

Wed, September 17

Joint meeting summary between:

Aurora, Clear Roads, & AASHTO Winter Weather



Source: Z. Hans

Welcome & Opening Remarks

Jed Falgren (Minnesota, AASHTO Winter Weather) opened the meeting by welcoming participants and setting the tone for the day's discussions. The introduction encouraged participants to think openly and collaboratively about both present challenges and future opportunities. Two guiding questions were posed to frame the dialogue:

- **“Share your opinions and your dreams.”** Participants were invited to go beyond operational issues and express broader aspirations for the future of winter operations, technology, and collaboration.
- **“Where do you want to turn your attention?”** This question emphasized the importance of prioritization—identifying which problems, innovations, or initiatives should command the greatest focus from pooled fund groups and partner agencies.

The opening remarks underscored a spirit of **collaboration, innovation, and forward-looking dialogue**, reminding attendees that the meeting was not only about reporting current practices but also about envisioning what could be achieved collectively.

Consortia Introduction

Representatives from each of the three groups—**AASHTO Winter Weather Management Technical Services Program, Aurora, and Clear Roads**—provided introductions to their respective programs and highlighted their roles, activities, and resources.

- **AASHTO Winter Weather Management Technical Services Program** (Brad Darr, ND)
 - The program includes **39 states** as members, along with several partners such as Clear Roads and Aurora.
 - AASHTO's focus is on **“big picture” issues**, providing national-level coordination and support for winter weather management.
 - Additional details were shared in his presentation slides.
- **Aurora** (James Roath, MI – Vice Chair)
 - Aurora is a **pooled fund program with 17 state members**, dedicated to improving the safety, efficiency, and reliability of road weather information systems (RWIS).
 - The group meets **monthly** and hosts two **in-person meetings** annually.
 - Every two years, Aurora organizes a **Friends of Aurora event**, bringing together around **20 entities** from industry and academia to strengthen partnerships.
 - Aurora conducts a **research idea solicitation process** to guide future project selection (details provided in slides).
- **Clear Roads** (Todd Law, VT – Chair)
 - Clear Roads currently has **39 member states** and is working to expand to 40.
 - The program intentionally avoids duplicating Aurora's work, focusing instead on **parallel efforts** to maximize efficiency and conserve DOT resources.
 - Clear Roads offers a wide array of **resources, research, and tools** available on its website, including:
 - The Entry-Level Driver Training for Maintenance Equipment Operators is a widely used and highly popular resource.
 - The **National Winter Safety Campaign**, branded *“Ice and Snow, Take It Slow.”*
 - The **Qualified Products List**, a resource taken over from the Northwest Pacific Snow fighters, provides vetted materials for winter operations.
 - The **Annual Survey of State Winter Maintenance Data** has been collecting state-reported operational data for **ten years**.
 - Numerous other projects, training modules, and tools are also available online.
- Rick Nelson (AASHTO Winter Weather Management TSP)
 - Noted that the last joint meeting of the three groups took place in 2017 in Pittsburgh, making this session an important milestone.
 - Recommended that participants explore the **National Briefings at Talking Winter Ops**, which provide accessible summaries and updates on group activities.
 - Encouraged participants to **expect to learn something valuable**, even if not every session feels directly relevant to their state's needs.

Session 1. Weather Data and Winter Operations

This session was **focused** on framing the value of integrating weather data with winter maintenance operations. **It is relevant** given that all three groups benefit from stronger coordination between data systems, forecasts, and operations, so the hope for this session is to support that directly.

Moderator: Mike Mattison Nebraska (Clear Roads)

Opened the session by emphasizing the **importance of integrating weather data into winter maintenance operations**. The moderator framed the discussion around how better use of weather information can enhance both **safety** and **operational efficiency**. He noted that weather integration is not just a technical improvement but a critical operational need, influencing decisions about resource allocation, treatment timing, and roadway closures.

Best Practice Presenter: Miguel Tovar Colorado (Aurora)

Advocated strongly for the use of **preemptive road closures** as a proactive strategy to mitigate risks before they escalate. By closing roads ahead of deteriorating conditions, Colorado aims to prevent motorists from becoming stranded in areas with limited accommodations or heightened hazards, especially in mountain corridors.

Explained that Colorado operates through a **regional structure**—five regions and nine maintenance sections—each empowered to make operational decisions. This structure allows flexibility but relies heavily on **real-time weather data** to coordinate resource shifts.

Highlighted how weather forecasting informs the shifting of plows, personnel, and equipment across regions. In addition to plowing and treatment, Colorado integrates weather data into avalanche management and traffic operations support, ensuring a comprehensive approach to winter storm response.



Source: Z. Hans

Group Discussion Summary – Weather Data, Friction Sensors, and RWIS Maintenance

Key takeaways: Agencies are **expanding the use of friction sensors and mobile RWIS** to improve decision-making, but **ROI validation is ongoing**. Preemptive closures are increasingly common, but agencies must carefully manage public/stakeholder expectations. RWIS maintenance practices vary widely, from student interns to vendor contracts, with **annual costs ranging from tens of thousands to hundreds of thousands of dollars**. Pathfinder adoption remains uneven, suggesting room for broader integration.

Colorado (CO) explained that it operates five regions and nine maintenance sections, with each region/section making its own winter maintenance decisions. The Department of Maintenance and Operations (DMO) provides statewide support, including weather, avalanche, systems, and traffic operations. In the northeast corner of CO, shifting resources (people and equipment) is particularly critical, and weather forecasting tools are central to decision-making. The state relies on RWIS data and is transitioning toward mobile RWIS technology to give operators real-time friction readings.

Washington (WS) asked about the operational use of mobile friction sensors. These sensors are mounted on plow trucks and provide real-time friction readings. Operators use quick reference guides to determine when to apply materials: if readings hold steady or rise, they do not apply; if readings drop, they apply the material. This system helps conserve resources and improve treatment precision.

Iowa (IA) described procedures for preemptive road closures. Poor visibility and snow accumulation are key triggers.

Colorado (CO) described that, on I-70, where lodging options are sparse, closures are staged closer to Denver so travelers have access to accommodations. Large weather events trigger a statewide coordination call followed by a Pathfinder call. Messaging is delivered via VMS boards at state entry points, press releases, 511 postings, and notifications to trucking companies. Procedural directives also exist for wind: gusts exceeding 60 mph trigger restrictions for lightweight and over-height vehicles. Regions can independently trigger resource mobilization as needed.

North Dakota (ND) asked how many states employ in-house meteorologists. Only a few do. The majority (over half) reported contracting for forecasting services.

Minnesota (MN) asked whether non-invasive sensors justify their cost.

Colorado (CO) explained they are tracking ROI, citing a test comparing five sensors with traditional snow depth measurements; results were within six inches of actual totals. Differences between test areas translated to hundreds of thousands of dollars, though variability limited exact

comparisons. CO mounts mobile friction sensors behind the front bumper on the driver's side. Newer models (6–8 inches long) are durable and protected by the bumper. Hard-wired plow installations perform better than plug-in supervisor units, which sometimes have connection issues. One example showed that sensor data confirmed sufficient grip, allowing CO to skip unnecessary applications and achieve cost savings.

Iowa (IA) raised the issue of interstate closures and potential pushback from stakeholders. Agencies generally agreed that closures are broadly accepted if tied to safety. **Nebraska (NE)** explained that as hotels fill, interstates are progressively closed farther from the storm center to prevent motorists from being stranded. While roads in those areas may remain clear, closures are staged to protect travelers. NE, an MDSS state, coordinates closely with NWS and adjacent states, reinforcing the credibility of decisions. Operators are also encouraged to take photos and share them publicly to validate closure actions.

Massachusetts (MA) reminded agencies that sensors require regular cleaning during storms to prevent salt and snow buildup that can compromise accuracy.

