

# **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:

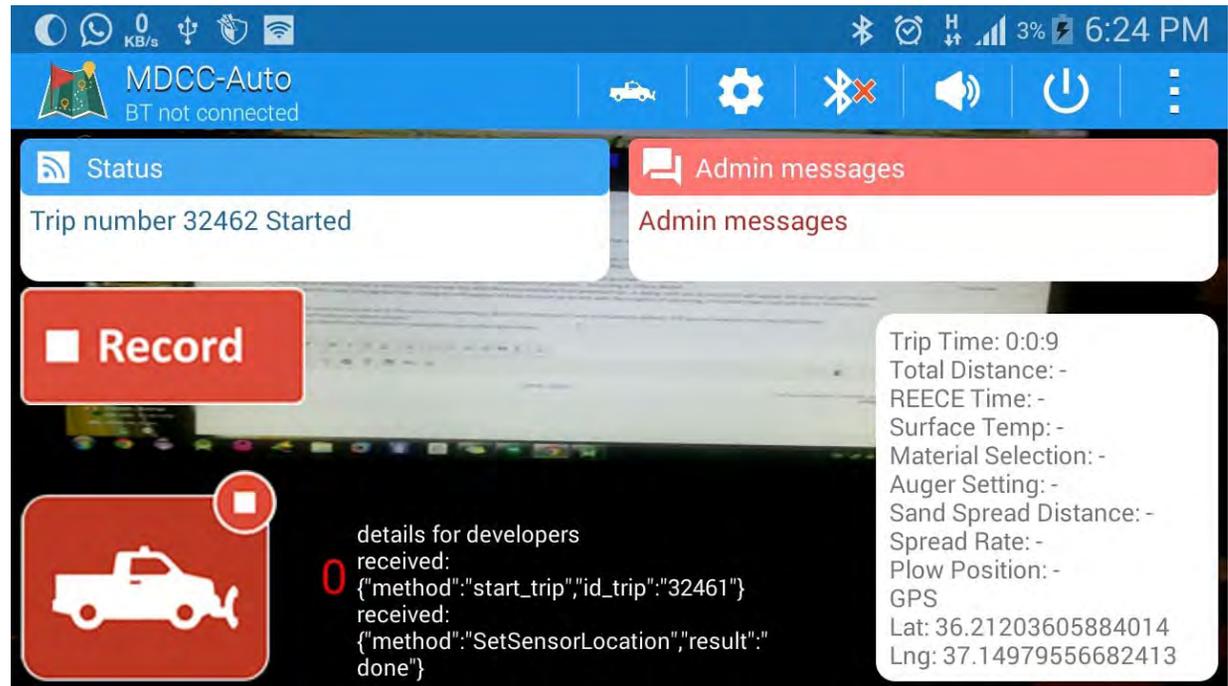
Surface temp	Wind strength/direction
Ambient temp	Humidity
Barometric pressure	Dew-point and rainfall

