Connected Vehicle Tracking to Improve Operational Efficiency...

Opportunities to Improve Work Zone & Road Weather Management with Connected Vehicles

August 26, 2015

Gabriel Guevara
Agenda

- Connected Vehicles (CV)
- Road Weather Management - Goal
- Connected Vehicle Data
- Connected Vehicles and Road Weather
  - Enabling Systems / CV Road Weather Applications
  - Deployment Scenario
- Work Zone Management
  - CV Application
  - Deployment Scenario
- CV Road Wx PM-tool
- Other Ongoing Research Projects
Connected Vehicles (CV)

Goals
- Improve Safety
- Improve Mobility
- Improve Environment

By Leveraging
- V2V
- V2I and/or I2V
- AV
Sample Deployment Concept -
~ Improving the Efficiency of Road Maintenance ~

- Improve Snow Removal
  - Enhanced Maintenance Decision Support System

- Improve Management of Work Zones
  - Work Zone Traveler Information

- Improve Situational Awareness
  - Probe-based Pavement Maintenance

Synergies among applications increase benefits and reduce costs
Connected Vehicle Data

- Potentially low cost data source as technology becomes mandated
- Direct measures of vehicle
- Enables greater data resolution and data density
- Enables the integration of traffic management and maintenance deployment

**Windshield Wiper**
Head Lights
Outside Air Temperature
Barometric Pressure

**Speed**
Location
Heading
Elevation

**ABS/Brakes**
Traction and Stability Control
Steering Angle
Throttle Position

**Differential Wheel Speed**
Accelerometer
Yaw/Pitch/Roll
Engine Load
Road Weather Management

- Goal - Improve mobility and safety by alleviating the impacts of weather on the surface transportation system

  “Anytime, Anywhere Road Weather Information” is the program’s mission

- This includes current and predicted information about weather’s effect on roads, the decision support tools to aid road users and operators to make effective decisions,
  - When to pre-treat roads for snow & ice control
  - When to post traveler advisories (fog, floods, rain, snow, etc.)
CV Road Weather Applications

- **Enabling Systems**
  - WxDE
  - VDT
  - Integrated Modeling

- **RW Applications**
  - Enhanced Maintenance Decision Support Systems (EMDSS)
  - Motorists Advisories and Warnings (MAW)
  - Weather Responsive Traffic Management Strategies
    - Variable Speed Limits
    - Wx-responsive SPaT
    - Crowd Sourcing/Citizen Reporting
Enabling Systems for CV Road Weather Applications

- **Weather Data Environment (WxDE)**
  - The WxDE is a research based data system that acquires, validates, stores, and shares transportation-related weather data
  - Access at: https://www.its-wxde.net/

- **Vehicle Data Translator (VDT)**
  - Incorporates connected vehicle based data to create highly detailed weather and road condition outputs (nowcasts and forecasts) on a segment-by-segment basis

- **Integrated Modeling for Road Weather Condition Prediction (under development)**
  - This system uses connected vehicle data to predict future road conditions, which are then incorporated into a host of applications for travelers, transportation operators, and maintenance managers
Benefits of Enabling Systems for CV Road Weather Applications

- WxDE enhances road weather data management and quality checking for improved accuracy of application outputs
  - CV data provides a solid foundation to help develop new Road Weather Connected Vehicle Applications and enhance functionality of existing ones
  - Provides quality checked high resolution road weather data in real time
- VDT has modules for advanced Road Weather Hazard (RWH) and Road Weather Alert (RWA) algorithms that different applications can use
The Vehicle Data Translator

CONNECTED VEHICLES: the Vehicle Data Translator

- Doppler Radar (remote)
- Weather Satellite (remote)
- ESS (local)

Vehicle Data
- temperature
- velocity
- steering
- wiper status
- pressure
- brake status
- traction control
- headlights status

Data Processing Center (remote)

Warnings sent to approaching vehicles
Enhanced Maintenance Decision Support System (EMDSS)

- Incorporates Connected Vehicle (CV) data, processes it through the VDT, and uses the outputs into the road weather forecast and maintenance decision processes.
- The information may come from either vehicles operated by the general public and commercial entities or specialty vehicles and public fleet vehicles.
- EMDSS also acquires data from fixed roadside sensors that are part of Environmental Sensor Station (ESS) sites, and the National Weather Service.
- Produces road weather forecasts and treatment recommendations to aid maintenance managers and other personnel in key decisions of treatment type, timing, rates, and locations.
EMDSS Estimated Benefits