Wisconsin (WI) described its annual preventive maintenance cycle for RWIS sensors, including replacement of in-pavement units prior to winter, since crews cannot spare time during storms. WI contracts out RWIS maintenance due to limited staffing at an annual cost of \$180,000.

South Dakota (SD) employs summer interns to service over 150 RWIS sites, including cleaning, calibration, and vegetation management. This program has been effective.

Arizona (AZ) maintains 22 RWIS stations through its ITS staff, who are vendor-certified, ensuring warranty coverage for issues. This arrangement has worked well for the state.

Minnesota (MN) operates 163 RWIS sites through an MOU with statewide radio communication technicians. Eight shops across the state each employ two techs, who are equipped with the necessary tools, parts, and training to maintain the stations.

Nebraska (NE) has electronic technicians dedicated to RWIS station upkeep.

Washington (WS) asked about costs for pre-winter preventative RWIS maintenance.

- **New Jersey (NJ):** Contracts for 37 stations and a number of mobile sensors at \$12,000/month.
- **Wisconsin (WI):** Annual ITS maintenance contract totals \$180,000 for labor; equipment costs \$200,000 (including overdue replacements delayed in prior years).
- **Iowa (IA):** Operates 76 full-size stations. Annual non-contract costs average \$350,000 (e.g., repairs from sensor damage or power issues), in addition to standard maintenance budgets.

Pathfinder Usage: A poll revealed that while most agencies are familiar with the Pathfinder framework, only 24 reported using it to guide storm response planning, while 16 said they do not incorporate it into operational decision-making.

Group Discussion Summary – Forecast Adaptation

How does your agency adapt to wrong forecasts, changing weather patterns, and changing weather intensities?

Key takeaways: Forecasts serve as essential planning tools, but **real-time adaptation and direct communication with forecasters** are equally critical. Contracted services, Slack groups, and direct calls are increasingly common methods for bridging gaps when official NWS forecasts deviate from actual conditions.

Colorado (CO) explained that weather forecasts are relied on heavily in the days leading up to storms. These forecasts shape pre-storm coordination meetings and Pathfinder calls, setting expectations for operations. Once storms begin, forecasts are treated as starting points, but field conditions are monitored continuously. Adjustments are made in real time, with plows and personnel shifted between regions to provide support where impacts are most severe. This flexibility is seen as essential given the variability of storm intensity and movement.

Nebraska (NE) asked whether agencies receive direct alerts from contracted weather service providers. Most agencies confirmed that they do, highlighting how contracted forecasting services have become a critical tool for timely, actionable updates.

Texas (TX) described challenges with National Weather Service (NWS) forecasts, noting irregularities that created operational difficulties. To compensate, Texas contracted with a private weather service that tailors forecasts specifically to DOT needs. Within their Emergency Management System, two forecasters are employed, but they tend to forecast conservatively on the extreme side. While DOT staff trust these forecasts, there is an internal challenge: ensuring that forecasts, while cautious, do not overstate risks in ways that burden operations unnecessarily.

Illinois (IL) detailed its collaboration with five different NWS offices. The state has particularly strong ties with the St. Louis office, which it considers a highly responsive partner. Illinois staff communicate with NWS forecasters via Slack, which allows real-time interactions and the ability to receive targeted updates. Operating across multiple NWS offices (e.g., St. Louis and Lincoln) gives Illinois broader situational awareness across its diverse geography.

Minnesota (MN) reported that it has established a Pathfinder group on Slack that includes a private forecasting provider as well as six NWS offices. This setup allows staff to collaborate actively with multiple forecasters, ask direct questions, and receive clarifications during evolving conditions. Minnesota emphasized that direct phone access to forecasters remains particularly valuable, as communication style and responsiveness are critical in building operator trust and ensuring that decisions are informed by the best possible information.

General Consensus: Participants agreed that in many states, frontline maintenance staff, supervisors, and directors have direct contact with forecasters. These direct lines of communication help agencies adapt quickly when forecasts prove inaccurate or when weather patterns shift unexpectedly. By connecting operators with forecasters in real time, agencies gain actionable insights that support more precise and timely operational decisions.

Session 2. The Connected Fleet: Turning Data into Winter Strategies

This session **focused** on exploring sensor system performance and evolving mobile data sources. **It is relevant** towards connecting AASHTO, Clear Roads, and Aurora goals through exploring how fleet-based data improves winter maintenance decisions, enhances forecasting, and supports integration across systems.

Moderator: Mark Goldstein, Massachusetts (Clear Roads)

- Opened the session by noting the wide variety of **sensors now available** to agencies for monitoring winter operations.
- Highlighted Massachusetts' experience with **mobile RWIS sensors**, emphasizing significant cost savings in material usage. In the first year of deployment, the state installed **24 mobile RWIS sensors**. That year, they used **87% of the salt predicted by their algorithm**, marking the first time in two decades that usage fell below **90%**. With deicing materials costing the state approximately **\$20 million annually**, even a **3% reduction equated to \$600,000 in savings**. The initial investment of **\$100,000 (with additional FHWA support)** effectively generated about **\$900,000 in savings**.
- Stressed the importance of placing **MD30 sensors on supervisor trucks**, since supervisors oversee multiple sheds. The data allows supervisors to guide sheds toward more efficient use of materials.
- Noted that **grip sensors** are being installed in more and more vehicles across the country. Once a **critical mass of grip data** is reached, DOTs will be able to use this shared dataset to further refine and optimize winter operations.

Best Practice Presenter: Gabe Alvarado, Arizona (Clear Roads)

- Described how Arizona connects **fleet data to its winter strategies** through the use of an AVL-integrated dashboard.
- The **dashboard provides a statewide, regional, and truck-level view** of pre-wet application rates, including metrics such as gallons per ton. This transparency allows Arizona to monitor material application from a broad overview down to the actions of individual plows.
- Reported that **AVL integration** has provided several operational benefits:
 - Helped locate and recover a **stolen plow**.
 - Enhanced management of **I-40 operations**, particularly in responding to weather events and heavy traffic demands.
 - Provided **greater transparency to the public**, allowing the DOT to respond to questions about winter operations with data-backed evidence.
- Confirmed that Arizona conducts **annual calibration of sensors**, ensuring accuracy and reliability of operational data.

- Looking ahead, Arizona will begin incorporating **MD30 sensors this winter**, integrating them into its fleet and connecting the new data streams to its existing strategies for material application and operational oversight.

Group Discussion Summary – Calibration, Fleet Sensors, and Stockpile Measurement

Key takeaways: Agencies are experimenting with **low-cost sensor innovations, camera deployments, and lidar/drone technologies** for monitoring fleet activity and salt stockpiles. While lidar and drones deliver improved accuracy and transparency, their **costs and staffing requirements** (e.g., licensed drone pilots) remain barriers. Handheld and camera-based methods continue to serve as practical alternatives. Research partnerships (e.g., Maine with Alberta) show promise for AI-based approaches to supplement RWIS networks.

Idaho (ID) opened the discussion by asking how agencies conduct annual sensor calibration and how confident they are in the results. Most agencies reported confidence in their calibration processes, though some noted difficulties when calibrating pre-wet systems using water instead of brine or material.

Iowa (IA) described an operator-developed innovation for monitoring carbide blade wear. A bolt is attached to the blade, and once the blade wears down to the carbide, the bolt breaks an electrical connection. This activates a dashboard light, signaling the operator to replace the blade. Iowa emphasized that this is a simple, effective, and low-cost solution not currently replicated in commercial systems.

South Dakota (SD) explained that they have added signaling systems to their trucks: a light on the dashboard or at the rear of the sander indicates when the box is empty, and a separate signal shows when the auger is no longer dispensing material. The design was shared with truck builders, and it is now part of the truck specifications.