- 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

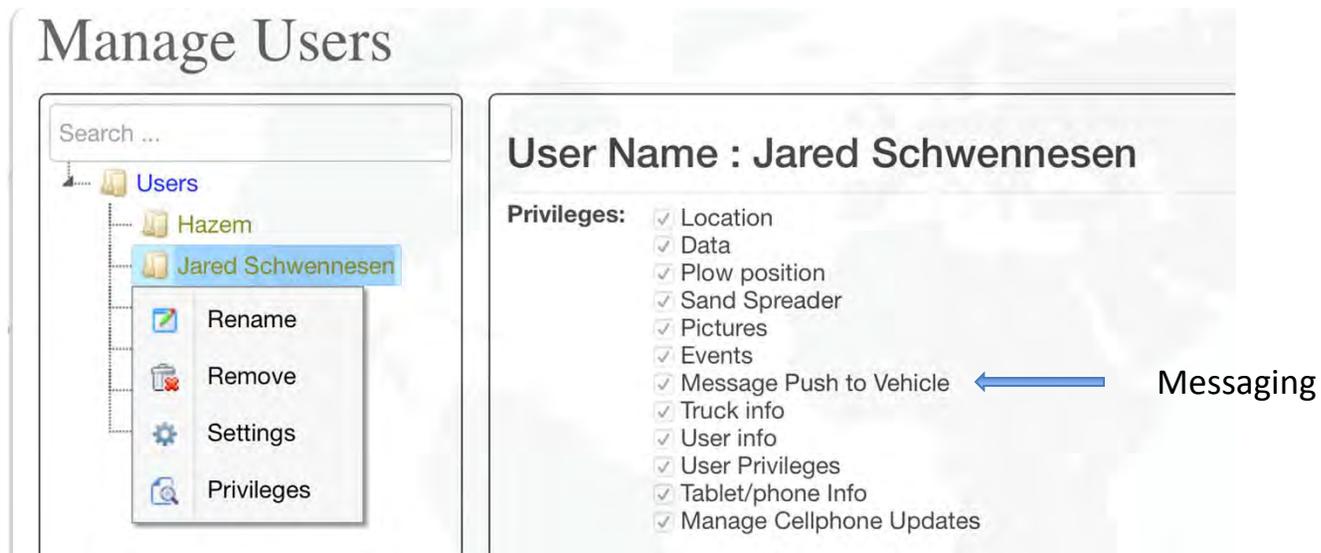
# MDCC Driver Interface

- 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



# 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



The screenshot displays the 'Manage Cellphones' interface. On the left, a tree view shows a folder named 'Cellphones' containing several devices: ATT001, ATT002, ATT003, ATT004, ATT005, ITS004, ITS005, ITS03 (selected), Samsung001, ammar, hazem, and note2. A context menu is open over the 'ITS03' device, showing options for 'Rename', 'Remove', and 'Settings'. On the right, the 'Settings' form for 'ITS03' is visible, including fields for 'New Password', 'Repeat Password', and 'Mac Address' (displaying '2c:54:cf:fb:23:e1'), and a 'Save' button.

# 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 GARFEILD 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

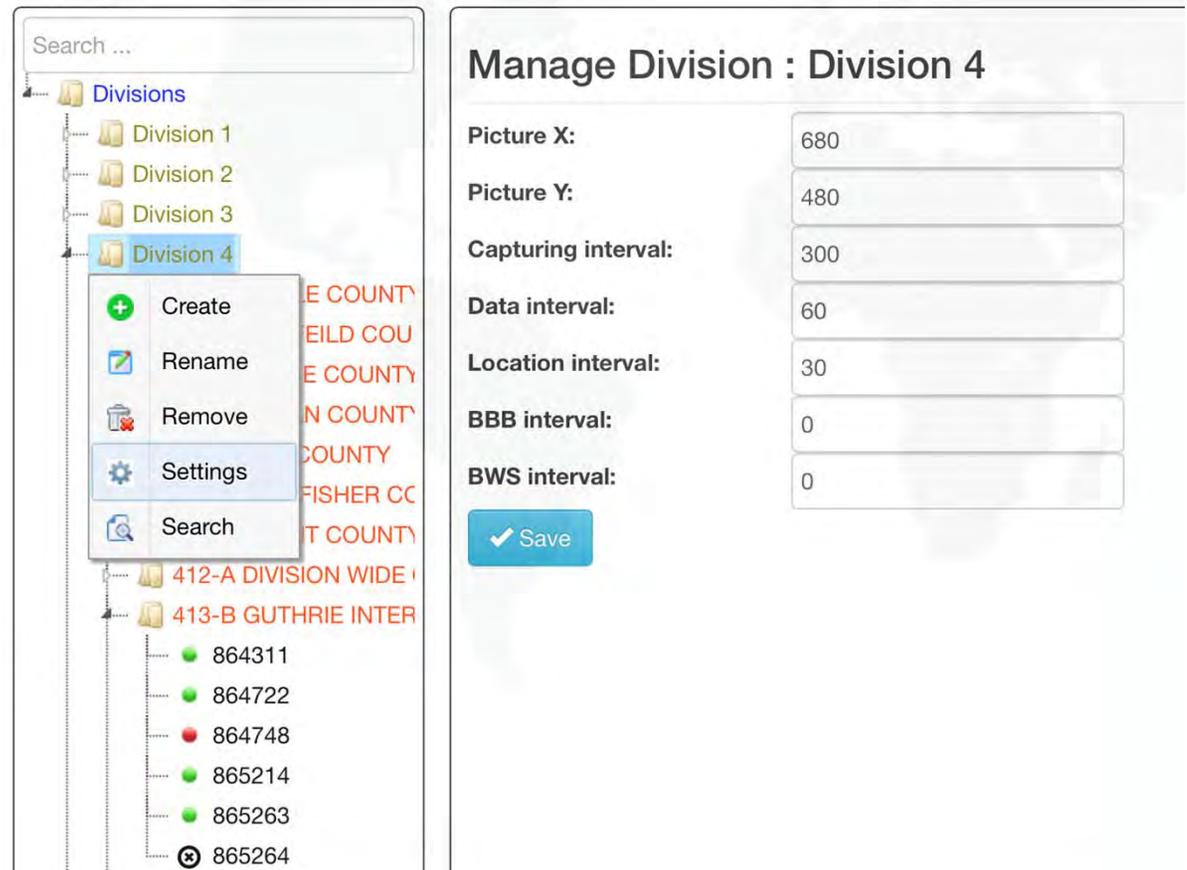
**Commissioned:** Active

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



The screenshot shows a web interface for managing truck data collection settings. On the left, a tree view displays a hierarchy of 'Divisions' (Division 1 through Division 4) and specific truck units. A context menu is open over 'Division 4', offering options: Create, Rename, Remove, Settings (highlighted), and Search. Below the tree, several truck units are listed with status indicators (green or red dots): 412-A DIVISION WIDE I, 413-B GUTHRIE INTER, 864311, 864722, 864748, 865214, 865263, and 865264.

