Utilizing Vehicle Data for Road Weather Management (Pikalert 5.0)

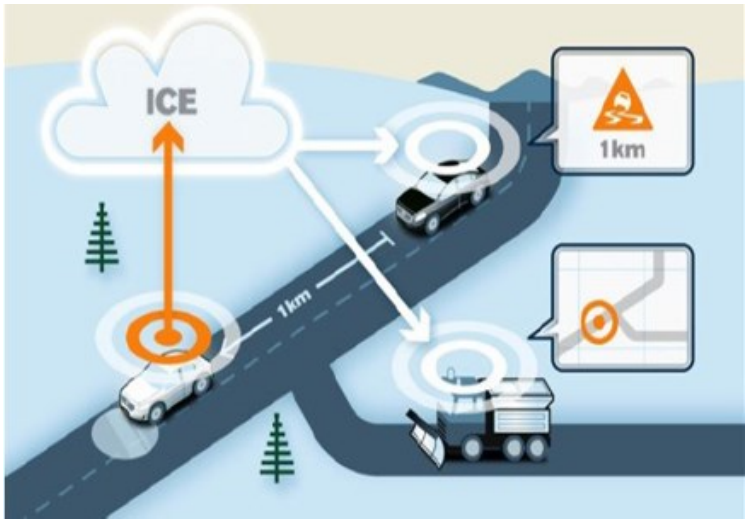
FHWA-JPO-17-513

Background

Weather has a significant impact on the operations of the nation's roadway system year round. For example, rain reduces pavement friction; winter weather can leave pavements snow-covered or icy; fog, smoke, blowing dust, heavy precipitation, and vehicle spray can restrict visibility; and flooding, snow accumulation, and wind-blown debris can cause lane obstructions.

Weather events may prompt travelers to change departure times, cancel trips, choose an alternate route, or select a different mode. Slick pavements, low visibility, and lane obstructions lead to driving at lower speeds or with increased following distances. These changes in driver behavior can impact the operation of signalized roadways, where traffic signals are timed for clear, dry conditions; through reduced traffic throughputs; increased delays; and increased travel times, or be stuck in a traffic jam. Travel time reliability for motorists and commercial vehicle operators is affected by a variety of weather and road conditions. Adverse weather and road conditions also impacts the operational effectiveness and productivity of traffic management agencies and road maintenance agencies through increased costs and lost time.

It is, therefore, an important responsibility of traffic managers and maintenance personnel to implement operational strategies that optimize system performance that mitigate the effects of weather on the roadways. The operational approaches used by these personnel dictate their needs for weather and road condition information. Accurate, timely, route-specific weather information of high resolution, allows traffic and maintenance managers to better operate and maintain roads under adverse conditions.



Source: FHWA

Connected vehicle technologies hold the promise to transform road weather management. Road weather connected vehicle applications will dramatically expand the amount of data that can be used to assess, forecast, and address the impacts that weather has on roads, vehicles, and travelers; fundamentally changing the manner in which weather-responsive transportation management and operations are conducted. The broad availability of road weather data from an immense fleet of mobile sources will vastly improve the ability to detect and forecast road weather and pavement conditions, and will provide the capability to manage road-weather response on specific roadway links. Going from a stream of vehicle data to effective road weather applications is not trivial, requiring extensive data processing to make the observations useful. The Road Weather Management Program has developed the software to do just that.

Pikalert System

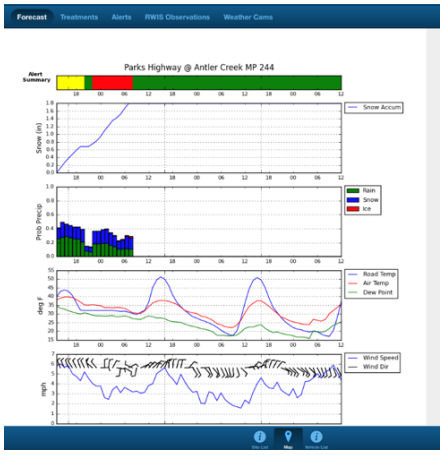
The purpose of the Pikalert System is to provide high precision road weather forecasts and recommendations. It assesses current weather and road conditions based on observations from connected vehicles, road weather information stations, radar, and weather model analysis fields. It also forecasts future weather and road conditions out to 72 hours, utilizing information from numerical weather models.