Nebraska (NE) reported exploring cameras installed at specific locations in trucks to visually confirm whether material remains in the box. They are looking at cameras for safety and protection.

Iowa (IA) discussed its extensive use of cameras:

- Forward-facing plow cameras provide roadway images that are also shared publicly. These images are popular with the traveling public and enhance transparency.
- Rear-facing safety cameras installed on trucks allow operators to monitor box loads and spinner operation, helping them determine when to reload or identify spinner malfunctions. Images are for operator use only, not public dissemination.
- Dash cameras have been deployed on 900 plows across the state. These have become a preferred source of images compared to fixed RWIS or traffic cameras. Dash cams are

particularly useful for claims, investigations, and operational oversight, while fixed cameras remain valuable for broader monitoring.

Massachusetts (MA) raised the issue of salt usage tracking, outlining three common approaches:

- *Snoops* – visually inspecting stockpiles before and after storms.
 - *Scoops* – counting the number of loader buckets filled and applied.
 - *Closed-Loop Spreader Controllers* – sensor-based spreader feedback.
- A key question was whether these methods produce consistent results.

Iowa (IA) responded that handheld lidar systems have been effective for validating stockpile volumes. Since salt density varies between vendors and even across loads, lidar provides more reliable validation than estimates. Iowa uses a handheld lidar measurement system for stockpile validation. Staff scan piles from all sides and on top to capture volume. With around 300 salt buildings statewide, the lidar system is used for verification rather than real-time tracking.

Nebraska (NE) has developed training materials for non-DOT staff to better utilize salt.

Michigan (MI) reported piloting lidar-based sensors installed at shed entrances/exits and on trucks. This system aims to automate salt tracking, which is particularly valuable when monitoring usage on routes operated by contract trucks.

Alaska (AK) uses drones with measurement tools to monitor stockpiles indoors and outdoors. The state has found this approach valuable for capturing lidar-type information and has reduced salt purchases based on improved accuracy.

Illinois (IL) questioned whether lidar and drones justify their cost compared with simpler estimation methods, arguing that experienced staff can often estimate volumes reliably.

Texas (TX) responded that it uses fixed cameras in sheds to track when loaders remove material. Drones are used for outdoor piles or in sheds without cameras. This combination has been accurate enough for operational needs.

Idaho (ID) added that supervisors use lidar apps on iPhones for reporting and also employ drones for in-shed lidar. However, subscription costs for handheld Stockpile Reports can reach \$60,000 annually, posing budget challenges.

Nevada (NV) reported piloting an iPhone lidar app to validate manual measurements. They aim for 5% accuracy. A legislative audit had flagged discrepancies in reported volumes, but the agency clarified that differences were due to methodology. Work is underway to improve consistency in reporting.

Michigan (MI) also uses Stockpile Reports based on drone imagery, though coverage is limited by the small number of licensed drone pilots. The program has improved stockpile stacking practices and even led to better lighting in sheds to support drone operations, which in turn improves safety.

Washington (WS) highlighted several ongoing Clear Roads projects on stockpile measurement. Washington piloted iPhone-based Stockpile Reports units at shed entrances, costing \$200/month. Accuracy was within 2%, but the method was deemed cost-prohibitive for statewide use across hundreds of sheds. Washington continues to rely on handheld systems with manual backups. Vendors have subsidized some pilot projects (e.g., in Texas) as part of their marketing strategy.

General Observations Across States: Several DOTs reported that they either hold or are pursuing UAV (drone) licenses to expand stockpile measurement capacity in-house.

Maine (ME) shared a research initiative with the University of Alberta, using AI models to estimate grip factors from still camera images. These models fill gaps between RWIS stations and have shown very accurate results. Findings have been published in TRB papers, highlighting the academic and practical significance of the approach.

Session 3: Using External Data and Partnerships to Boost Performance

This session **focused** on exploring strategies to enhance winter operations using supplemental 3rd party data sources. **It is relevant** in considering how external data and partnerships might help all participants to improve storm response, optimize operations, and enhance data-driven decision-making.



Source: Z. Hans

Moderator: Tina Greenfield, Iowa (Aurora)

- Opened the session by sharing insights from a vendor demonstration showing how **sensor data from passenger vehicles** can be used to estimate roadway grip conditions. This data is then aggregated into **maps highlighting areas of reduced traction**, providing agencies with an additional layer of situational awareness.
- Agencies noted that the usefulness of such systems depends heavily on **vehicle penetration rates** within a state. In states with sufficient coverage from connected vehicles, the approach could be highly effective. In areas with lower connected-vehicle presence, its reliability and scalability may be more limited.
- Highlighted the growing number of **AI-driven traffic data services**, which provide roadway insights by analyzing variables such as **traffic speed patterns, aggregated vehicle trajectories, or OEM-provided datasets**. These sources can supplement traditional RWIS and AVL data, particularly for detecting real-time changes in roadway conditions.

Best Practice Presenter: Neal Hawkins, Iowa State University (Aurora)

- Framed the discussion by urging participants to think not only about **data collection** but also about **partnerships and shared expectations** across agencies and pooled funds. The growing data marketplace provides vast amounts of information, but agencies need strategies to make sense of it and extract operational value.
- Explained how **connected vehicle data** produces a “breadcrumb trail” of speed, bearing, and location every second. From this, agencies can calculate indicators such as **hard braking, average speeds, and changes in traffic flow**. For winter operations, this enables performance-based decision-making: for example, after plowing a road segment, agencies can assess whether speeds have normalized before deciding if another pass is necessary.
- Discussed **cellular-based data sources**, acknowledging both the **privacy concerns** and the opportunities. Many insurance companies provide discounts for safe driving programs that rely on telematics. The anonymized and aggregated data from these programs can be accessed by agencies, showing patterns such as **where and when cell phones are in use while driving**—information with potential safety applications.
- Returned focus to winter operations, raising the fundamental question: **How are agencies gathering information about conditions on the road?** Inputs may include operators’ observations, sensor readings, AVL systems, or connected vehicle data. Combining these streams provides the most comprehensive view.
- Noted that a **national telecommunications provider** is currently working with vehicle OEMs to build a large-scale system for delivering safety alerts directly to **vehicle dashboards**, rather than just to phones. This could fundamentally change how real-time safety messages are communicated. Agencies stressed that DOT engagement will be critical to ensuring that **the right information is prioritized** in these systems. Groups like **Aurora and Clear Roads** have an important role in defining the variables and content that should be delivered to in-vehicle displays.

Group Discussion Summary – Use of 3rd Party Data and AVL for Pretreatment and Alerts

How are you using 3rd party data or data services (e.g., weather, traffic, vehicle telemetry) to inform pretreatment decisions in complex storms?

Key takeaways: Agencies are actively **experimenting with third-party data** (friction values, AVL, HAAS, Waze/Google) to improve pretreatment decisions and traveler alerts. While pilots show strong promise, **data integration challenges, vendor selectivity, and cost barriers** remain major hurdles to widespread adoption.

Colorado (CO) shared work with a private sector provider of mobile friction data. These data streams can feed into decision-support systems and provide additional insight for treatment recommendations. The integration into Colorado DOT’s systems (led by operations staff) is planned to support material application decisions during storms.

Iowa (IA) described that one data provider (Nira) is using axle slip information from vehicles to estimate roadway grip values in real time. These live friction estimates can be integrated into operations to supplement RWIS data. Aurora members had the opportunity to access this dataset for an entire winter season, demonstrating its utility for broader adoption.

Maine (ME) reported that AVL data from plows is being piloted to provide priority signals (such as green lights) based on GPS positions, tested using OBD units. This allows plows to be recognized as priority vehicles at certain intersections. Maine asked if other agencies are experimenting with GPS-based plow prioritization.