On the right, the 'Manage Division : Division 4' settings panel is visible, containing the following configuration options:

Picture X:	680
Picture Y:	480
Capturing interval:	300
Data interval:	60
Location interval:	30
BBB interval:	0
BWS interval:	0

A 'Save' button is located at the bottom of the settings panel.

# 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

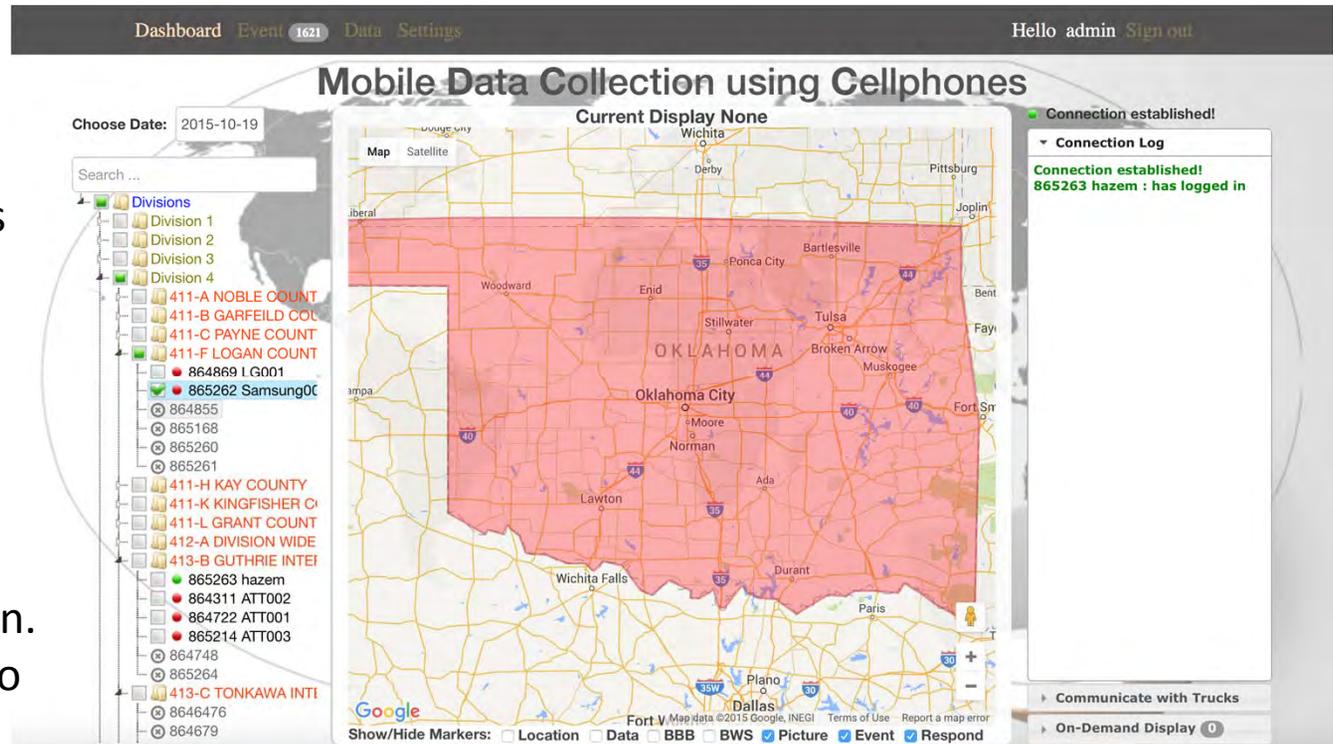
The screenshot shows a web application interface. On the left, there is a calendar for the month of September 2015, with the 4th of the month highlighted. Below the calendar is a search bar and a tree view of divisions. The main area displays a table titled "Manage Sensors Event" with columns for Division, County, Truck ID, Longitude, Latitude, Datetime, Event, and Viewed. The table contains 14 rows of data, all from Division 8, 811-A CRAIG COUNTY, with various truck IDs and timestamps. A "Confirm Dialog" window is overlaid on the table, showing the text "Accident with injury" and "Priority :  Low  Mid  High". The dialog has "Confirm" and "Cancel" buttons.

