**Project 16-01: Utilization of AVL/GPS: Case Studies**

**Summary of Utah DOT In-Person Interviews**

**Overview**

Interviews were conducted by Ming-Shiun Lee and Dan Nelson of AECOM and coordinated with Tim Ularich of the Utah Department of Transportation (UDOT) on November 27 and 28th, 2017.

*UDOT Staff Interviews*

Meeting attendees throughout the day on Mon. Nov. 27th included the following individuals:

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| --- | --- |
| * + *Tim Ularich, Deputy Maintenance Engineer*   + *Brandon Klenk, Methods Engineer*   + *Kevin Griffin, Director of Maintenance*   + *Jeff Casper, Equipment Operations Manager*   + *CJ Connor, Maintenance Programs and Contracts Manager* | * + *Troy Starley, Equipment Specialist*   + *Wendy Kemp, Procurement Specialist*   + *Rodney Andrews, Equipment Specialist*   + *Nicole Godfrey, Equipment Systems Specialist* |

Meeting attendees throughout the day on Tues. Nov. 28th included the following individuals:

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| --- | --- |
| * + *Tim Ularich, Deputy Maintenance Engineer*   + *Jason Davis, Director of Operations*   + *Kevin Griffin, Director of Maintenance*   + *CJ Connor, Maintenance Programs and Contracts Manager* | * + *Kaitlyn Marousis, GIS Analyst*   + *Adam Radel, GIS Program Manager*   + *Greg Searle, Region 3 District Engineer*   + *Michael Cole, Area Supervisor*   + *Chad Hansen, Station Supervisor* |

*UDOT Executive Level Interviews*

Group met at the UDOT Headquarters in West Valley City to discuss how UDOT proceeded through the procurement process of their AVL / GPS system. UDOT determined in 2014 to install AVL / GPS technology in winter maintenance vehicles in an effort to increase the public transparency of their operations by providing snow plow locations to the general public via a public UDOT traffic information page and mobile application.

As part of the AVL / GPS procurement process, UDOT sent out a Request for Information (RFI) in 2014 to industry providers of AVL equipment requesting information on system costs, types of technology, and other items of interest. The responses to the RFI indicated that financially UDOT would not be able to deploy the AVL systems on a statewide basis as it had been desired.

Around that time, UDOT learned about a pre-negotiated contract that Verizon had entered into in 2011 with the Western States Contracting Alliance (WSCA), which is currently managed by the National Association of State Procurement Officials (NASPO). As a member of the WSCA, UDOT would be able to utilize that contract to purchase the associated hardware and software required for their AVL / GPS system.

UDOT had previously tested a pilot program with a Precise AVL / GPS system in 2012. Some issues encountered at that time related to sensor reliability and difficulty in data utilization. Upon further review of the system in 2014 though, UDOT found that they could implement their entire fleet of winter maintenance vehicles with the Verizon AVL system and still accomplish the objective of public transparency while staying within the available project budget.

In the spring of 2015, UDOT requested Verizon to perform a demonstration of the overall system on approximately 50 winter maintenance vehicles. Verizon performed the hardware installations on the vehicles and demonstrated the functionality and reliability of the system over a two-month period for UDOT. The vehicles were monitored by UDOT through the software package (NetworkFleet) by UDOT staff and features of the software were observed to confirm that the system was functioning properly.

Upon successful completion of the demonstration, UDOT purchased additional Verizon hardware that was then installed by a Verizon team of subcontractors in all 508 Class 8 winter maintenance vehicles prior to the 2015-2016 winter season. Since that time, additional UDOT maintenance equipment and Incident Management (Safety Service Patrol) vehicles have been equipped with Verizon units. UDOT staff have been trained to perform the installation of Verizon hardware on new winter maintenance vehicles and other maintenance equipment (i.e. sweepers, loaders, skid steers, mini-excavators, graders, etc.).

Key challenges associated with UDOT’s decision-making and deployment include:

* Financial constraint was the biggest barrier.
* Due to financial constraints, UDOT had to find a balance between plow location data vs. material usage data. The need for public transparency on plow locations outweighed tracking of material usage through AVL.
* The concern about "Big Brother" watching from drivers has been lessened but still persists for some.
* Involvement from Districts and Regions is key to success. Exposing technology to people helps buy-in and implementation. UDOT worked with staff in each region to gain buy-in to the system. In addition to providing continued training, UDOT holds monthly meetings with District Engineers to identify and discuss innovations.