- **Minnesota (MN)** responded that a DSRC-based corridor system had been deployed but was later discontinued. They continue to monitor this area of technology for potential future applications.

Iowa (IA) also highlighted a collaboration with John Deere where tractors and DOT mowers equipped with blower attachments can automatically be displayed as slow-moving maintenance vehicles. Messages are sent to roadside DMS boards warning motorists.

- **Iowa (IA)** further noted that plow trucks converted for summer maintenance operate at low speeds as well. Data from these vehicles can be shared with Google, Waze, and 511 systems to display their locations as slow-moving vehicles, enhancing awareness for drivers.

Kentucky (KY) described its approach to alerting motorists about work zones using AVL data.

- Kentucky's ITS division explained that AVL-equipped trucks are linked with a private navigation platform, displaying truck locations within a two-mile range (one mile ahead and one mile behind). This functionality will be extended to plows during the winter season to provide broader traveler alerts.

Washington (WS) reported that HAAS alert technology is being installed in 20 plow trucks. Already used for work zones, the system pushes alerts to mobile phones rather than vehicle dashboards, which operators and agencies find preferable.

- **Texas (TX)** uses a third-party vehicle alerting system for plows and maintenance vehicles. Texas noted the importance of avoiding false alerts to drivers on the opposite side of divided highways. For smart-connected vehicles, alerts appear on in-vehicle dashboards. Texas is piloting this with sand trucks, and vehicles from certain OEMs (e.g., Stellantis) can now display these alerts.

Ohio (OH) operates a system similar to Kentucky's, where AVL data triggers Waze to show alerts for both work zones and plows.

Connecticut (CT) recalled testing HAAS a few years prior, using Samsara with an API connection. This provided a lower-cost alternative to standalone HAAS units and was integrated with Connecticut's light-duty fleet.

Iowa (IA) posed a broader question to agencies about sending plow or weather-related data to Google or Waze. Few agencies reported doing so, and Iowa asked why participation was so limited.

- **Kansas (KS)** explained the difficulty of establishing these connections. Waze and Google are selective about data formats and demand substantial detail to accept data feeds. Kansas worked with Castlerock to configure systems for 511 integration, but broader connections remain challenging.

Group Discussion Summary – AI, Machine Learning, and Predictive Tools in Winter Operations

Have you integrated AI/machine learning, predictive analytics or vendor-provided tools to optimize winter operations (de-icing, sanding, plowing, timing, staffing, etc.)?

Key takeaways: AI and predictive analytics are **already producing operational results** (e.g., hazard detection, friction estimation, automated speed adjustments), but **adoption timelines vary widely** across agencies. Some are moving quickly with pilots, while others face institutional and IT restrictions. Low-cost sensing solutions combined with AI are emerging as promising areas, though further validation is still needed.

Texas (TX) reported that its traffic management staff are piloting AI-based systems using traffic cameras to detect pedestrians and unexpected objects on interstate highways. When the system identifies a potential hazard, alerts are sent directly to the Traffic Management Center (TMC). Early results show approximately 95% accuracy, providing a strong case for AI-supported roadway monitoring to improve safety and responsiveness.

New Hampshire (NH) referenced an active NCHRP project focused on performance measures for winter operations. In this project, New York State DOT is partnering with **SUNY-Albany** to use camera imagery to evaluate road conditions and generate alerts for operators.

- **New York State (NYS)** added that the AI-based assessment of road conditions is still relatively new and under development. SUNY-Albany manages a statewide camera network that provides a wide variety of metrics, which can be leveraged for winter road condition monitoring.
- **NCHRP staff** mentioned that the work of the SUNY-Albany researcher was recently highlighted on the *Talkin' Winter Ops* podcast, signaling growing visibility of this approach.

Iowa State University (IA/Aurora Program) shared that Aurora has already completed several AI and predictive analytics projects:

- Using weather variables to automatically adjust roadway speeds in real time, removing the need for human intervention.
 - Applying machine learning models to estimate roadway friction, expanding beyond traditional RWIS data.
- The emphasis was on finding **practical, implementable applications** rather than theoretical research, ensuring results can be directly integrated into DOT operations.

Group feedback on adoption timelines: When asked about agency plans for AI or machine learning, responses were mixed:

- One agency indicated plans to implement AI solutions within the next three years.
- Several others noted interest in adopting AI within five years.
- Many agencies reported that their organizations currently do not allow the use of AI due to internal restrictions, policy concerns, or IT security barriers.

Iowa (IA) further described a University of Utah project funded under Aurora, which is testing low-cost infrared cameras to assess road surface conditions. While the approach has demonstrated successes, there are also gaps and areas requiring improvement. The project applies AI and machine learning to interpret infrared imagery for roadway status assessment.

Partnering for Better Data Use

Are there external partnerships (e.g., with private fleets, vendors, or research organizations) that strengthen your data-driven winter operations?

Key takeaways: External partnerships can greatly expand data availability and collaboration (e.g., RWIS data sharing, 511 integration, coalitions), but **institutional barriers, staff acceptance, and vendor limitations** remain significant obstacles to innovation. Adaptive routing shows strong promise for cost savings and efficiency but requires both **better data coverage** and **vendor support**, as well as strategies to gain staff and leadership buy-in.

Iowa (IA) shared an example involving 18 mini-RWIS sites. The system is designed so that other Iowa agencies using the same platform can access DOT data if data-sharing agreements are established. Conversely, the DOT can view county or city data when those agencies agree to share, expanding the scope of situational awareness.

Maryland (MD) described the MATOK group, which brings together counties, municipalities, transit agencies, and cities. The group meets regularly to exchange post-storm information and to maintain awareness of ongoing events, work zones, and projects.

Iowa (IA) recalled the 2024 floods, when counties lacked an effective method to share road closure data. In response, the Iowa DOT worked with counties to integrate their closure information into the statewide 511 system. This collaboration created new opportunities for broader closure reporting and information sharing.

- **Iowa (IA)** added that, in winter, closure notices or “travel not advised” messages are still posted at the county level, rather than for specific roadways. Efforts are underway to shift toward roadway-level reporting.
- **Iowa State University (IA)** mentioned that the I-80 Coalition is working on approaches to share operational information across participating agencies.

A discussion question was raised about whether technology initiatives had been discontinued and why.

- **New Jersey (NJ)** responded that the installation of forward-facing cameras in trucks initially faced strong union resistance due to privacy concerns. It took four years of negotiations before cameras were accepted, illustrating how labor considerations can delay technology adoption.

Iowa State University (IA) commented on the potential of adaptive routing, noting that while it is widely used in private sector package delivery, DOTs typically continue to rely on long-established plow routes. Institutional inertia and operational barriers have slowed adoption, even though adaptive routing could improve efficiency and responsiveness.

- **Minnesota (MN)** agreed with the potential cost savings of adaptive routing but questioned how gaps in roadway condition data could be addressed, since data coverage remains incomplete.
- **Nebraska (NE)** echoed this concern, reporting that adaptive routing was considered but met with staff resistance. Field crews felt they already knew where and when to plow, and without demonstrated benefits, skepticism hindered adoption.

Iowa State University (IA) suggested a variation: conducting AI-based route optimization before the winter season to pre-establish improved routing plans. This could balance innovation with operator acceptance by reducing disruption during active storms.

- **Minnesota (MN)** noted that some newer AVL providers are beginning to apply route optimization analytics. However, when the agency asked its current AVL provider to explore these capabilities, the vendor declined, unwilling to customize solutions for a single client. This created a roadblock not only for adaptive routing but also for AVL-based road condition reporting. The point underscored the need for collective pressure from agencies to push vendors toward innovation.