The screenshot shows a mobile data application interface. On the left, there is a search bar and a tree view of divisions. The main area displays a table titled "Manage Sensors Event" with columns for Division, County, Truck ID, Longitude, Latitude, Datetime, Event, and Viewed. The table contains 20 rows of data, all from Division 8, 811-A CRAIG COUNTY, with various truck IDs and timestamps. A "Confirm Dialog" window is overlaid on the table, showing the text "Accident with injury" and "Priority :  Low  Mid  High". The dialog has "Confirm" and "Cancel" buttons.

- Search feature per division, county, truck

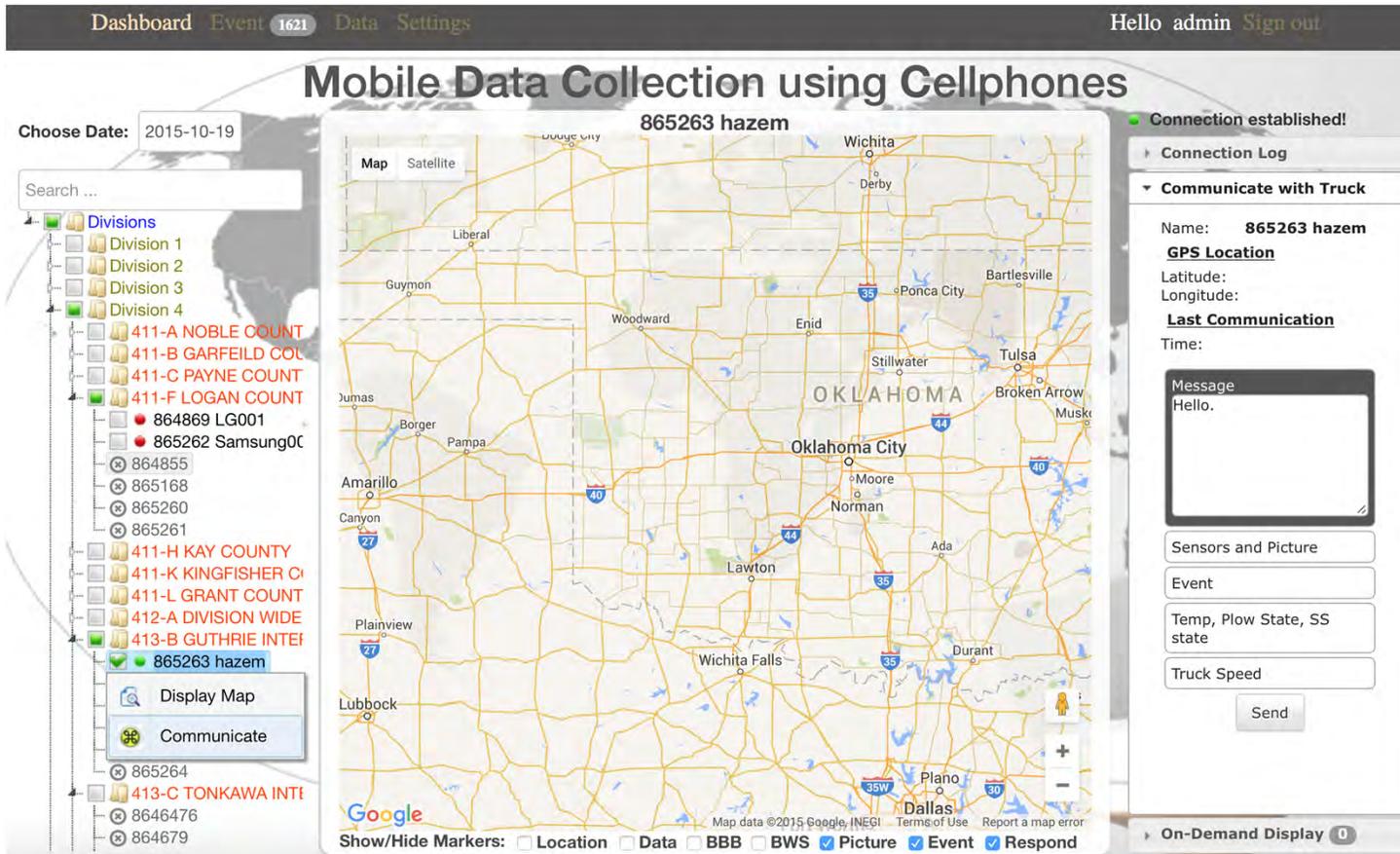
# Real-Time (RT) Monitoring: Dashboard

- 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 dashboard interface includes a top navigation bar with 'Dashboard', 'Event 1621', 'Data', and 'Settings'. The user is logged in as 'admin' with a 'Sign out' option. The main title is 'Mobile Data Collection using Cellphones'.

