks.



# RT- Communication: Dashboard

- Unicast (single truck) and broadcast (multiple trucks within a county or division) messages can be transmitted to truck(s).
- On-demand requests can be transmitted for additional information.

The screenshot displays the RT- Communication Dashboard interface. At the top, there are navigation tabs: Dashboard, Event (1621), Data, and Settings. The user is logged in as 'admin' and can click 'Sign out'. The main title is 'Mobile Data Collection using Cellphones'.

On the left, there is a 'Choose Date' dropdown set to '2015-10-19' and a 'Search ...' input field. Below these is a tree view of 'Divisions' and counties, including:

- Division 1
- Division 2
- Division 3
- Division 4
- 411-A NOBLE COUNT
- 411-B GARFIELD COL
- 411-C PAYNE COUNT
- 411-F LOGAN COUNT
- 864869 LG001
- 865262 Samsung0C
- 864855
- 865168
- 865260
- 865261
- 411-H KAY COUNTY
- 411-K KINGFISHER C
- 411-L GRANT COUNT
- 412-A DIVISION WIDE
- 413-B GUTHRIE INTE
- 865263 hazem (selected)
- 865264
- 413-C TONKAWA INTI
- 8646476
- 864679

Below the tree view are buttons for 'Display Map' and 'Communicate'.

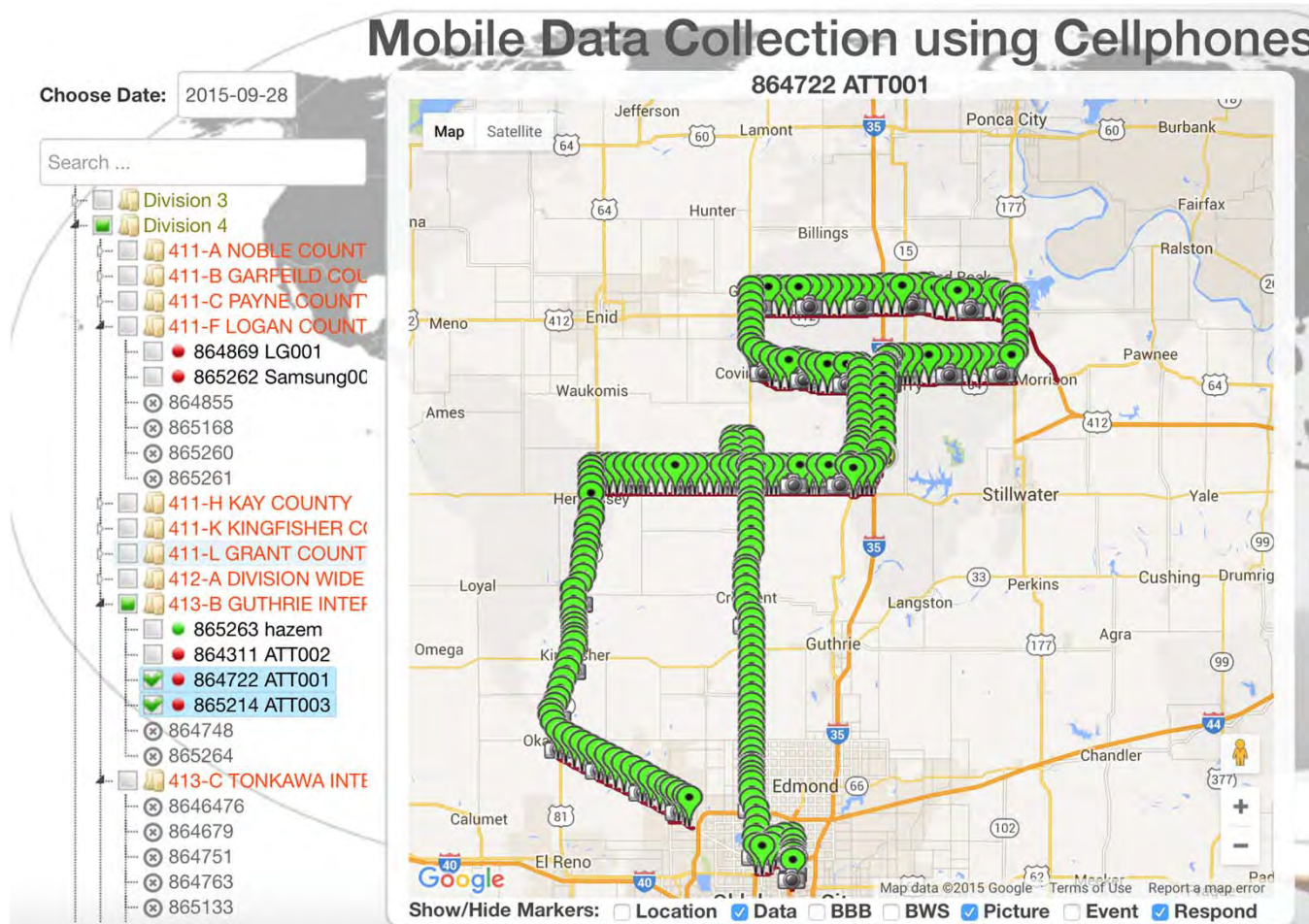
The central map shows Oklahoma with various cities labeled, including Liberal, Woodward, Enid, Ponca City, Bartlesville, Stillwater, Tulsa, Broken Arrow, Muskogee, Oklahoma City, Moore, Norman, Ada, Lawton, Wichita Falls, Durant, Plano, Dallas, Lubbock, Plainview, Canyon, Amarillo, Borger, Pampa, and Jumas. A specific truck, '865263 hazem', is highlighted on the map near Woodward.