- **Iowa State University (IA)** emphasized that pooled conversations like this help agencies consolidate concerns into key issues, which can then be presented to vendors as clear challenges for industry response.
- **Minnesota (MN)** reflected on its experience with the MDSS system, noting that it is only as effective as the quality of data input. Keeping the system functional requires significant agency investment. If support lapses, staff interest declines, undermining system value. Minnesota stressed the importance of demonstrating benefits to frontline staff while maintaining leadership engagement. Staff must feel supported, but leadership must also consistently promote and sustain system value.
- **Nebraska (NE)** indicated that adoption of some technology-based practices was mixed at the district level but expects that districts will engage if it makes their jobs easier.

Session 4: Operator Safety and Motorist Messaging

This session was **focused** on framing the intersection of operator awareness, in-cab alerts, road closures, working with other agencies, and public information. **It is relevant** in supporting both groups through exploring strategies to improve operator safety and deliver timely, consistent hazard messaging to motorists and operators through integrated systems and partnerships.



Source: Z. Hans

Moderator: Jed Falgren, Minnesota (AASHTO Winter Weather)

- Reported on Minnesota's integration of **AVL data with DMS (Dynamic Message Signs)** to deliver real-time hazard messaging. Currently, if a Minnesota plow truck drives past a message board at a speed lower than the posted speed, the system automatically adjusts the board to display a **reduced speed limit message**. The slower the plow drives, the longer the alert remains active.
- This represents **Generation 3** of their system, developed in collaboration with ITERIS. It integrates AVL data with **IRIS**, allowing message boards statewide to update automatically. The long-term goal is to extend this functionality directly into vehicles.
- Moving into **Generation 4**, Minnesota has now replaced all AVLs with a new provider. Over **800 plows** are equipped with updated technology, and there are **4,343 units** in service. A major operational challenge is preventing **duplicate alerts for the same event**.
- All AVL data flows into **511 and the associated API**, which feeds into navigation apps such as **Waze**, strengthening real-time information sharing with the traveling public.
- Minnesota is also testing a **custom circuit board** that integrates a Geotab unit directly into message boards. This allows events to automatically appear in the 511 system, creating seamless integration.
- Safety remains a concern, as Minnesota plows are struck more than **100 times per year**. To address visibility, the state is working with the **University of Minnesota Human Factors**

Lab, which recreates highway scenarios to test how drivers respond to **lighting flash patterns** and other warning configurations.

- Beginning this winter, **100–150 plows** will be fitted with **conspicuity tape**, primarily chevron patterns but also box patterns, to make trucks more visible in low-visibility conditions.
- Some custom developed solutions may too costly to commercialize.

Best Practice Presenter: Craig Bargfrede, Iowa (Clear Roads)

- Presented examples of Iowa’s ongoing innovations and lessons learned in winter operations:
 - Iowa is a relatively flat state, making **wind and visibility issues** a recurring challenge.
 - Three years ago, Iowa DOT partnered with **Iowa State University** to explore solutions for operators driving in **low-visibility conditions**. A major tractor equipment manufacturer subsequently approached the DOT with a technology that mounts on the front of a truck and provides a dashboard display. The system maps routes and enables operators to maintain precise lane position in near-whiteout conditions, with accuracy measured in inches.
 - A pilot demonstrated strong results, and Iowa presented a **business case** to its leadership to install **24 units across six districts**.
 - The system was first installed in a road grader to confirm feasibility. Based on success, the DOT is now in the final stages of contracting to install the technology in **24 trucks for the 2025–2026 winter season**.
 - **Cost:** \$7,000 per unit, including one year of subscription. Ongoing maintenance will cost \$1,200 per year. Once a route is mapped on one truck, the route can be transferred to other trucks, expanding flexibility.
 - Iowa is also piloting **geofenced DMS plow presence messages**. When a plow enters a geofence, nearby DMS boards activate with warnings such as “*Caution: Plows Ahead.*” The message turns off automatically when the truck leaves the geofence. This pilot will be rolled out in the **2025–2026 winter season**.
 - For more than a decade, Iowa’s **511 system** has displayed AVL data, allowing the public to see plow locations, direction of travel, and whether a truck is plowing or spreading material. The system also displays **plow camera images**, updated every two minutes. To protect operator privacy, images are only posted if the plow is moving at least 8 mph and is within 20 feet of the centerline—preventing images of refueling, loading, or breaks from being displayed.
 - The system is highly valued by the **public, media, and staff**. It increases transparency, aids traveler decision-making, and enhances confidence in DOT operations.
 - Iowa conducts **media outreach** in close partnership with the State Patrol and NWS. Every two weeks during winter, Iowa holds media calls to review events, preview upcoming storms, and provide educational graphics and terminology. Six years ago, Iowa expanded this into a **regional webinar** with more than **40 media outlets across IA, MN, and NE**, improving cross-border messaging. This effort has increased media

engagement and allowed DOTs to shape how the public receives winter operations information.

- One key communication theme has been **speed differential awareness**—educating motorists that plows travel slowly and that rapid closing speeds can cause accidents.
- Iowa is also developing a policy for **IPAWS (Integrated Public Alert and Warning System)** to formalize messaging during interstate closures.
- Finally, Iowa is in **early discussions with Google** about navigation rerouting. The goal is to ensure that when Google reroutes traffic during closures, it directs vehicles to preferred detour routes rather than onto secondary roads that may be less safe or poorly maintained.

Group Discussion Summary – Operator Safety and Motorist Messaging

Key takeaways: Agencies are expanding **geofence-triggered DMS alerts and operator safety systems** while emphasizing **media collaboration** to improve public awareness and safety. Minnesota’s integration with NWS provides a model for proactive storm and hazard messaging, while Colorado is exploring advanced sensor systems for mountain corridors.

Arizona (AZ) asked how far dynamic message signs (DMS) are typically placed from geofenced plow locations. The response was that distances will likely vary by location. Initially, the system will be limited to plow trucks, with the potential to expand coverage depending on performance results from the upcoming winter season.

Iowa State University (IA) noted that the American Traffic Services Safety Association (ATSSA) annually presents awards recognizing media representatives for excellence in communicating roadway work and lane closure conditions. This was raised as an example of how media engagement can be leveraged to promote roadway safety messaging.

Iowa (IA) added that ongoing discussions with media also focus on ensuring reporter safety while covering roadway and weather-related conditions. The DOT emphasized the importance of educating reporters on safe practices when conducting live coverage in hazardous areas.

Colorado (CO) suggested that mountain corridors in the state could benefit from John Deere’s low-visibility navigation sensor technology. CO asked whether the system requires cell phone coverage and was informed it operates via satellite communication, making it suitable for remote mountain regions. Some local jurisdictions in Colorado are already using this technology, and CO recommended direct engagement with John Deere for more information.

Minnesota (MN) reported active collaboration with the University of Minnesota to develop a system that improves operator safety in low-visibility conditions. This system assists drivers in staying on the roadway and maintaining awareness of their location, addressing one of the most challenging aspects of plow operations.

Minnesota (MN) also described its work with the National Weather Service (NWS) to expand hazard messaging on DMS boards. Key initiatives include:

- **Blizzard warnings:** Minnesota now provides advance blizzard alerts up to six hours before events, displayed directly on DMS boards.
- **Snow squall warnings:** When issued by NWS, Minnesota automatically activates nearby message boards in the affected area and posts the warning on the state's 511 traveler information system.
- Minnesota highlighted positive outcomes from the Pathfinder project, particularly in strengthening the consistency and reliability of NWS messaging for motorists.

Group Discussion Summary – Real-Time Hazard Alerts to Motorists

What approaches do you use to alert motorists of winter hazards, especially via real-time, location-specific channels?

Key takeaways: **South Dakota** demonstrated how combining roadway signage with IPAWS alerts provides layered communication, while **Texas** highlighted the organizational and procedural challenges of adopting IPAWS but confirmed its growing value. Emerging opportunities include **two-way engagement** with motorists during emergencies, which could improve response and situational awareness but will require new protocols.