**Left Panel:** A tree view of 'Divisions' (Division 1-4) and various county-level events (e.g., 411-A NOBLE COUNT, 411-B GARFIELD COL, 411-C PAYNE COUNT, 411-F LOGAN COUNT). A search bar is present above the tree. Below the tree are buttons for 'Display Map' and 'Communicate'.

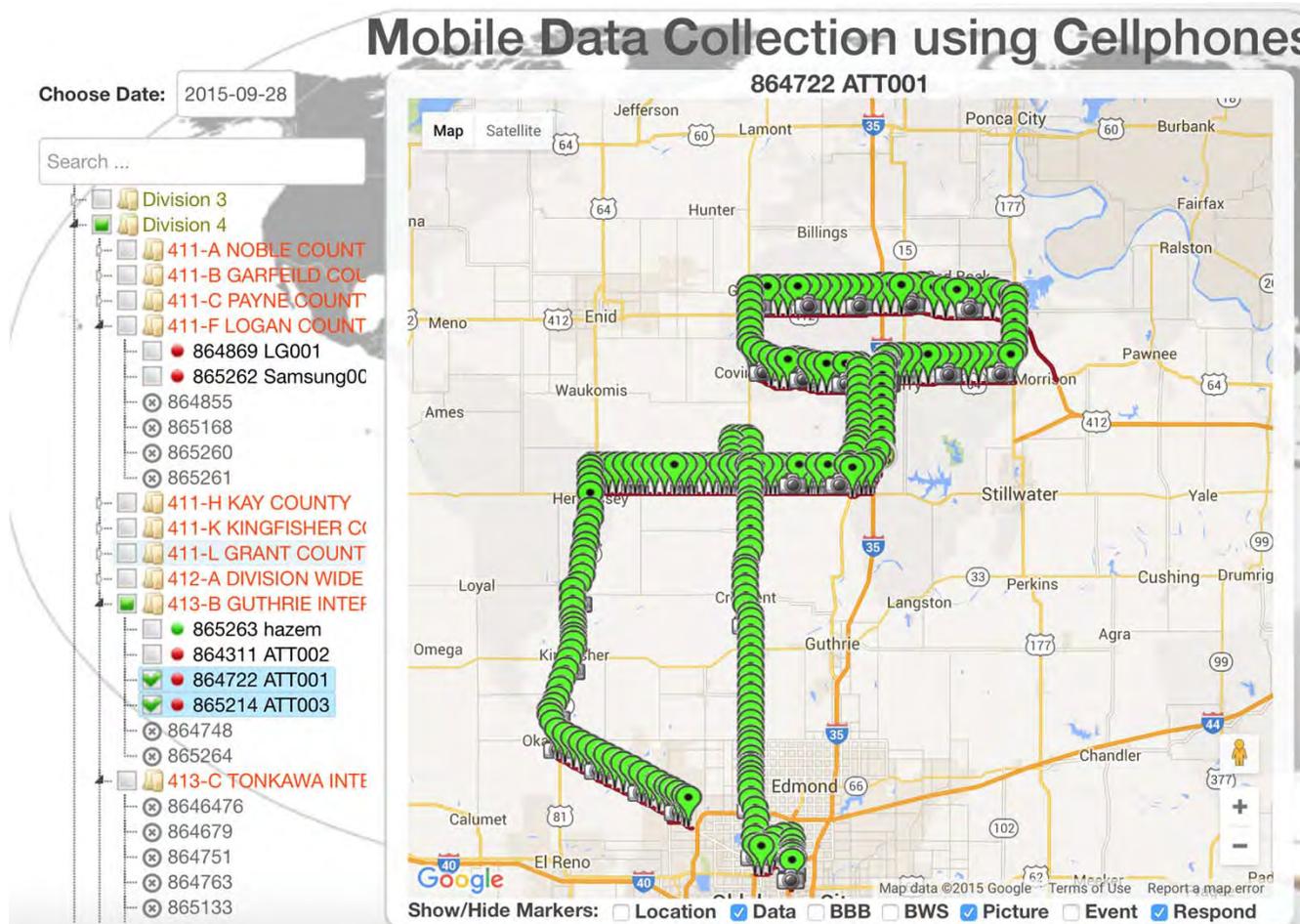
**Map:** A Google Map of Oklahoma with a red location marker for '865263 hazem' near Woodward. The map shows major highways and city names like Oklahoma City, Tulsa, and Broken Arrow.

**Right Panel:** A communication interface for the selected truck. It shows 'Connection established!' and a 'Connection Log'. The 'Communicate with Truck' section includes:
 

- Name: 865263 hazem
- GPS Location: Latitude and Longitude fields.
- Last Communication: Time field.
- Message input area with the text 'Hello.'
- Buttons for 'Sensors and Picture', 'Event', 'Temp, Plow State, SS state', and 'Truck Speed'.
- A 'Send' button.