Key benefits identified by the UDOT executives include:

* Ability to provide records of plow locations and activities, which help achieve public transparency.
* AVL data helps address liability issues and resolve tort claims.
* AVL data provides assistance in route planning and prevents gaps in plowing routes.
* AVL data with RWIS data provides real-time road conditions information which integrated in UDOT's Snow and Ice Performance Dashboard.
* The system facilitates better resource sharing and cross-regional coordination.
* AVL data supports performance management. AVL data enables UDOT to make performance measures available to the public, which in turn promotes public trust.
* Truck diagnostics have helped UDOT mechanics optimize their time by allowing for truck error code access to perform a preliminary diagnostic on mechanical issues.

UDOT noted their future plan related to expanding the system capabilities and to winter operations. The future plan includes:

* Integrating AVL system with spreader controllers to gather material usage data.
* Further development and enhancement of performance measures and management program.
* Investigating and implementing connect vehicle technologies.
* Equipping DSRC to snow plows to help with signal priority and I2V communications.

*UDOT Supervisor / Manager Level Interviews*

Group met at the UDOT Headquarters in West Valley City to discuss how UDOT staff interact with the AVL / GPS system. Vehicle maintenance staff that attended discussed the benefits that they have observed in reading the vehicle diagnostic codes that are communicated through the AVL software package (NetworkFleet). Staff receive automated alerts when these codes are detected, which provides valuable information on the appropriate maintenance actions needing to be taken. It was noted that in some cases, the codes have saved maintenance technicians from having to travel multiple hours to where snow plow drivers have stopped operating because of the vehicle error codes presented to them on the vehicle dashboard.

This capability is made possible through connection of the Verizon AVL hardware with the existing vehicle’s On-Board Diagnostics (OBD-II) port, which allows pre-defined vehicle codes to be sent as alerts through the NetworkFleet software package to alert UDOT staff that vehicle maintenance is needed in a specific area. This was noted as a major benefit of the system by UDOT managers and supervisors when discussing how they have used the NetworkFleet software. Given the long distance of some snow plow routes that travel through remote areas on UDOT highways, supervisor / maintenance staff would have to travel for multiple hours to address a problem that can now be diagnosed and addressed remotely from the garage.

UDOT Maintenance Supervisors also use the NetworkFleet software package to have automated reports generated for specific system users on items of concern, namely vehicle idling for extended periods of time or high speeds of travel in excess of pre-defined speed values on specific routes. These reports can be presented by supervisors to specific drivers as informational reports, which have had an observed positive impact on driver behavior. The information can also be used for training, retraining and coaching of new or targeted drivers.

UDOT also noted that the system allows for more efficient resource sharing and relocation to fight major (particularly localized) storms.

UDOT Maintenance staff noted another benefit of the Verizon NetworkFleet system has been the use bread crumb trail reports to address public complaints about the lack of snow clearance on specific roads or reported damage to parked vehicles by snow plows. UDOT supervisors at a regional or area level are able to quickly run a report in a specific area over the range of time that the public complaint was received. UDOT staff can then respond to the public complaint by presenting an image of when the snow plows had cleared snow along a specific roadway, or whether they were present along a roadway when damage had occurred to a parked vehicle.

It was noted that the general public has been pleased with UDOT’s responsiveness to the public’s complaints, even in cases where a UDOT snow plow was found to be liable for damage caused to a parked vehicle. The ability to use the AVL data and bread crumb trail of where vehicles have been in past snow storm events has also helped to accomplish the overall goal of increasing public transparency with respect to winter maintenance operations.

Installation of the system was smooth, and UDOT didn’t experience any issues. Additional wires and customized installation, however, was required on older trucks that did not have ODB-II ports. UDOT didn’t experience any issues with maintenance of the system either.

UDOT noted some issues with other equipment on the snow plows:

* UDOT experienced issues with plow sensors and gate sensors due to rusty or loose connections of wires. Nevertheless the sensors were very reliable with approximately 2 to 3 failures over more than 500 units over the past years.
* There were still gaps with cellular coverage. Verizon had the best coverage, but 75% to 80%.

UDOT uses the AVL system data to monitor and report the following performance measures:

* Snow and Ice Dashboard, which includes RWIS data and non-invasive "roadway grip" sensors to determine effectiveness of plowing operations
* New GIS based dashboards are being developed for Public Consumption.
* They also used the records from past storms to over serve past performance and identify contributing factors (e.g. types of material and equipment used). This helps UDOT to improve operations.