On the right side, there is a 'Connection established!' status. Below it is a 'Connection Log' section. The 'Communicate with Truck' section shows the truck's name '865263 hazem' and options for 'GPS Location' (Latitude, Longitude), 'Last Communication' (Time), and a 'Message' input field with the text 'Hello.'. There are also buttons for 'Sensors and Picture', 'Event', 'Temp, Plow State, SS state', and 'Truck Speed', along with a 'Send' button.

At the bottom, there is an 'On-Demand Display' section with a dropdown menu set to '0'. Below the map, there are checkboxes for 'Show/Hide Markers': Location, Data, BBB, BWS, Picture (checked), Event (checked), and Respond (checked).



# RT- Truck Location Monitoring (data/image markers)



# RT- Truck Location Monitoring (video marker)

## Mobile Data Collection using Cellphones

Choose Date: 2015-09-28

Search ...

- Division 3
- Division 4
  - 411-A NOBLE COUNT
  - 411-B GARFIELD COL
  - 411-C PAYNE COUNT
  - 411-F LOGAN COUNT
    - 864869 LG001
    - 865262 Samsung0C
    - 864855
    - 865168
    - 865260
    - 865261
  - 411-H KAY COUNTY
  - 411-K KINGFISHER C
  - 411-L GRANT COUNT
  - 412-A DIVISION WIDE
  - 413-B GUTHRIE INTE
    - 865263 hazem
    - 864311 ATT002
    - 864722 ATT001
    - 865214 ATT003
  - 864748
  - 865264
  - 413-C TONKAWA INTE
    - 8646476
    - 864679
    - 864751
    - 864763
    - 865133

Map Satellite

truck ID: 864722  
Latitude: 36.1504936 Longitude: -97.3298908

864722 ATT001

00:00 | -00:03

Google

Show/Hide Markers: ☐ Location ☐ Data ☐ BBB ☐ BWS ☐ Picture ☒ Event ☒ Respond



# Interactive Data Review & Management

- Rich search features
- Export data into CSV
- Map location and routes taken by trucks.

**Manage Trips**

Trip Date : 2015-09-28  
2015-10-19

Search ...