South Dakota (SD) reported that media outlets and roadway message boards remain the primary means of alerting the public to winter hazards. Standard messages include advance notice of interstate closures and storm warnings. For flood gates, signs display specific closure and reopening times for I-90, giving motorists clear expectations. Beyond roadway signage, SD also relies on cell phone alerts through the **Integrated Public Alert and Warning System (IPAWS)**, which functions like Amber Alerts. These alerts are issued by the State Patrol and Emergency Management Team, reaching all cell phones in the affected geographic area with both a text and an audible signal. This capability ensures timely, location-specific hazard information reaches motorists directly.

Texas (TX) explained that it has been using the IPAWS system for two years. A major challenge was gaining agreement from the state's Emergency Management Team to allow DOT participation in issuing alerts. The process now works as follows: a local shop supervisor drafts an alert message, which is then reviewed by district headquarters and the traffic division before final approval and release by emergency management. This multi-layered process balances operational urgency with oversight. Texas also noted that the IPAWS system includes a feature that allows recipients to opt into a **two-way communication channel with emergency services**. Although Texas has not yet activated this feature, it was mentioned that **Pennsylvania** is already using it, providing a potential model for expansion.

Group Discussion Summary – Integrating RWIS/AVL with Safety Systems

How do your RWIS or AVL platforms integrate with safety warning systems for maintenance

vehicles or other partners like the State Patrol?

Key takeaways: States are experimenting with ways to **integrate RWIS/AVL data with safety communication platforms**. Strategies range from **direct roadside warnings** (bridge deck sensors activating lights in Minnesota) to **centralized ATMS platforms** (Rhode Island) and **third-party data integration** (Maine). Massachusetts’s approach of linking RWIS to automated DMS triggers illustrates the trend toward **predictive, automated hazard alerts** that reduce reliance on manual intervention.

Massachusetts (MA) reported that it is evaluating how downstream RWIS (Road Weather Information System) data could be used to automatically trigger upstream dynamic message sign (DMS) alerts. The goal is to provide motorists with advance warnings about icy pavement or adverse weather conditions before they encounter them, enhancing both safety and driver preparedness.

Minnesota (Winona District) described its deployment of three non-invasive road condition sensors mounted on bridge decks. Instead of feeding directly into DMS units, these sensors activate flashing warning lights positioned on the bridges themselves to alert motorists when slippery conditions exist. The data is also sent to the state’s Traffic Management Center (TMC), where operators can post related hazard messages to DMS boards across the broader network. This dual system of **on-site visual warnings plus centralized TMC integration** enhances both local and regional response.

Rhode Island (RI) explained that its DOT has contracted with the Traffic Management Center to build a new advanced transportation management system (ATMS) software platform. This platform is designed to integrate multiple data sources and communication tools—RWIS, camera systems, and DMS—into a single interface. The system aims to streamline operations by giving staff one cohesive view of roadway and weather conditions alongside messaging and camera feeds.

Maine (ME) reported that it uses third-party TomTom data to monitor travel times across the state’s network. When significant slowdowns appear in the system, TMC operators update DMS boards with information about traffic delays. This approach integrates real-time travel condition monitoring with driver-facing safety alerts, ensuring that motorists receive accurate and timely updates.

Group Discussion Summary – Operator Alerts for Critical Road Hazards

What systems are in place to alert operators to road hazards, low visibility, or black ice?

- **Minnesota (MN)** shared that commercially available data sources, such as Google, can provide useful supplemental insights for identifying roadway hazards. For example, when multiple vehicles are observed to swerve or suddenly reduce speed in the same location, this pattern may indicate the presence of a pothole, roadway obstruction, or localized hazard. Minnesota noted that while this type of data is not a primary source for operational decisions,

it can serve as a **real-time indicator of potential hazards**, helping agencies confirm field reports or prioritize inspections.

Group Discussion Summary – Using Connected or Crowd-Sourced Data

Are you using connected vehicle or crowd-sourced data to enhance situational awareness or message timing?

Key takeaways: Agencies are actively experimenting with **crowd-sourced reporting platforms** (e.g., Waze, CarPlay/Android Auto voice reports) to strengthen situational awareness and improve the **timing of public alerts**. Kansas' integration highlights the potential of **in-vehicle voice reporting** for direct 511 feedback, while Iowa demonstrated how crowdsourced alerts can serve as an **early-warning system** for incident detection and emergency response.

Kansas (KS) reported that it has developed a **map-based interface for CarPlay and Android Auto**, designed to integrate directly with its 511 traveler information system. Through this platform, motorists can submit voice reports while driving to identify potholes, hazards, or other roadway issues. These reports feed into the state's 511 system, where they can be monitored and acted upon by operators. The system was built by Castlerock, Kansas's 511 vendor, and funded through a technology grant. By leveraging **in-vehicle interfaces** instead of requiring separate apps or manual entry, the approach makes it easier and safer for drivers to provide timely hazard information.

Iowa (IA) explained that it integrates **Waze driver alerts** into its operational workflow. When motorists report crashes, hazards, or delays through Waze, the Iowa Traffic Management Center (TMC) receives the alerts and uses them as part of the DOT's emergency incident notification process. Iowa noted that a significant number of roadway incidents are **first detected via Waze reports** before traditional channels like law enforcement or field staff confirm them. This underscores the value of **crowdsourced situational awareness tools** in improving response speed and message accuracy.

Session 5: Operational Decision Support with Dashboards and Tools

This session was **focused** on providing an overview of the tools used by Clear Roads and Aurora to support real-time and proactive decisions. **It is relevant** as we will highlight how dashboards and decision tools help members improve forecasting, resource planning, and real-time winter operations through integrated data and performance tracking.

Moderator: Ty Winther, Idaho (Clear Roads)

- Idaho demonstrated how it has developed an advanced **dashboard system that integrates AVL data** into structured datasets, enabling analysis at multiple levels—district, shed, route, RWIS station, and material usage. The dashboard includes a **live viewer** during storms, allowing crews to monitor material usage in real time as events unfold.
- Historically, Idaho tied **employee pay to roadway grip levels and performance outcomes**, but this practice unintentionally encouraged excessive salt use over time. This was identified as a lesson learned and has since been discontinued.
- Currently, Idaho operates **140 grip sensors statewide**, feeding real-time data into the dashboard system.
- Discussion explored how cost targets were established. It was explained that an **algorithm** estimates the appropriate material quantities per storm. For narrow storm bands or short frost events (under 30 minutes), data are excluded since they skew results. Conversely, **freezing rain events**, which demand more material, are factored in as they increase costs. Importantly, the system can flag when a storm is unlikely to be managed successfully, allowing agencies to **conserve resources** rather than over-applying materials.
- Employees must analyze **at least five storms each year** using dashboard data, then report to supervisors with lessons learned and improvement ideas, such as adjusting application timing or salt quantities. This practice helps build accountability and operational learning.
- Maryland shared that **drifting and ice events** required different algorithms, as drifting caused sensors to activate continuously and skew results. Idaho subsequently developed **specific algorithms** to account for drift events, improving precision in tracking salt use in these challenging scenarios.
- Iowa contributed additional insights:
 - Frequent drifting events require as much effort as managing falling snow. Iowa developed methods to **quantify drifting impacts** in winter operations.
 - Iowa maintains several **dashboards for salt, material use, and purchasing**, which supervisors use to benchmark district-level performance. Although some dashboards were previously public-facing, they are currently offline for a website refresh.
 - Iowa's salt dashboard is also **linked to the purchasing system**, logging transactions by date to detect and correct data errors.
- Arizona reported maintaining a **truck wash dashboard**, which tracks wash frequency as part of fleet management and contributes data to the broader **asset management system**.