*UDOT IT /Data Management Level Interviews*

Group met at the UDOT Headquarters in West Valley City on Tues. Nov. 28th to review how UDOT IT and GIS staff currently support the AVL / GPS system.

Previous support efforts have included the automated presentation of snow plow vehicle locations on the UDOT traffic information webpage at: <http://udottraffic.utah.gov/RoadWeatherForecast.aspx>. It was noted that this was made possible by Verizon sharing its Application Programming Interface (API) with UDOT. This allowed UDOT GIS staff to capture data attributes reported to Verizon on vehicle latitude and longitude coordinates at a sufficient frequency (once every 30 seconds during winter months, 2 minutes during summer as plow locations are turned off for the public interface). These latitude and longitude points are then used to display the vehicle location on the UDOT traffic information webpage and mobile app. Additional steps were taken by UDOT staff to delay the reporting of vehicle location on the webpage by 2-3 minutes to alleviate driver concerns that real-time vehicle location could be used by individuals to plan specific attacks on the snow plow vehicles. UDOT staff noted that some of the reasons to choose the Verizon system over other vendors were:

* Verizon was the most cost effective way to get statewide coverage of all Class 8 Snow Plows. The also offered an API to migrate data to a public interface and provide vehicle diagnostics to help mechanics.
* Verizon had the best cellular coverage in the state of Utah.

When the general public accesses the traffic information page either through a computer or mobile device, they are presented with the following disclaimer which helps users to understand why there may be some observed inaccuracies in the route taken by snow plow vehicles:

“*The snowplow location feature on the UDOT Traffic displays information about actively working UDOT-only snowplows throughout the state of Utah. Plow location information is updated every 3-5 minutes. This information is provided to help travelers make smarter decisions about where and when to travel. Please note that areas without cellular phone coverage will not show plow movements, even though plows may be working. Plow location information is provided for awareness and is not intended to redirect plow resources. Every attempt has been taken to ensure the data is as accurate as possible, however data discrepancies may appear at any time.*”

Verizon stores UDOT AVL data on its server for one year. UDOT also downloads and stores the data in its GIS database. Staff resources for developing and maintaining the GIS interfaces and database were not an issue. Most of the resources were dedicated to the initial development of the GIS database and making vehicle location information available on the webpage. UDOT’s goal was to aim for automation of the system.

Issues with data accuracy were identified by UDOT staff. Data inaccuracy was mainly due to:

* Downtown areas due to urban canyons
* Canyon areas where cellular coverage was spotty
* Data was not detailed enough with a 30-second polling rate

UDOT GIS staff are currently developing an algorithm that would automate the process of using the software package to gather a bread crumb trail that would be used to respond to public complaints about either a lack of snow plowing along roadways or potential damage to parked vehicles caused by UDOT snow plows. Currently, this a manual process where Region or Area Supervisors will access the NetworkFleet software and search for bread crumb trails around the location and time of the complaint about winter maintenance operations. The automated process will reduce the amount of time spent by UDOT staff in searching for information to be used in responding to public complaints.

*UDOT Technician / Driver Level Interviews*

Group traveled to Region Three garages in Orem, UT to visit with technicians and take pictures of UDOT snow plow vehicles. UDOT is split into four regions that generally cover the northern, central, southern, and metro areas of the state. Within each region, UDOT winter maintenance staff are structured into the following general positions:

Region District Engineer: Responsible for overseeing all Areas within the region in terms of response to winter storms. This supervisor may be responsible for allocating some of the region’s resources to other regions of the state in the event of severe weather impacting that specific region.

Area Supervisor: Responsible for monitoring how multiple Maintenance Stations within the their respective area have allocated resources to plow roads within a specific area of that region. Reports to District Engineer and communicates with Station Supervisors as needed during winter events.

Station Supervisor: Responsible for overseeing multiple snow plow drivers performing along their assigned snow plow routes within that part of the Area within the Region.

It was noted that District Engineers and Area Supervisors use the NetworkFleet software package on a more frequent basis than Station Supervisors, who also are active in plowing snow during winter weather events. Area Supervisors noted the ability to monitor vehicle locations to enable sharing and relocating resources was extremely useful. In addition to monitor vehicle locations, Area Supervisors felt the system was very useful for:

* Verifying snow maintenance activities
* Coupled with UDOT cameras, verifying and confirming pavement conditions

UDOT staff noted that drivers might have high level of resistance to the AVL system initially but the concern has been mostly alleviated now. Showing the vehicle locations on the public webpage didn’t create issues or damages to drivers, which helps alleviate the concern.