**Divisions**

- Division 1
- Division 2
- Division 3
- Division 4
  - 411-A NOBLE COUNT
  - 411-B GARFIELD COU
  - 411-C PAYNE COUNT
  - 411-F LOGAN COUNT
  - 411-H KAY COUNTY
  - 411-K KINGFISHER CX
  - 411-L GRANT COUNT
  - 412-A DIVISION WIDE
  - 413-B GUTHRIE INTEF
  - 864311
  - 864722
  - 864748
  - 865214
  - 865263
  - 865264
  - 413-C TONKAWA INTE
  - 414-A SIGN CREW
- Division 5
- Division 6
- Division 7
- Division 8

**Search in : ALL Divisions**

	Division	County	Truck ID	Start Date	Start Time	Finish Date	Finish Time	Options
1	Division 4	413-B GUTHRIE INTER	864722	2015-09-28	13:35:49	2015-09-28	14:23:22	📍 📄 ⌂
2	Division 4	413-B GUTHRIE INTER	864722	2015-09-28	12:44:15	2015-09-28	13:35:12	📍 📄 ⌂
3	Division 4	413-B GUTHRIE INTER	864722	2015-09-28	09:14:36	2015-09-28	12:33:53	📍 📄 ⌂
4	Division 4	413-B GUTHRIE INTER	864722	2015-09-28	08:00:28	2015-09-28	09:09:22	📍 📄 ⌂

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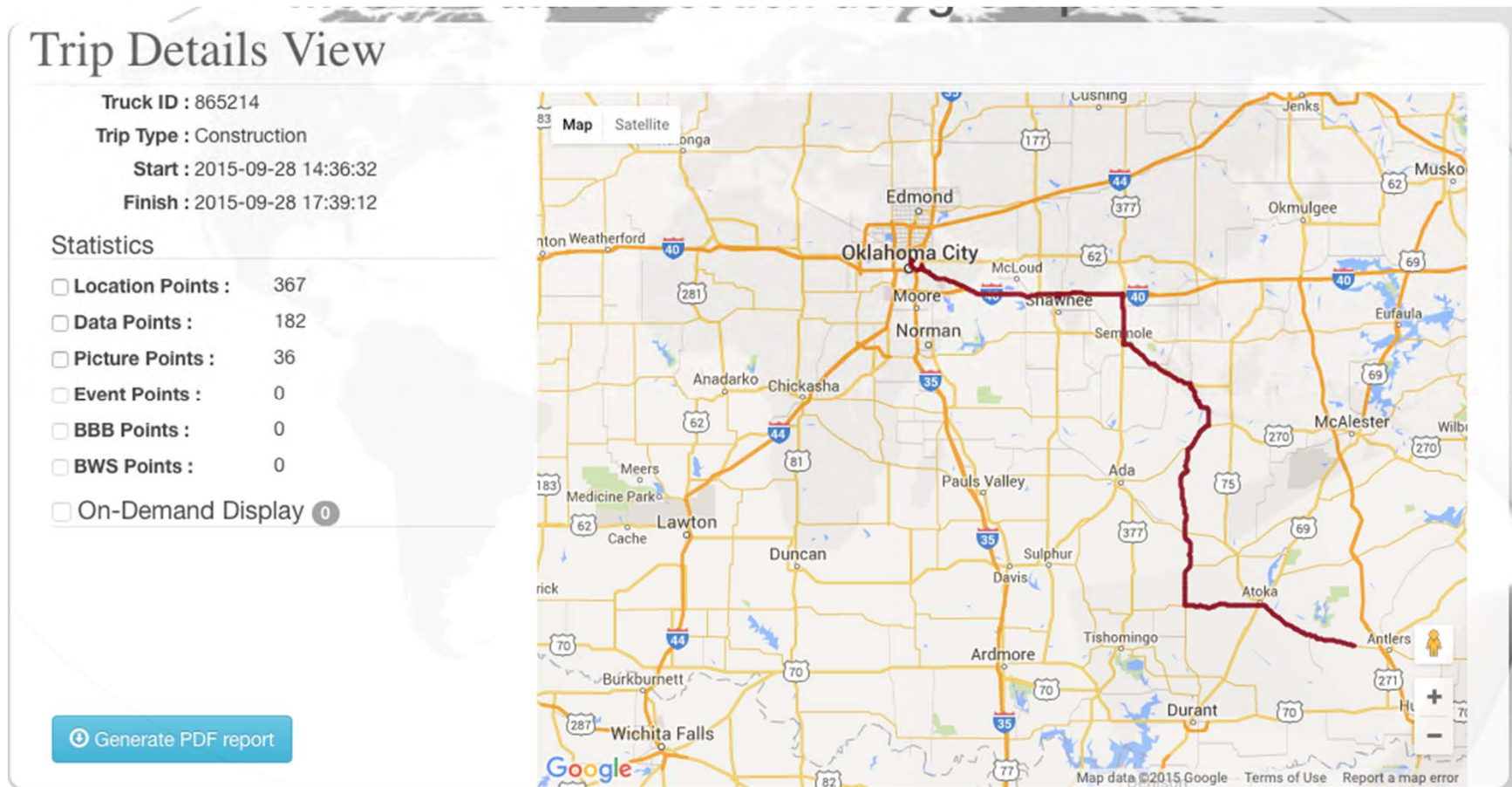
Location Points Data Points Picture Points Event Points BBB Points BWS Points On-Demand

