





Weather Business

Our Observation Solutions

Mega Trends

Our Markets

METEOROLOGY ENERGY 1001 000110 1001 Digitalization and Big Data Climate Change TRANSPORTATION Renewable Connected Devices Energy

INTELLIGENT TRANSPORTATION SOCIETY OF ALASKA

Employs 1600 professionals worldwide

EMEA 69%

29%

Americas 23%

APAC 8%



Has over

38% of Vaisala people work outside Finland

in **16**

countries

Serves customers in over countries annually



44%

2016 R&D investments over of net sales

20% of employees work in R&D activities

Committed to using 100% renewable energy by 2020





Reliable Observations







Airports

- Runway Weather
- Atmospheric Sensors
- Lightning
- How it impacts operations









HOW ARE TODAYS SENSORS USED?





Dynamic Message Signs

6

TMM662-GI

FOG & POOR CONDITIONS

> Alerts the Public Triggered by Data





CZ 54 VB-C

HIGH WINDS

SLOW DOWN

VARIABLE SPEED LIMITS











British Columbia



British Columbia is making huge advancements in winter maintenance



Incorporating new methods and programs also required new technologies











Variable Speeds Based on Conditions (wind and visibility) and Grip





The data from these sensors are also used in treatment decision making and performance measurement





Case study: Colorado DOT

Weather related hazard

- Plowed snow accumulated on a blind curve on a busy highway just outside of Aspen, Colorado.
- Snow would melt during the day and refreeze after road became shaded later in the day.
- CDOT noticed numerous crashes were occurring at this curve despite generally good driving conditions
- They concluded that drivers were traveling at a higher rate of speed in good conditions, and were not prepared for the refreezing snow and ice conditions once they entered the turn.



Solution:



 Station installed with remote sensor at curve location. Sign located well before curve to advise drivers of hazard ahead





Results

- 80% reduction in accidents
- Before system average of 15 accidents per year
- After ~ 3 accidents
- Approximately 12 accidents saved every year
- Assuming 2 serious and 10 slight injury accidents
- **Saving** of (2x\$216k)+(10x\$80k) = **\$1.232M per annum**
- Estimated 15:1 return of investment in 1 year



Oregon variable speed limit



INTELLIGENT TRANSPORTATION SOCIETY OF ALASKA

- In a first of its kind project in Oregon, Oregon Department of Transportation highway managers are testing new variable speed signs on Interstate 84, to provide what authorities call a greater margin of driving safety during winter weather.
- ODOT crews installed variable speed signs in a critical thirty-mile corridor of Interstate 84 from Ladd Canyon to Baker City.
- "These electronic message boards indicate a safe speed limit for vehicles when weather conditions turn adverse. Computers collect data regarding temperature, skid resistance (ice) and average motorist speed to determine the most effective speed limit for this area, and then present that speed on the variable speed signs," according to an ODOT news release.
- "This gives motorists additional information about their drive in order to remain safer on the highway. The signs will lower and raise speeds automatically to meet observed conditions on the roadway," the release added.



AUTOMATIC VEHICLE LOCATION





Huge Advances in AVL

Accident management tool ♦ When, Where, ect. Inventory control tool Calibration of Trucks Complaint resolution tool ♦ When, Where, ect. Route monitoring tool ♦ Is there a quicker way Customer support Contractor oversight ➢ Real-time data and Images









Iowa DOT Dashboard Cams









Minnesota Displays the Latest Image along with Several Previous Images



SALA

VA



Reviewing data individually with grip







Would anti-icing have had an impact here?

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berty Lake at 296 dinates 6'38" W 47° 40' ude	(Bow station on map) 13" N	Nearest stations Garden Springs at 27 Perry Curves SR 395 © Hastings R T.J. Mennach Bridge Waste-Energy Plant	7 19.1 km 21.1 km d 25.7 km 27.4 km 30.1 km		Grou Spoka	ıs ne Region - Sites				
Station Overview	Graph Camera History Surface Temperature - Se	History Table	•	Dew Puint Ter	ngerature - Atmospheri	c șita	•	Level of	grip - Surface site 1	L+
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Combining AVL with Weather Data to Measure Performance

The pink line is grip and the red line is pavement temperature.