- Colorado described its **operational readiness dashboard**, which tracks staffing levels, material stockpiles, and out-of-service trucks, providing a real-time snapshot of resources and supporting **resource shifting across regions** when needed.

Best Practice Presenter: Jeff Williams, Utah (Aurora)

- Utah showcased the development of a **real-time Storm Severity Index (SSI)**, created by leveraging RWIS data. This SSI models the weather conditions encountered by snowplows and is cross-referenced with measured **roadway grip values** to assess whether service levels are being met.
- Utah maintenance standards indicate that service levels can be maintained at **snowfall rates up to one inch per hour**. Above this threshold, operations lack the capacity to significantly improve conditions. The SSI accounts for this limitation by flagging conditions where service improvements are not realistically achievable.
- The SSI incorporates additional variables such as **road temperature, wind speed, and storm intensity**, adjusting severity levels accordingly.
- To support decision-making, the SSI uses a **color-coded system (red, yellow, green)** to indicate weather severity, roadway grip, and whether resources should be shifted to areas of higher need.
- Beyond real-time operations, the SSI supports **post-storm analysis and financial accountability**, helping agencies evaluate performance and allocate resources more efficiently.
- Utah emphasized that this tool is currently a **custom-developed system**, not commercially available, and reflects their investment in tailoring RWIS data to operational decision-making.

Group Discussion Summary – Forecasting Road Surface vs. Weather

What challenges do you face in forecasting road surface conditions vs. general weather?

Key takeaways: Forecasting **road surface conditions** presents additional challenges beyond general weather forecasting because of the dependence on **sensor alignment and cleanliness**. Even small obstructions, such as cobwebs, can distort readings. Contracted maintenance and regular cleaning (as practiced in Idaho) are practical strategies to preserve sensor accuracy and support more reliable surface condition forecasting.

One agency noted that some road sensors can provide unreliable readings if they are not aimed directly at the pavement surface. Misalignment or external obstructions can cause inaccurate data, which in turn affects the accuracy of surface condition forecasts. A specific example mentioned cobwebs interfering with sensor accuracy, creating false readings. This highlighted the need for careful installation, ongoing inspection, and periodic review of sensor placement to ensure reliable outputs.

Idaho (ID) reported that its DOT contracts out maintenance for RWIS (Road Weather Information System) sensors. As part of these maintenance activities, technicians are responsible

for cleaning and washing sensors to reduce data interference. Routine cleaning helps mitigate issues such as debris, dust, or cobweb buildup, ensuring more consistent performance and more accurate pavement condition forecasts.

Group Discussion Summary – Dashboards with Performance Metrics

How are performance metrics (e.g., material usage, storm response time, weather indices) incorporated into dashboards?

Key takeaways: Agencies are increasingly using dashboards to track **material usage, equipment operations, and storm response times**, but data gaps remain—particularly when AVL systems do not capture true speed or when assumptions are needed. Plowing speed practices vary by state, but most agencies keep application speeds below 35 mph. Emerging performance metrics, such as Kansas’ focus on **time to service recovery**, illustrate a shift toward **outcome-based measures** rather than solely operational inputs.

Indiana (IN) reported that its AVL (Automatic Vehicle Location) system is only active when spreaders are engaged. The system tracks data specific to equipment operation rather than vehicle speed. As a result, Indiana must make assumptions about plowing speed during application, even though AVL data may indicate continuous operation. This limitation creates potential gaps in understanding true operational performance.

A **discussion question** was raised: *Who plows or applies material at speeds above 40 mph?* This led to a comparative discussion across states about speed practices, safety, and equipment limits.

South Dakota (SD) explained that plowing above 40 mph is permitted on roadways with posted speeds of 65 mph or higher. The reasoning is that maintaining higher plowing speeds helps reduce the risk of rear-end collisions with faster-moving traffic. However, for material application, South Dakota sets lower limits, with plows traveling at speeds below 30 mph.

Washington State (WS) reported that it does not enforce a specific plowing speed limit, but operators typically remain below 35 mph when applying materials.

An **unspecified speaker** noted that recommended plowing speeds were generally established in consultation with equipment vendors and manufacturers. According to these guidelines:

- Junior wing plows and underbody plows can withstand operational speeds of up to 40–45 mph.
- Two-plow configurations also max out around 45 mph.
- For material application, however, recommended speeds are much lower—around 30 mph—though in practice speeds vary depending on roadway conditions and operator judgment.

Kansas (KS) reported that it is currently evaluating “**time to return to level of service**” as a new performance metric. This measure focuses on how quickly roadways return to expected service levels after a storm, reflecting both operational efficiency and the effectiveness of treatment strategies.

Session 6: Integrating Systems and Sharing Data

This session was **focused** on highlighting challenges and opportunities for multi-agency and multi-system data integration. **It is relevant** as the session addresses shared AASHTO, Clear Roads, and Aurora challenges by exploring how to integrate systems, align data standards, and improve collaboration across agencies and platforms.

Moderator: Joe Huneke, Minnesota, Aurora and Clear Roads

Best Practice: Dan Varilek, South Dakota, Clear Roads



Source: N. Hawkins

Group Discussion Summary – Sharing Data with Partners

How do you share data (RWIS, AVL, weather, storm severity, Pathfinder) with local agencies or contractors?

Key takeaways: **South Dakota** demonstrated a proactive model for **local integration and preemptive storm planning**, combining technology (ITARIS, MDSS, Google triggers) with interagency coordination. **Minnesota’s inquiry** highlighted the potential for **multi-state Pathfinder collaboration**, though such groups will need to emerge from state leadership rather than FHWA direction. **Colorado’s quad-state meetings** show how regional partnerships already support knowledge sharing across borders.

South Dakota (SD) described several strategies for improving data sharing with counties, reservations, and partner agencies:

- The state identified specific **trigger words recognized by Google** that display official road closure information. This knowledge was shared with counties and reservations to ensure their closures also appear on Google Maps.
- SD worked with **ITARIS** to allow outside agencies (counties/reservations) to “piggyback” on the state’s system. Each local agency designates one representative who

can directly enter closure information into the statewide system, giving them greater visibility and integration with the DOT's network.

- Coordination with the **Highway Patrol** plays a central role in preemptive interstate closures. For impending storms, SD uses **MDSS (Maintenance Decision Support System)** and meets with the National Weather Service (NWS), the Governor's Office, Highway Patrol, and the National Guard. Together, they evaluate worst-case scenarios and plan proactive closures when necessary.
- Beyond technical tools, SD stressed the importance of **neighbor-to-neighbor outreach**—meeting with nearby states and agencies ahead of the winter season to share updates on new technologies, systems, and processes. This pre-season awareness building strengthens mutual preparedness and coordination.

Minnesota (MN) asked whether there had been any formal movement toward creating **multi-state Pathfinder groups**. The Federal Highway Administration (FHWA) responded that no official group currently exists but emphasized that states are free to form such collaborations independently. FHWA offered to facilitate regional coordination if desired, but did not see itself as the driver of such initiatives.

Colorado (CO) reported that it participates in **rotating regional meetings** with neighboring states, specifically Kansas, Nebraska, and Wyoming. These “quad state” meetings provide a platform for sharing experiences, aligning practices, and discussing emerging technologies in winter operations.

Group Discussion Summary – Standards and Platforms for Integration

What platforms or data standards (e.g., APIs, WZDx) support this integration?

Key takeaways: States are making progress with **API-based integration** of RWIS, AVL, and work zone data into traveler information systems, but technical and operational challenges remain. **South Dakota's MIMS approach** demonstrates the potential for integrated, HAAS-like safety alerts. **Minnesota and Iowa's experiences** illustrate common issues with **image alignment, API integration, and long-term data management**, raising the need for clearer standards and retention policies to reduce future burdens, especially in legal contexts.