- With the new improved VDT algorithms the expected benefits of EMDSS are:
  - Improved accuracy of short (12hrs), and medium to long (24 hrs to 48 hrs) high resolution forecasts
  - High accuracy of forecasts will help maintenance personnel draft efficient strategies to optimize labor, equipment and chemicals thereby reducing costs
  - Timely treatment recommendations to potentially improve safety and roadway levels of service during adverse weather

Example of high resolution forecasts
Motorist Advisories and Warnings (MAW)

- Provides a transformational approach to providing hyper-local, near real-time road weather information to the travelling public
- Incorporates the VDT outputs that use CV data into a forecast engine to provide 24-hour forecasts of road weather conditions
- Displays road weather alerts and forecasts of hazards to provide traveler information to decision makers from DOT personnel to the traveling public
- Uses Road Weather Hazard output and a road weather forecast to provide these alerts
- A web-based display can be used for decisions before traveling; a phone application provides information on the road
MAW Estimated Benefits

- With the improved VDT algorithms, the expected benefits of the MAW are:
  - Create advisories and warnings with greater temporal and geographic resolution than is otherwise currently available
  - Provide short time-horizon alerts for visibility, road condition, and road precipitation
  - Provide medium and long term advisories to help motorists better plan trip routes during adverse weather conditions
Work Zone Management

“Innovative strategies designed to optimize work zone safety and mobility”

• Policies and practices used to incrementally and continuously improve WZ operations
• Tools to reduce WZ crashes and delays
• Tools to enhance WZ management strategies
Sample Deployment Concept
~Work Zone Traveler Information~

Projected Impacts:
- State vehicles act as traffic probes, integrated with private sector probe data
- Better traveler information regarding work zones results in a 30% increase in travel time reliability
- Travelers can adjust their travel patterns based on more reliable traveler information
- Fewer vehicles traveling through work zones reduces congestion and improves worker safety
Work Zone Management and Connected Vehicles

Characteristics and Challenges:

- Work zones are dictated by repair needs and work flow/process
- Work zones vary widely and often overlap
- These work zone characteristics make establishing and maintaining temporary traffic control (TTC) challenging

*Connected Vehicles can enhance an agency’s ability to maintain TTC in and around work zones*
Work Zone Management and Connected Vehicles (cont.)

Connected vehicle technology provides an opportunity to integrate roadside and vehicle data and messaging:

- Vehicle-to-vehicle (V2V) communications to notify upstream travelers of the presence of the work zone
- Vehicle-to-infrastructure (V2I) communications to allow the traffic management center (TMC) interact and monitor the work zone
- V2V communications to exchange vehicle position and status information between the lead truck and the attenuator truck

Source: TTI
FHWA V2I Safety Applications: RSWzW Overview

- Roadside Equipment (RSE): connection to TMC and/or local network in work zone
- In-vehicle device: issues alert to driver to reduce speed, change lanes, and/or prepare to stop
- Speed limit/work zone information provided to vehicle
CV RW-PM Tool

- Demonstrate prototype RW-PM tool that provides for
  - Integration of traffic mobility, road weather maintenance and motorist advisory analysis and information
  - Continuous near real-time data processing, including
  - Continuous updating of traffic control, RdWx maintenance and motorist advisory recommendations as RdWx conditions evolve throughout weather events.
Motorist and Road Weather Maintenance Website Display

- Conceptual illustration of motorists and road weather maintenance RW-PM Website showing map-based traffic mobility and road weather information.

<table>
<thead>
<tr>
<th>Traffic Mobility</th>
<th>Road Weather</th>
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<tbody>
<tr>
<td><img src="image1" alt="Traffic Mobility Map" /></td>
<td><img src="image2" alt="Road Weather Map" /></td>
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</table>

- Traffic Mobility
  - Low
  - High
  - Congestion Level

- Road Weather
  - Road Surface Grip
  - ≤ 0.6
Review of Current Research Projects

- Connected Vehicle Safety Applications
- Connected Vehicle Road Weather Performance Management Tool
- Tire Friction Measurement to Determine Pavement Conditions
- IMO 3.0 Project > States using DSRC to share connected vehicle data
- Integrated Modeling & Prediction Tool
- PM’s Tool that uses CV data
- WRTM Strategies

For more information visit the RWMP Website at: http://ops.fhwa.dot.gov/weather/
Q & A
Plow Cam Project & Track A Plow Website
Utilize readily available technology to capture, upload, and geographically display photos taken from snow plow vehicles during winter operations.