DATA FROM THE TRUCK IS SHOWN ON THE ROAD CONDITIONS PAGE

	T32147	20:06	
	Parameter	Value	
	Driver	7601	
60 (P)	Speed Speed	20 mph	05 01
19°	2 ^{S*} Direction	SSE	25 25
	Air temperature	27.1 °F	
	Surface temperature	21.0 °F	Se
	Blast pass norm	NORMAL	
	Dry material	SALT	75, 75,
2.2	20:06 Target dry rate	275 lbs/lane-mile	21:09 21:14
site 1	Clic Actual dry rate	275 lbs/lane-mile	
	Pre-wet material	BRINE	te del se liter seat liter i
	Target pre-wet rate	14 gal/lane-mile	
snowy	Actual pre-wet rate	33 gal/lane-mile	
3 (4)			
0 0		Close	

THE PERFORMANCE DURING A STORM IS EASILY SEEN



DSC111 – Road State Measurement

- Based on active transmission of infrared light beam (eye safe lasers) and detection of backscattered light
- Uses selected wavelengths to independently measure water, ice and snow thickness
- Nominal sensitivity of 10 µm or 0.01mm or 0.000394"
- Or a resolution that is 8 times smaller than the average width of a human hair (ranges from 18 to 180 µm)
- (a water layer thickness of 30 µm or 1/1000" is enough water to leave a clear tire track mark, thus is a good threshold from moist to wet)
- Measurements of dry, moist, wet, ice & snow/frost
- Road area sensed is approximately 1 Sq Foot









Storm Performance Index

• What is it?

- A numerical value estimates winter maintenance performance
 - Data comes from RWIS sites

How is it calculated?

- There are 3 main parts to the Index:
- Storm Severity Index = WS (Max) + WEL (Max) + 300/ST (Min)
 - Where the following units are used:
 - WS = Wind Speed (mph)
 - WEL = Water Equivalent Layer (millimeters)
 - **ST** = Surface Temperature (degrees F)
 - [Index range is 10 to 80 for typical storm events with severe cold and high winds running as high as 500]
- Winter Performance Index = Ice-Up Time (hours) / Storm Severity Index
 - Where:
 - Ice-Up Time is when the grip is below 0.6 for at least a 30 minute period
 - The goal is to have a Winter Performance Index of 0.5 or less.

• The Winter Mobility Index (0-1.00)

 Derived using the percentage of time the road conditions did not significantly impede mobility during a storm event (safe "grip" value) when precipitation was on the surface with below freezing surface temperatures being observed.





Storm Performance Index – How did we do?

• The input parameters are run through an algorithm that produces an index......

								Storm Perfo 0 0.00 - 0.30 0.31 - 0.49 0.50 - 0.69 0.70 -	rmance Index Successfully f Significantly a Some succes Very little suc Limited maint Observation d	Legend treated accelerated s at grip re acess at de enance or i ata / paran	grip recovery covery icing no deicer succe: neter missing or	ss temp is belov	v threshold
				Duration	Max Wind	Max Ice	Max Snow	Max Water	Min Surface	Severity	Performance	Mobility	
Station	Date	Time Range	Event	(hours)	Speed (mph)	Layer (mm)	Layer (mm)	Layer (mm)	Temp (°F)	Index	Index	Index	Comments
D5 - Mal	ad Summit												
	26-Oct-2012	04:30 - 10:00	FROST treated	5.50	5.59	0.00	0.00	0.02	26.06	17.12	0	100%	
D6 - Idal	no Falls		0.515										
	25-Oct-2012	02:45 - 04:45	GRIP<.6	2.00	3.80	0.14	0.87	0.21	30.56	14.49	0.14	38%	
	25-Oct-2012	04:45 - 06:00	IREATED	1.25	2.91	0.00	0.00	1.18	31.28	13.68	0		
D6 - Los	t Trail Pass												
	24-Oct-2012	09:15 - 10:30	GRIP<.6	1.25	5.14	0.31	0.31	0.12	14.72	25.84	0.05		
	24-Oct-2012	10:30 - 12:00	TREATED	1.50	5.82	2 0.15	0.04	1.15	19.76	22.15	0	55%	
	25-Oct-2012	02:00 - 11:15	GRIP<.6	9.25	4.47	0.13	0.81	0.00	18.50	21.50	0.43		
	25-Oct-2012	11:15 - 14:00	TREATED	2.75	7.61	0.08	0.16	1.96	20.66	24.09	0	470/	
	25-Oct-2012	14:00 - 23:00	GRIP<.6	9.00	8.05	0.07	0.75	2.36	4.82	72.65	0.12	47%	
	25-Oct-2012	23:00 - 12:45	TREATED	13.75	7.61	0.14	0.00	1.82	16.16	27.99	0		
	26-Oct-2012	15:00 - 16:00	TREATED	1.00	5.14	0.10	0.01	0.34	28.76	15.92	0	1%	
	26-Oct-2012	16:00 - 13:45	GRIP<.6	21.75	7.38	0.26	0.85	3.20	23.00	23.63	0.92	4 /0	
	27-Oct-2012	16:30 - 17:30	TREATED	1.00	5.59	0.04	0.02	0.27	30.38	15.74	0	33%	
	27-Oct-2012	17:30 - 19:30	GRIP<.6	2.00	6.71	0.11	0.63	0.00	28.22	17.97	0.11	5576	
	27-Oct-2012	22:45 - 06:15	GRIP<.6	7.50	7.83	0.06	0.82	0.00	28.58	19.15	0.39	0%	
	28-Oct-2012	08:15 - 09:15	GRIP<.6	1.00	4.92	2 0.04	0.78	0.00	28.94	16.07	0.06	0%	
	29-Oct-2012	23:00 - 05:00	TREATED	6.00	4.25	0.00	0.00	0.16	30.38	14.29	0		
	30-Oct-2012	05:00 - 10:00	GRIP<.6	5.00	5.59	0.15	0.05	0.01	27.68	16.58	0.30	57%	
	30-Oct-2012	10:00 - 10:30	TREATED	0.50	8.50	0.00	0.00	0.17	28.04	19.37	0		