	Truck ID	Longitude	Latitude	Datetime	Picture
1	864722	-97.8994377	36.0713137	2015-09-28 13:35:04	
2	864722	-97.8956949	36.1166872	2015-09-28 13:30:04	
3	864722	-97.8118938	36.1162755	2015-09-28 13:25:03	
4	864722	-97.7152254	36.1159806	2015-09-28 13:19:59	
5	864722	-97.6232424	36.1160673	2015-09-28 13:14:58	
6	864722	-97.5468399	36.1160087	2015-09-28 13:09:57	

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# Trip Report

- Interactive database tool
- Data collected per trip.
- Generate a PDF report



# Video reviews

## Trip Details View

Truck ID : 864722

Trip Type : Construction

Start : 2015-09-28 13:35:49

Finish : 2015-09-28 14:23:21


### Statistics

<input type="checkbox"/> Location Points :	96
<input type="checkbox"/> Data Points :	47
<input type="checkbox"/> Picture Points :	8
<input checked="" type="checkbox"/> Event Points :	1
<input type="checkbox"/> BBB Points :	0
<input type="checkbox"/> BWS Points :	0
<input type="checkbox"/> On-Demand Display	0

[Generate PDF report](#)

2015-09-28 13:41:51

truck ID: 864722  
Latitude: 35.9869564  
Longitude: -97.9091263



Map Satellite

Google

Map data ©2015 Google Terms of Use Report a map error



# Image review

## Trip Details View

Truck ID : 864722

Trip Type : Construction

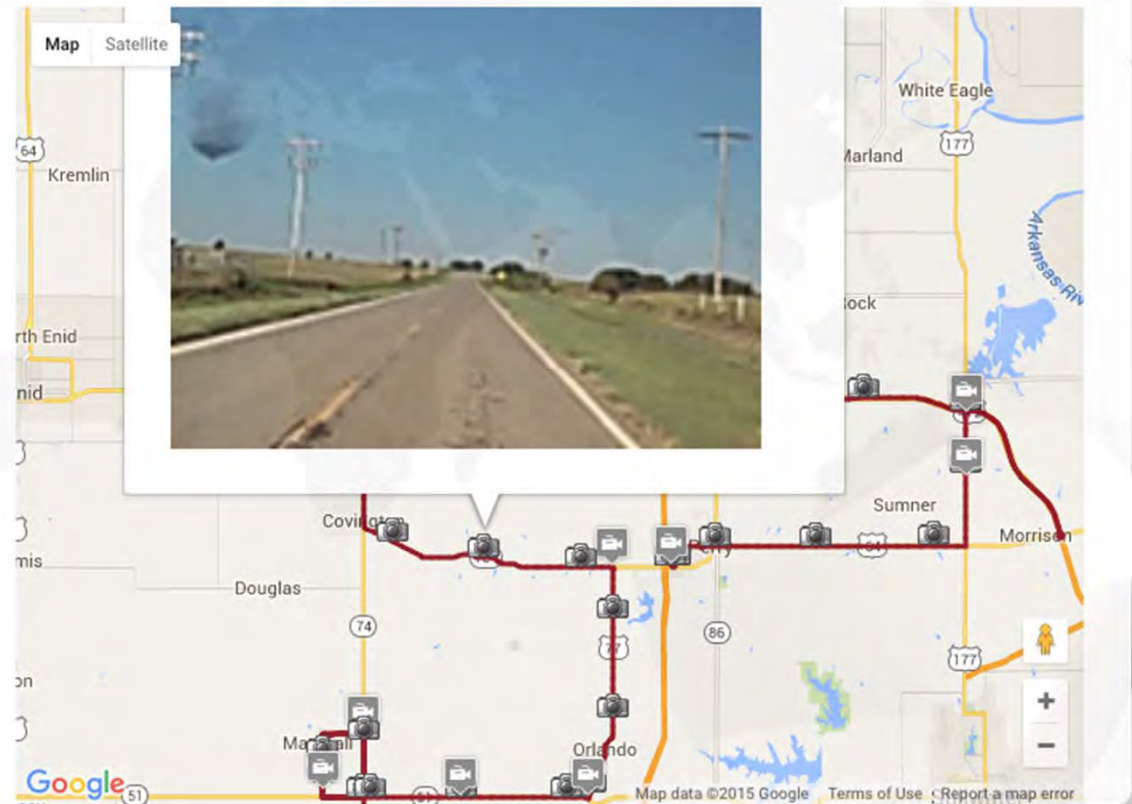
Start : 2015-09-28 09:14:35

Finish : 2015-09-28 12:33:52

### Statistics

- ☐ Location Points : 400
- ☐ Data Points : 199
- ☒ Picture Points : 39
- ☒ Event Points : 10
- ☐ BBB Points : 0
- ☐ BWS Points : 0
- ☐ On-Demand Display 0

[Generate PDF report](#)









# PDF Report and CSV data files

- The report includes date, time and GPS location at the moment data are being collected.
  - Route location.
  - Cellphone gyroscope and acceleration.
  - Sand spread information.
  - Plow position.
  - Weather parameters.
  - Surface temperature.
  - Distance traveled.
  - Truck speed.