Plow Cam & Track A Plow
Camera Criteria

* Quality of photo
* Availability of hardware
* Availability of software/application
* Multi-functionality
* Simplicity
* Unobtrusiveness
* Connectivity and data transfer
* Cost
Internet
Parts List

- Suction cup phone mount
- Cigarette Lighter Socket
- Extension cable
- Fuse
- Phone Charger
- iPhone

[Image with parts listed and labeled]
Findings To Date...

- Many uses
  - Situational awareness
  - Operational/treatment decisions
  - Roadway/travel conditions
  - Performance analysis
  - Research
- Positive field staff and public acceptance
- Simple
- Adaptable
Questions??
Fleet Management with Telematics GPS Tracking and Diagnostics System

Arkansas State Highway and Transportation Department

DANNY KEENE
DIVISION HEAD
EQUIPMENT AND PROCUREMENT

AUGUST 26, 2015
State of Arkansas Chooses Networkfleet to Streamline Fleet Management and Increase Accountability

Networkfleet’s engine diagnostics, installation, training and warranty rated highly by state agency

The Arkansas State Highway and Transportation Department selected Networkfleet under NAPA contract to streamline fleet management and increase accountability for its 2,400 state vehicles. Arkansas will implement the Networkfleet GPS fleet tracking system to help analyze fleet utilization, track vehicle location and improve overall fleet efficiency.

The Arkansas State Highway and Transportation Department selected Networkfleet for its fleet of on-road passenger vehicles used in highway maintenance, transportation, administration, construction and law enforcement. The Department evaluated Networkfleet and another vendor under a NAPA contract and rated Networkfleet highest in the areas of engine diagnostics, installation, customer support, training and warranty.

“As a public agency, we are looking for ways to improve our efficiency,” said Danny Keene, division head of equipment and procurement, Arkansas State Highway and Transportation Department. “Networkfleet will help us evaluate our vehicle usage, identify problems early in our maintenance program and reduce our overall operating costs. Increasing our accountability to the public that we serve is a top priority for the state. Networkfleet’s GPS tracking capability will help us accomplish that.”

Keith Schneider, president and CEO of Networkfleet Inc., said, “As the state looks to achieve accountability for fleet expenses, Networkfleet’s comprehensive reporting capability will give the department the information it needs to understand how different vehicles in varying divisions and districts are being used, and how to apply that information to improve fleet efficiency.”

Networkfleet, a Verizon Communications Inc. (NYSE, NASDAQ VZ) company, is a leading provider of wireless fleet management services that improve fleet efficiency by reducing fuel use, emissions, and maintenance expenses. The company’s technology combines vehicle diagnostic monitoring with an online GPS fleet tracking system. Founded in 1999, Networkfleet is headquartered in San Diego, CA, and has more than 50 patents issued or pending surrounding remote diagnostics. Networkfleet has received numerous awards for its technology, including the 2012 Telematics Update award for Best Telematics Solution for Commercial Vehicle. For more information, please visit www.networkfleet.com.
Installed Networkfleet’s GPS with Diagnostics in “On-Road Passenger” vehicle fleet (approx. 2,500 vehicles)

Objectives

- Ease Of Installation
- User Friendly Web Application
- Monitoring Driver Behavior
- Increased Accountability - Worker Efficiency
- Vehicle Health – Reduced Maintenance Costs
- Agency Compliance
EASE OF INSTALLATION

- Plug and Play Installation
- 30-45 Minutes per Vehicle
Increased emphasis on driver behavior has multiple benefits including increased safety, reduced liability, decreased fuel costs, and increased efficiency.

- Reduce Speeding
- Reduce Excessive Idling
- Less Miles Driven (Less “Side Trips”)
- Increase MPG Due To Better Driving Habits
WORKER EFFICIENCY

- Monitoring worker activity and unnecessary miles driven will allow for more precise work scheduling leading to shorter job completion times

- Greatly increased efficiency in the effective mobilization of forces and snow plow/spreader trucks during winter weather events
SPEEDING

- We are experiencing less speeding incidences which is a cost savings.

- Every 1 MPH over the speed limit costs the Department approximately 1% in fuel economy as well as decreased life of tires and brakes.