At the bottom, there are checkboxes for 'Show/Hide Markers' (Location, Data, BBB, BWS, Picture, Event, Respond) and an 'On-Demand Display' button.

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



# RT- Truck Location Monitoring (video marker)

## Mobile Data Collection using Cellphones

Choose Date: 2015-09-28

Search ...

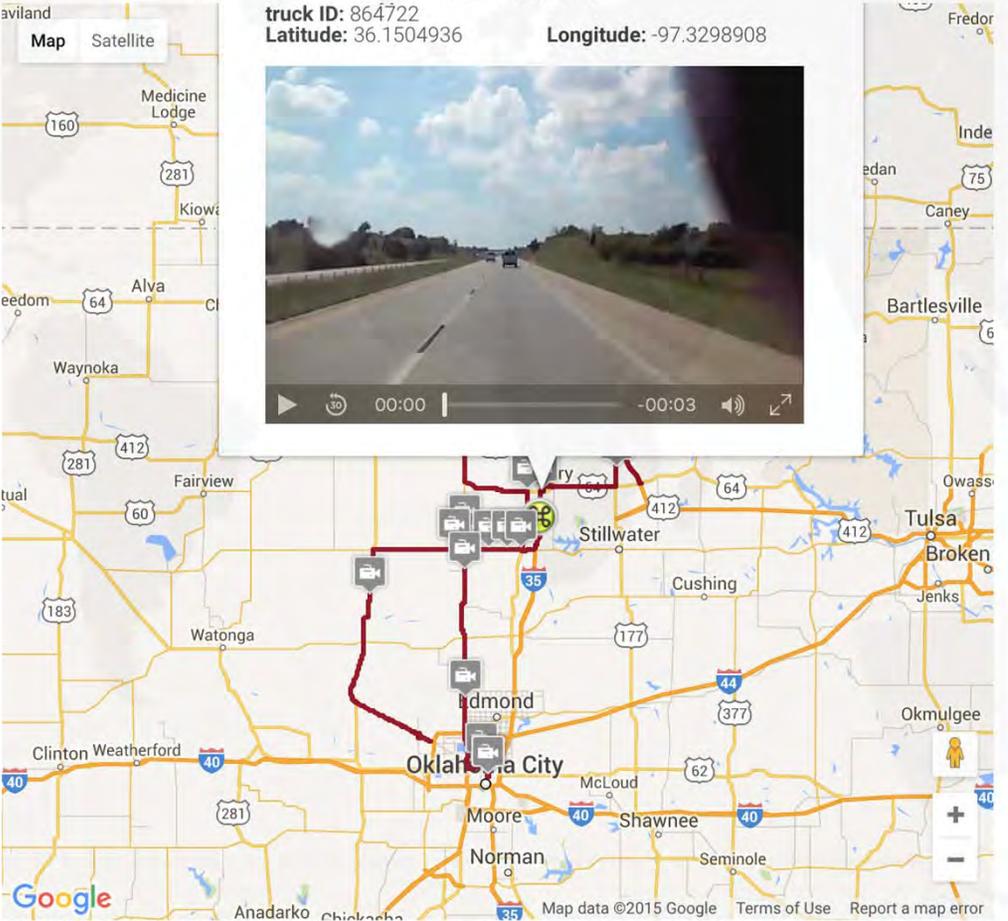
- Division 3
- Division 4
  - 411-A NOBLE COUNT
  - 411-B GARFIELD COL
  - 411-C PAYNE COUNT
  - 411-F LOGAN COUNT
    - 864869 LG001
    - 865262 Samsung0C
    - 864855
    - 865168
    - 865260
    - 865261
  - 411-H KAY COUNTY
  - 411-K KINGFISHER CO
  - 411-L GRANT COUNT
  - 412-A DIVISION WIDE
  - 413-B GUTHRIE INTEF
    - 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



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 INTERST	864722	2015-09-28	13:35:49	2015-09-28	14:23:22	📍 📄 🗄
2	Division 4	413-B GUTHRIE INTERST	864722	2015-09-28	12:44:15	2015-09-28	13:35:12	📍 📄 🗄
3	Division 4	413-B GUTHRIE INTERST	864722	2015-09-28	09:14:36	2015-09-28	12:33:53	📍 📄 🗄
4	Division 4	413-B GUTHRIE INTERST	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	