## Mobile Data Collection using Cellphones

22	36.3975366	-97.4723732	2015-09-28 10:45:27	
23	36.3974643	-97.5704851	2015-09-28 10:40:27	
24	36.3437095	-97.5863324	2015-09-28 10:35:27	
25	36.2925306	-97.5611124	2015-09-28 10:30:26	
26	36.2822502	-97.4833751	2015-09-28 10:25:25	
27	36.2750102	-97.3988607	2015-09-28 10:20:19	

# Future Software Development

- Incorporate route coloring to indicate past time since last plow or sand application per roadway.
- Improve auto zooming capabilities.
- Incorporate weather status maps into the driver interface
- Allow search by location, roadway, or highway.
- Implement play back function of historical trips.

# Future Big Data and Research Activities

- Develop data mining algorithms to detect hidden patterns.
- Develop truck deployment algorithms to optimize road condition improvements.
- Develop models for dispensing proper (optimal) amount of sand needed to clear and maximize road condition improvement.
- Models to relate road condition improvements (measured by average travel speed increase on a roadway segment ) with the amount of dispensed sand, plow trips, materials type, etc.
- Models to relate weather patterns, road surface temperature, materials type, and truck velocity with road condition improvement.



# Conclusion

- Transforming snowplow trucks into data collection platforms.
- Improving driving conditions of roadways while enhancing safety of motorists.
- Providing public with RT data and empowering public to make proper driving decisions.
- Reducing materials cost and sand wastefulness.
- Reducing environmental impact of excessive sand application.

# Acknowledgment

- Oklahoma Department of Transportation for funding this project.
- Mr. Alan Stevenson and Mr. Jared Schwennesen for providing valuable implementation ideas, critical reviews, and support.
- Mr. Ron Bruce and Ms. Reina Wilson for conducting field-testing.