- Networkfleet’s vehicle tracking gives us the ability to dispute erroneous speeding accusations by the traveling public.
### Alert Details

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<td>Speed</td>
<td>83 mph</td>
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<td>Posted Speed</td>
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In pickup trucks, the Department is currently experiencing an increase of 2 MPG which translates to an increase in fuel economy of approximately 10%

Some data reflected up to 20% improvement
Our baseline idle indicated that we averaged approximately 35% idle time.

Cost of idle time is ½ to 1 gallon of fuel per hour.

Idle time reduction of 10% can result in an increase in MPG of 6-8%.

Our goal was to reduce idle time to 20% or less.
HARD FACT (IDLING)

June 19, 2014 – June 18, 2015 AHTD
average idle time =

15.86%
At the present time, fuel consumption reduction savings are at approximately $490,000 - $500,000 annually as a result of reducing idling to an acceptable level.
Prior to implementation of GPS program:
Total average miles driven in FY2011 and FY2012 by vehicle groups designated for GPS installation = 36,549,931

After implementation of GPS program:
Total average miles driven in FY2013 and FY2014 by same designated vehicle groups = 34,644,141

Average less miles driven annually = 1,905,790
Average less miles driven per month = 158,816
Average monetary savings annually = $476,448
Average monetary savings per month (.25/mile) = $39,704
62 months prior to implementation of GPS program:
Average gallons per month = 167,656

33 months since implementation of GPS program:
Average gallons per month = 140,581

Average gallons per month savings = 27,075
Average price per gallon = $3.31
Average monetary savings per month = $89,618.25
Average monetary savings annually = $1,075,419.00
TOTAL YEARLY UNLEADED GASOLINE PURCHASED (GALLONS) FY2008 THRU FY2015
62 months prior to implementation of GPS program:
Average gallons per month = 184,973

33 months since implementation of GPS program:
Average gallons per month = 177,727

Average gallons per month savings = 7,246
Average price per gallon = $3.32
Average monetary savings per month = $24,056.72
Average monetary savings annually = $288,680.64
TOTAL YEARLY DIESEL FUEL PURCHASED (GALLONS)
FY2008 THRU FY2015
HARD FACTS (UNLEADED GASOLINE AND DIESEL FUEL)

62 months prior to implementation of GPS program:
Average gallons per month = 352,629

33 months since implementation of GPS program:
Average gallons per month = 318,308

Average gallons per month savings = 34,321
Average monetary savings per month = $113,774.11
Average monetary savings annually = $1,365,289.32
VEHICLE HEALTH

- Alerts notifying us of Diagnostic Trouble Codes (DTC), helps to keep Department personnel informed of immediate vehicle maintenance needs, which reduces repair costs (this is another enhancement to our existing extensive preventive maintenance program)

- Roadside Assistance is available for all vehicles when needed, up to four occurrences per vehicle per year
Manage Vehicle Diagnostics History

Start Date: 6/12/15 12 AM 00
End Date: 6/19/15 12 AM 00
Set Window
Submit

0649 KEENE, DANNY

Current Diagnostic Summary

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<td>Pending DTCs</td>
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Diagnostic History

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</table>
SUMMARY

IMPACT OF VEHICLE MANAGEMENT/GPS TRACKING SYSTEM

- Currently operate **approximately 2,550** vehicles
- **63%** operate on Unleaded Gasoline
- Approximately **324,900** less gallons of Unleaded purchased annually
- **37%** operate on Diesel Fuel
- Approximately **86,952** less gallons of Diesel purchased annually
- Total fuel savings of **$1.365 million** annually
- Initial cost for implementation = **$660,000**
- Average total yearly service fees = **$670,000**
- Reduction of idle time (35% to 15.86%)
- Reduced incidences of speeding
- Greatly reduced out of route miles
- Increased driver safety
- Lower maintenance costs
- Increased driver accountability – worker efficiency
- Ability to dispute erroneous driving/location accusations
- More effective mobilization of forces/trucks during winter weather events
For every $1 expended on Telematics GPS Tracking and Diagnostics System, AHTD is recognizing $2 plus in savings.
DOT IMPROVES ACCOUNTABILITY, CONTROLS COSTS WITH NETWORKFLEET

A large public agency facing constant governmental and taxpayer oversight, the Arkansas State Highway and Transportation Department (AHTD) wanted to improve its fleet's operating efficiency while becoming more accountable to its constituents. Since implementing Verizon Networkfleet, the department has improved its ability to keep the public informed while significantly saving on operational fleet costs.