Page 1 of 1 10 View 1 - 10 of 10

# Trip Report

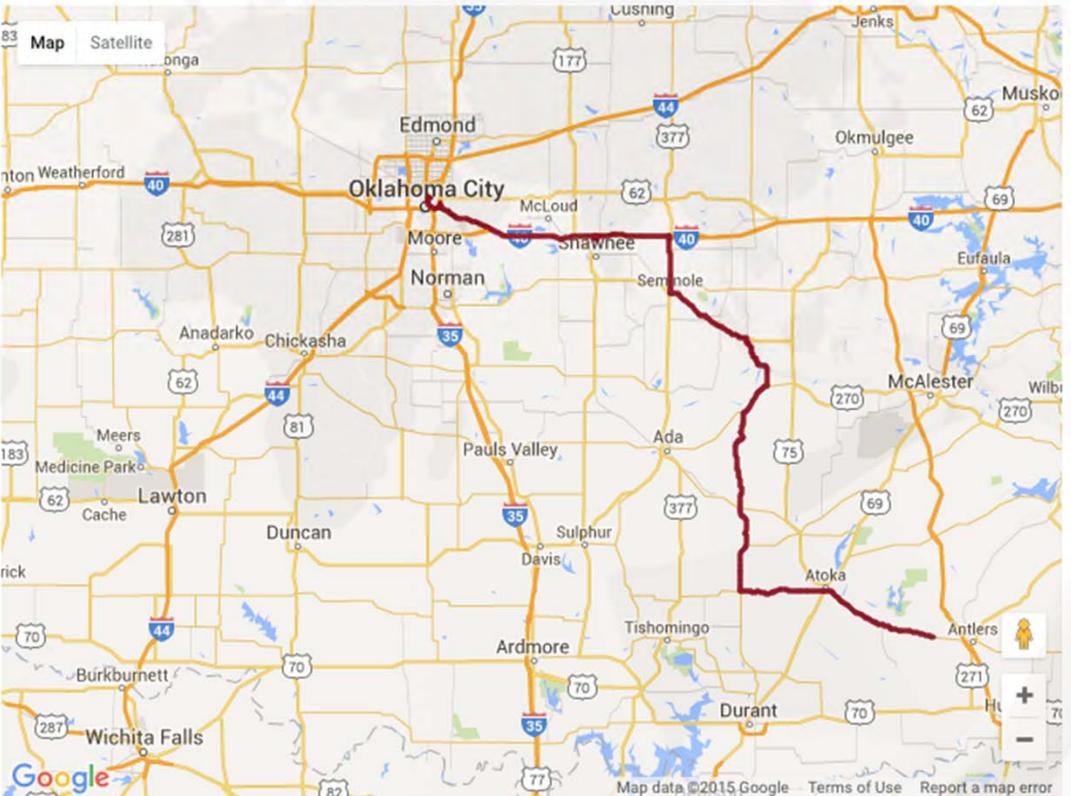
- Interactive database tool
- Data collected per trip.
- Generate a PDF report

## Trip Details View

Truck ID : 865214  
Trip Type : Construction  
Start : 2015-09-28 14:36:32  
Finish : 2015-09-28 17:39:12

### Statistics

<input type="checkbox"/> Location Points :	367
<input type="checkbox"/> Data Points :	182
<input type="checkbox"/> Picture Points :	36
<input type="checkbox"/> Event Points :	0
<input type="checkbox"/> BBB Points :	0
<input type="checkbox"/> BWS Points :	0
<input type="checkbox"/> On-Demand Display	0



[Generate PDF report](#)

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

# 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**

- Location Points : 96
- Data Points : 47
- Picture Points : 8
- Event Points : 1
- BBB Points : 0
- BWS Points : 0
- On-Demand Display **0**