Storm Performance Index

• The input parameters are run through an algorithm that produces an index.....

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Station	Date	Time Range	Event	(hours)	Speed (mph)	Layer (mm)	Layer (mm)	Layer (mm)	Temp (CF)	Index	Index	Index	Comments
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D6 - Ida	ho Falls	00.45 04.45		0.00		0.44	0.07		20.50	44.40	0.44		
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D6 - Los	t Trail Pass												
	24-Oct-2012	09:15 - 10:30	GRIP<.6	1.25	5.14	0.31	0.31	0.12	14.72	25.84	0.05	550/	
	24-Oct-2012	10:30 - 12:00	TREATED	1.50	5.82	0.15	0.04	1.15	19.76	22.15	0	55%	
	25-Oct-2012	02:00 - 11:15	GRIP<.6	9.25	4.47	0.13	0.81	0.00	18.50	21.50	0.43		
	25-Oct-2012	11:15 - 14:00	TREATED	2.75	7.61	0.08	0.16	1.96	20.66	24.09	0	470/	
	25-Oct-2012	14:00 - 23:00	GRIP<.6	9.00	8.05	0.07	0.75	2.36	4.82	72.65	0.12	41%	
	25-Oct-2012	23:00 - 12:45	TREATED	13.75	7.61	0.14	0.00	1.82	16.16	27.99	0		
	26-Oct-2012	15:00 - 16:00	TREATED	1.00	5.14	0.10	0.01	0.34	28.76	15.92	0	4.9/	
	26-Oct-2012	16:00 - 13:45	GRIP<.6	21.75	7.38	0.26	0.85	3.20	23.00	23.63	0.92	470	
	27-Oct-2012	16:30 - 17:30	TREATED	1.00	5.59	0.04	0.02	0.27	30.38	15.74	0	220/	
	27-Oct-2012	17:30 - 19:30	GRIP<.6	2.00	6.71	0.11	0.63	0.00	28.22	17.97	0.11	33%	
	27-Oct-2012	22:45 - 06:15	GRIP<.6	7.50	7.83	0.06	0.82	0.00	28.58	19.15	0.39	0%	
	28-Oct-2012	08:15 - 09:15	GRIP<.6	1.00	4.92	0.04	0.78	0.00	28.94	16.07	0.06	0%	
	29-Oct-2012	23:00 - 05:00	TREATED	6.00	4.25	0.00	0.00	0.16	30.38	14.29	0		
	30-Oct-2012	05:00 - 10:00	GRIP<.6	5.00	5.59	0.15	0.05	0.01	27.68	16.58	0.30	57%	
		10.00 10.20	TOFATED	0.50	8 50	0.00	0.00	0.17	28.04	10.37	0	1	

ALASKA

The Mobility Index

TRANSPORTATION SOCIETY OF ALASKA

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	surrace	etemp	eratu	res D	eing	ODSE	erve	u.				
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ITD RWIS - Performance Index Results

For RWIS Highway Segments

Benefits for Crash Reduction



Value of Crashes Avoided



NRITS August 26, 2014



ITD Return on Investment

Season/new WPR sites	Annual Crashes pre data	Annual Crashes post data	Annual Net Difference	Return on Investment
2011-2013/9	109	34	75	33.7
2012- 2013/24	192	113	79	13.3

Assuming 10 year service life of RWIS site,

2011-2013 ROI = 75 x 72,700/((125,000/10+5,500) x 9) = 33.7

2012-2013 ROI = 79 x 72,700/((125,000/10 +5,500) x 24) = 13.3





The Performance numbers

In the words of DOT maintenance staff:

- They indicate how effective we were
- .50 -.70 is about what mother nature earns
- Below .50 indicates we helped
- The lower the performance index number the more we accelerated the removal of ice and snow
- .70 or higher may indicate we compacted the snow or prolonged the ice.