South Dakota (SD) reported that it is operating on the **Maintenance Management System (MIMS)** with vendor Adams AI. All system functions are supported through APIs, allowing integration with other platforms. Current efforts are underway to incorporate work zone data into the 511 traveler information system. Once this integration is complete, the system will be able to broadcast information similar to other 3rd party alerts, providing motorists with real-time hazard awareness and helping reduce crashes in and around work zones.

Minnesota (MN) shared its experience after transitioning to a new AVL vendor. The state faced challenges when integrating AVL data with systems such as 511, Castlerock, and DTN. A specific difficulty arose when converting video into still images: geographic alignment errors made it difficult to match the imagery accurately to road locations. Minnesota asked whether Iowa had encountered similar challenges with its Samsara integration.

Iowa (IA) confirmed that it too had experienced difficulties integrating its AVL vendor-provided **API**, though the state has managed to retain all historical data. Iowa is considering adopting a **formal data retention policy** to address the growing burden of managing long-term storage and retrieval requests.

- Iowa explained that problems also arose with **small-scale images** generated through processing methods. These images proved less precise than anticipated, complicating efforts to filter them for public-facing platforms such as 511.
- Additionally, Iowa reported challenges in **legal proceedings** where data was requested for the dates before their current AVL vendor. Retrieving archived information for litigation has required significant additional effort and resources from DOT staff, underscoring the importance of both data retention and accessibility policies.

Group Discussion Summary – Collaboration to Enhance Data Sharing

Are you partnering with others (Universities, tech providers, etc.) to streamline, visualize, or share data across systems?

Key takeaways: **Minnesota** is strengthening its autonomy by building direct APIs and custom analytics tools, while **Iowa** is leveraging partnerships with universities and vendors to make road condition reporting more **predictive and adaptive**. Both efforts highlight the trend toward **greater control, smarter forecasting, and advanced visualization** in winter operations data sharing.

Minnesota (MN) reported that it is transitioning to a new **Asset Management System**. As part of this shift, the state plans to take AVL data directly from its APL and set up an **API connection** to feed it into the new asset management platform. This approach will allow Minnesota to bypass reliance on DTN for report generation. Instead, the DOT will be able to develop its own APIs, build internal data pipelines, and create customized **dashboards**. By removing vendor dependency, the state expects greater flexibility in how operational data is structured, shared, and visualized, ultimately improving decision-making and reporting efficiency.

Iowa (IA) described a collaboration involving **Iowa State University, its 511 provider, and Pikalert**. The partnership focuses on improving the accuracy and timeliness of reported road conditions in the 511 system. Specifically:

- **Pikalert** notify garages when road condition reports in 511 become outdated, prompting updates.
- A **gridded forecast** is used to align 511 road conditions with the roadway segments that operators report on.
- Iowa State and Castlerock are working together to develop an **algorithm** that predicts what the road condition is trending toward, not just the current state.
- Iowa State is validating this approach to ensure accuracy before deployment.

This collaboration aims to deliver a **proactive 511 system** that evolves road condition reporting from static snapshots to forward-looking, predictive insights.

Group Discussion Summary – Pain Points in System Alignment

What are your biggest pain points in aligning multiple systems (forecasting, operations, messaging)?

Key takeaways: System alignment pain points often emerge when automation and field operations intersect. Minnesota’s example illustrates the difficulty of ensuring that automated road condition updates from MDSS into 511 remain accurate while also not overburdening field personnel with monitoring responsibilities. Effective workflows must balance automation efficiency with **real-time operator validation**.

Minnesota (MN) highlighted ongoing challenges with aligning multiple systems including **MDSS (Maintenance Decision Support System)**, 511 traveler information, and field operations. The state explained that MDSS now provides **automated road condition updates** directly to the 511 system. While this automation improves efficiency, it introduces new coordination issues.

- Automatic text alerts are sent to field personnel when MDSS updates 511 conditions. This ensures operators are notified of changes without needing to monitor the 511 platform continuously.
- Field staff are then expected to review the automated update and, if necessary, **override the information** in 511 when it does not reflect actual conditions.
- Minnesota noted that this workflow remains a **pain point** because field personnel are often occupied with storm response and may not have the capacity to monitor or validate automated outputs in real time. Balancing automation with human oversight continues to be a challenge.

Group Discussion Summary – Joint Tools and Templates for Collaboration

Are there areas where Clear Roads and Aurora can collaborate to create templates or tools for joint use?

Key takeaways: Agencies see strong potential for **joint guidance documents, shared standards, and collaborative projects** between Clear Roads and Aurora. Nebraska and Iowa pointed to **surface condition sensors** and **connected corridor initiatives** as immediate opportunities, while CTC’s **National Road Condition Legend** and Iowa State’s call for collective priority-setting highlight the importance of **standardization and industry engagement**.

Nebraska (NE) highlighted strong agency interest in **surface condition sensors**—both mobile and fixed—for monitoring grip levels and guiding salt application. Clear Roads already has a project underway in this area, and Aurora members are also deeply engaged. NE suggested that the two groups develop a **guidance document** to consolidate best practices and lessons learned.

While the scope of collaboration remains to be defined, NE emphasized that there are likely **multiple areas where Clear Roads and Aurora could coordinate** to avoid duplication and amplify impact.

Iowa (IA) stressed the importance of collaboration not only between **Clear Roads and Aurora** but also across **neighboring states**. A key example is the pooled fund solicitation for the **Connected Corridors Advancement Initiative (Solicitation 1633)**, spearheaded by the I-80 and I-35 coalitions. While these corridors are the initial focus, the effort is not exclusive to them. The initiative aims to **streamline information delivery** so that travelers receive consistent and accurate data as they move across state borders, reducing confusion and improving regional coordination.

CTC & Associates reported that a Clear Roads project is developing a **National Road Condition Legend**, which would standardize terminology and symbols across jurisdictions. This effort aligns with broader discussions about creating shared tools that can be adopted nationally for consistency in traveler information and operational reporting.

Iowa State University (IA) observed that numerous technology and research initiatives are already in progress across agencies and pooled funds. The university emphasized that the real value lies in **identifying which tools agencies most need next**, organizing collectively around those needs, and **communicating them effectively to industry partners**.

Closing Joint Meeting Summary

Joint Meeting Wrap-Up: Jed Falgren, Key Themes and Closing Notes

Key takeaways:

- Winter operations are becoming increasingly **data driven**, with agencies adopting mobile sensors, AVL dashboards, and connected data to guide treatment decisions, monitor performance, and improve roadway safety.
- **Dashboards** are now central tools for tracking material use, operational readiness, and post storm performance while supporting informed decision making at all levels.
- New **emerging tools** such as storm severity indices and crowd sourced alerts are improving real time awareness of changing conditions and helping agencies respond more effectively.
- **Proactive communication** through message boards, 511 systems, and coordinated media outreach remains essential for traveler safety and public confidence during severe weather events.
- **Partnerships with technology providers** are shaping how information is shared both through in vehicle systems and across public platforms, opening new opportunities for collaboration and innovation.
- **Cross agency collaboration** is advancing progress toward consistent data standards, shared tools, and collective innovation, though **institutional barriers** such as IT security, legal constraints, and staff acceptance still pose challenges.
- While **AI and predictive analytics** hold strong future potential, practical, low cost, operator driven solutions continue to deliver immediate benefits and help build trust for wider technology adoption.
- This **joint meeting** highlighted the value of bringing the three-winter maintenance and operations groups together to strengthen relationships, align goals, and build shared momentum toward smarter, safer, and more connected roadway management.

Adjournment

The joint meeting was formally **adjourned for the day**, with the shared understanding that the discussions provided a strong foundation for shaping collaborative priorities moving forward.