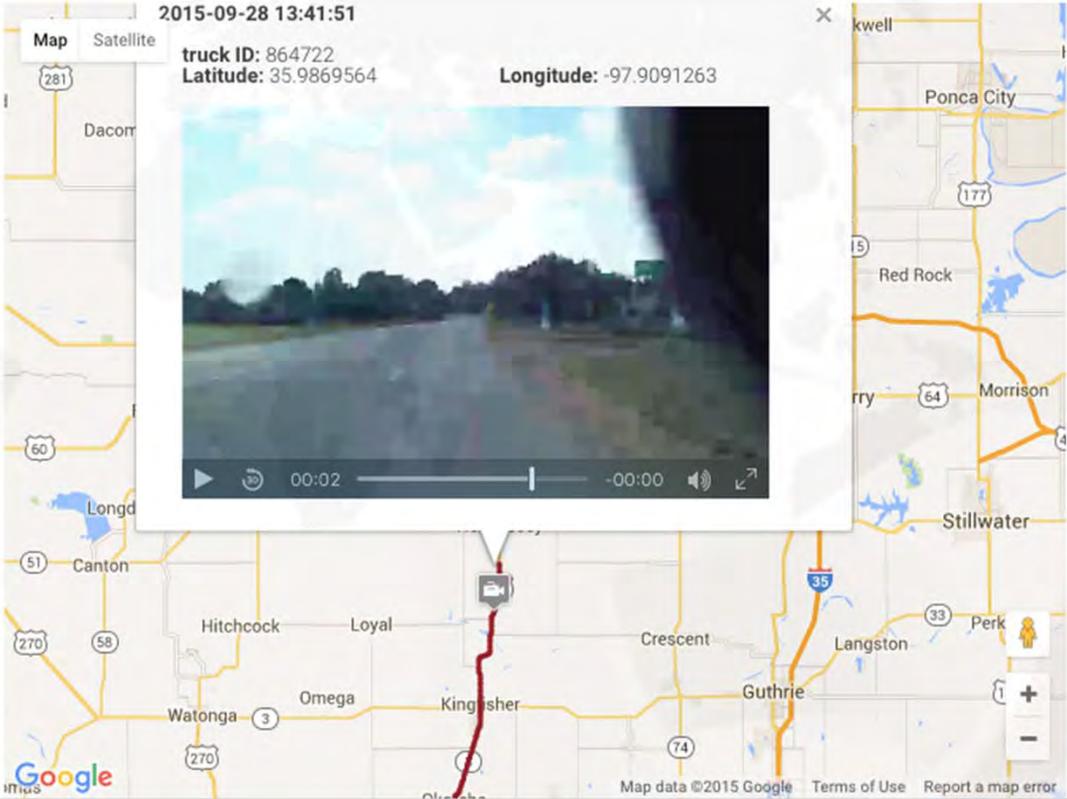
[Generate PDF report](#)

2015-09-28 13:41:51

truck ID: 864722  
Latitude: 35.9869564  
Longitude: -97.9091263



00:02 / -00:00



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

# Image review

## Trip Details View

Truck ID : 864722

Trip Type : Construction

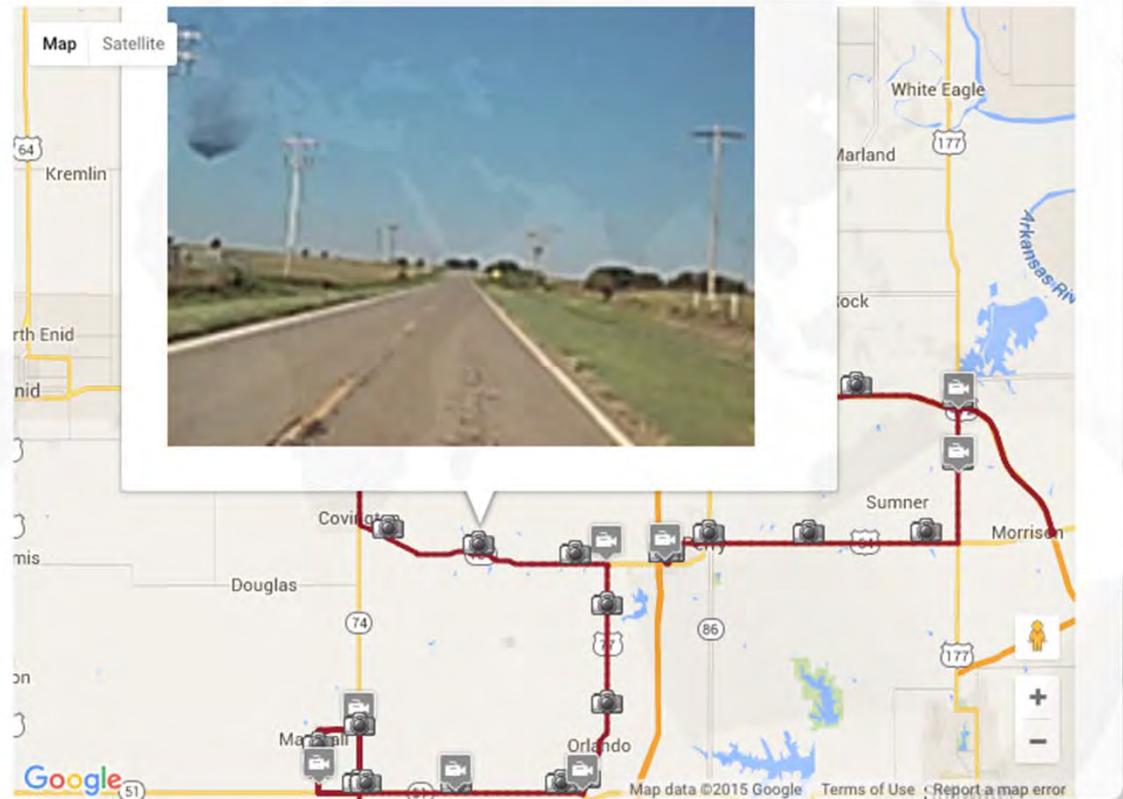
Start : 2015-09-28 09:14:35

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.