Lightning

Vaisala's U.S. National Lightning Detection Network® (NLDN) -24/7/365

Operational for over 25 years
Most scientifically validated detection system
Monitors Total Lightning activity
Software solution sending text & email alerts

FHWA Pathfinder Project

- https://ops.fhwa.dot.gov/publications/fhwahop16086/fhwahop16086.pdf
- Fundamental Principles:
 - Collaboration Across the Road Weather Enterprise (DOT's, NWS, Private Weather Companies)
 - Consistency of Message about the Weather and its Impact on Roads

Pathfinder Goal

Source: Georgia DOT

Searce: Georgia DOT

Strengthen the working relationships across State DOTs and the Weather Enterprise for the **dissemination of road weather information** to travelers that is

- · clear,
- concise,
- impact-based, and
- consistent

so that drivers are well informed and able to make safe and efficient travel decisions

Overview - Vaisala Pathfinder Approach

- Allow for increased utilization of NWS forecast content in Decision Support System offerings
 - Improve consistency of forecast information
 - Drive unique value-added models with NWS forecast information
 - Integrate NWS textual forecast products
 - Integrate NWS collaboration tools, such as NWSChat
- Collaborate with NWS Offices in support of DOT Objectives
- Vaisala is able to Work with NWS and also 3rd Party Weather Forecast Service Providers

Vaisala Pathfinder Concept – Further Detail

Vaisala Decision Support System / Display

- Atmospheric forecast information and supporting products sourced from NWS (e.g. NDFD and/or other products)
- Incorporation of NWS Tools, such as NWSChat
- Can include specialized tools, such as pavement models (available for both the maintenance agency and the NWS to view)
- Non-operational consulting services (e.g. consultative reports, performance measurement, optimization)
- NWS Continues Providing IDSS and Forecast Support to the DOT/Agency
- Local NWS WFO(s) given login access to private sector display systems (including pavement model results) for supplemental guidance (upon DOT authorization)
- Vaisala helps provide guidance on application of information to DOT operations

Simplification and Display of NWS Watches/Warnings/Advisories

Integration of NWS Forecast Data

Integration of NWS Textual Forecast Products

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9-Aug-2017 23:07 into early afternoon but low jevel mosture abundant enough for		
9-Aug-2017 22:40 typical cloud buildups and thunderstorms as the day progresses.		
0-Aug-2017 22:15 Going temperature forecast could be a tad warm in a couple spots,		
9-Aug-2017 16:04 but looks good overall.		
9-Aug-2017 15:55		
9-Aug-2017 15:38 Due to marginal upper level support one would suspect storm		
9-aug-2017 15:37 coverage to be less than Thursday, generally isolated west to		
9-Aug-2017 10:33 scattered east. This morning's sounding shows about the same		
9-Aug-2017 09:54 amount of moisture as influenday, but less directional shear than		
9-Aug-2017 05:08 the fox somaling and less min level from it general, around 12-20		
6.4up.2017 04:40 Knoss, while that how its substantial enough to keep storms moving and area black black decar to a rack and a black for the store of the store		
9-4ug-2017 04:03 man precision a wing man about an end a man a ma		
downnours are likely where storms do develop and repeated rains		
over saturated ground will lead to quick runoff		
The best chance for afternoon storms appears to be east of Tucson		
over Cochuse, Graham and Greenlee counties near the eastern edge		
of the dry slot, but with the aforementioned moisture and also		
sufficient instability, thunderstorms cannot be ruled out faither		
user. Strong than decrease minds are an oblig union order, but the		-
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Integration of NWSChat

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	"NWSChat Live" is a pure web browser instant messaging client for NWSChat. The purpose of the application is to provide users with a	a painless means to join the NWSChar conversa	ios without issue	long third
	party software or warrying about local network farewalls. Since this application runs purely over HTTPS (port 443) and without third pa- without local modifications. The only requirement is for any day of the same day of the same day.	nty browser plugnos, almost all users should be a	hile to run this ap	placation
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