**SMALL STATE, BIG TRANSPORTATION CHALLENGES**

The AHTD oversees the state’s largest highway system in the U.S., with a fleet of several thousand vehicles used for highway construction and maintenance, transportation administration, and law enforcement. The AHTD manages this massive fleet with limited funds while answering to both elected officials and state taxpayers. Without a GPS tracking system to monitor its vehicles, the department struggled to operate the fleet efficiently, keep the public informed, and justify its extensive resource needs.

**PILOT PROGRAM PORTENDS BIG DIVIDENDS**

After evaluating two state-approved GPS tracking vendors, the AHTD selected Networkfleet for its comprehensive warranty, extensive training resources, and roadside assistance plan which is included with the solution. The department then initiated a pilot program with Networkfleet on 12 of its vehicles.

“During the test period, Networkfleet allowed us to better monitor our forces during unplanned events like snow or ice, which was a primary goal,” says George Karos, division head of equipment and procurement. “We were also driving fewer miles and using less fuel. Projecting these results across our entire fleet, we could see the potential for huge cost savings.”

**AHTD ACHIEVES SUBSTANTIAL COST SAVINGS**

After the AHTD installed Networkfleet on all 2,500 of its highway passenger vehicles, the cost savings quickly began adding up. In the first year, reducing onaverage idling and miles driven saved nearly $500,000 in fuel expenditures. In addition, reduced maintenance costs and better operational efficiencies added to the total savings for the AHTD.

Networkfleet’s GPS tracking system also enabled the department to operate more proactively—a critical factor in increasing public accountability. Dispatchers can now direct dumptrucks, snowplows, and other vehicles to emergency situations faster. And fleet officials can use real-time data to keep the public apprised of where their forces are and what they’re doing.

Fleet managers can also reduce unnecessary excuses from the public by pinpointing the precise location of AHTD vehicles involved in complaints. Networkfleet can even make it easier to recover stolen vehicles by providing precise GPS locations to police departments.

**FOR MORE INFORMATION**

To find out how you can benefit from Networkfleet, contact your account manager or visit networkfleet.com.
Return on Investment Analysis
ARKANSAS STATE HIGHWAY AND TRANSPORTATION DEPARTMENT

Network fleet customers can achieve a positive return on investment within months of installing GPS tracking. This case study shows the return on investment (ROI) the Arkansas State Highway and Transportation Department (AHTD) realized by implementing Network fleet on its vehicles to reduce idle times, miles driven, and fuel consumed.

ESTIMATED SAVINGS BASED ON DOCUMENTED METRICS:

Idle Time
AHTD's baseline measurements indicated their vehicles averaged approximately 35% idle time, costing up to one gallon of fuel per hour, per vehicle. The department set a goal of reducing idle time to 20%, which was quickly achieved. Cutting average idle times almost in half resulted in annual savings of $490,000.

Miles Driven
AHTD also identified reducing miles driven as an important cost-reduction goal. Using Network fleet to route vehicles more efficiently and reduce unnecessary side trips, the agency lowered total miles driven by nearly five percent, generating fuel savings of more than $430,000.

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BY DEPLOYING NETWORKFLEET ON ALL ITS HIGHWAY PASSENGER VEHICLES, THE AHTD:
- Reduced unnecessary idle time and miles driven
- Saved nearly $1.2 million in fuel purchases
- Lowered total operational expenses
- Reduced vehicle theft
- Improved response times during emergency situations

The AHTD oversees the twelfth-largest highway system in the U.S., with a fleet of several thousand vehicles used for highway construction and maintenance, transportation, administration, and law enforcement.

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NORTHWORK FLEET CASE STUDY
ACCOUNTABILITY & COST CONTROLS

Increased Fuel Economy
AHTD also recognized an increase in fuel economy of 2.51%, due to better driving habits and reduced speeds, resulting in increased fuel economy/MPG generating fuel savings of more than $264,254.

BEFORE GPS

AFTER GPS

$264,254
2.51% MPG increase

ACTUAL SAVINGS WERE VERIFIED BASED ON:
Yearly Fuel Purchased
Yearly fuel purchases declined by 2.8%. Combined annual savings on fuel purchases totaled nearly $1.2 million.

To find out how you can benefit from NetworkFleet, contact your account manager or visit networkfleet.com.

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