As connected vehicle observations become more and more prevalent with the advent of autonomous vehicles, Pikalert has been designed to utilize these observations effectively. In particular, a number of quality check algorithms have been incorporated to guarantee that erroneous observations are flagged and set aside. Pikalert then assembles the observations that have passed the quality checks, associates them with the appropriate road segments, and then uses them to assess the road segment weather conditions. Detailed reports can then be generated, characterizing the status of the various road segments even when there is inadequate connected vehicle coverage.

Pikalert focuses on the following three conditions:

- Precipitation conditions (such as rain, snow, ice)
- Road surface conditions (such as snow packed, icy, clear)
- Visibility conditions (such as foggy, clear)

Pikalert advises users of the presence of these three conditions and will make pavement treatment recommendations for snow and ice removal. Pikalert information is made available through web-based technology that supports browser-based displays and smartphones.



Source: FHWA

Pikalert provides three graphical interfaces for users:

1. Pikalert EMDSS: The Pikalert EMDSS is a web-based display that provides road weather and road condition forecasts out to 72 hours. The EMDSS display is typically configured to cover a network of interstates and highways in, and configured for, an individual state. The EMDSS is geared toward maintenance personnel since it provides road treatment recommendations in addition to weather and road condition information.

US-36 between NW Parkway and I-25		
6pm		No advisories
7pm		No advisories
8pm		No advisories
9pm		No advisories
10pm		No advisories
11pm		No advisories
12am		No advisories
1am		**Yellow Advisory**: Slick roads
2am		**Yellow Advisory**: Slick roads
3am		**Yellow Advisory**: Slick roads
4am		**Yellow Advisory**: Slick roads
5am		**Red Warning**: Slick roads and poor visibility
6am		**Red Warning**: Slick roads and poor visibility
7am		**Red Warning**: Slick roads and poor visibility

Source: FHWA

2. Pikalert MAW: The MAW web-based display is oriented toward the public. Like the EMDSS, it provides road weather and condition information but restricts the time coverage out to 24 hours. It does not provide road treatment information, nor in depth plots of weather variables.

3. Pikalert MAW Phone Application: The MAW phone app is also oriented toward the public. It supports hands-off audio alerts of hazardous road conditions up ahead. The phone app will also inform the user of clearing conditions when exiting hazardous areas.

Source: FHWA

Pikalert System Modules

The Pikalert system can be broken down into two separate subsystems:

- A backend processing subsystem
- A server/display subsystem

In the Pikalert System and Data Flow Diagram (next page), the boxes connected by either green or blue arrows belong to the backend processing system. The boxes at the end of the purple arrows belong to the server/display subsystem.

Backend Processing Subsystem

The backend processing subsystem is responsible for ingesting connected vehicle data and weather data, processing that data including performing data quality checks, and subsequently generating road weather diagnosis and forecast products. It includes:

Vehicle Data Ingest

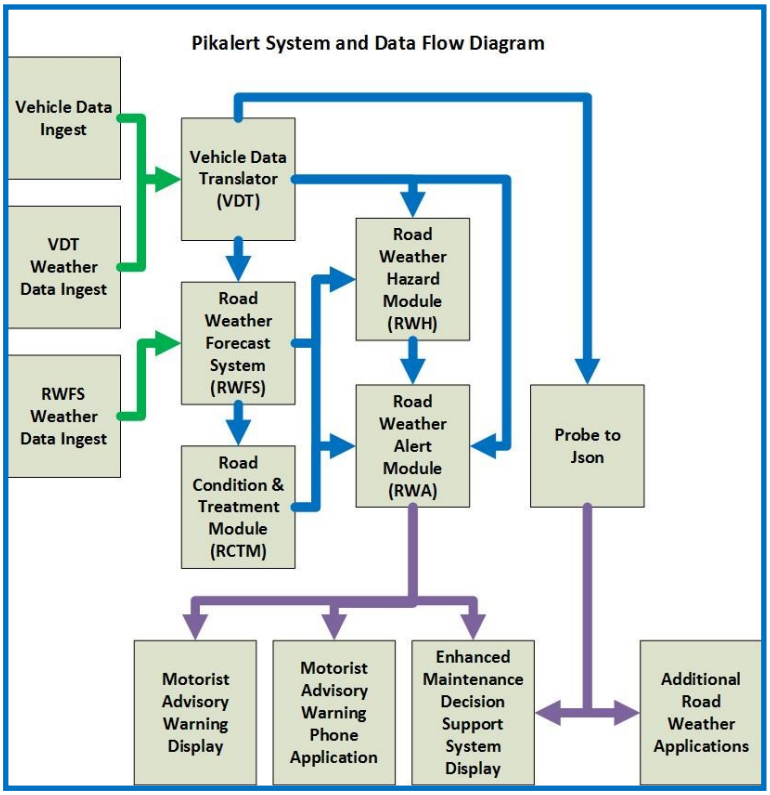
In order to utilize vehicle observation data, the Pikalert System must first ingest the observation data. Generally speaking, vehicle data ingest processing collects all mobile weather information provided. Such data consists of Controller Area Network Bus (CANBus) data and data that comes from additional sensors that have been installed such as customized wiper or wheel rotation sensors.

Vehicle Data Translator (VDT)

The VDT ingests the formatted mobile weather observations and then performs a series of quality checks including:

- Standard range checking to ensure mobile observations like temperature are within a reasonable range
- Climate range checking to ensure that mobile observations are within a reasonable range given the location, month of year and time of day
- Spatial checking comparing mobile observations with those taken at nearby RWIS stations
- Persistence checking to determine if the mobile observation is stuck on a value
- Time step checking to determine if the mobile observation is making an unreasonably large change
- Model comparison checking to determine if the measurement is in general agreement with meteorological model values
- Neighboring vehicle checking to ensure that measurements from nearby vehicles are in general agreement

The measurements that pass the quality check procedure are then used in generating statistics for road segments such as the mean air temperature at a road segment.



Source: FHWA

Road Weather Forecast System (RWFS)

The RWFS is a simplified forecast system that uses freely-available Numerical Weather Prediction (NWP) model data to produce forecast data in a format that can be readily used by the Road Condition and Treatment Module. This particular RWFS requires only NWP data to run. It is important to note that this RWFS can be replaced by a statistical forecasting system that uses multiple NWP

models as input. In fact in running Pikalert, the system managers typically makes use of a customized statistical forecasting system based on multiple NWP input models in order to enhance Pikalert's road weather forecast capability.

Road Weather Hazard (RWH) Module

The RWH collects road segment weather information then performs road weather hazard assessments. It uses decision tree logic in creating assessments for three road weather impacts: precipitation, pavement condition, and visibility.

Road Condition and Treatment Module (RCTM)

The RCTM, given roadway information (weather forecast and recent observations) at specific locations, will produce a road temperature and road condition forecast as well as provide treatment recommendations at the locations.

Road Weather Alert (RWA) Module

The RWA collects data from the RWH, the RCTM and the VDT and formats that data for system output. It produces road segment alerts based on user-configured rankings and treatments, and conveys RWIS and road segment statistics for the MAW and EMDSS backend servers. The more specific information known about the roadway and maintenance rules of practice, the more precise the recommendation.

Probe to JSON

Probe to JSON is a simple module that converts the mobile connected vehicle data to JSON format to enable easy presentation by the MAW and EMDSS .

Server/Display Subsystem includes:

Data Feeds

The Pikalert System generates a substantial amount of data. This data, such as quality checking results and statistical analysis, is available from the system and for use in other systems.

Motorist Advisories and Warnings (MAW)

The MAW provides motorists the capability to obtain road advisories and warnings for pre-trip planning via the web or for making tactical decisions when on route via a phone application. The MAW web-based display is useful for pre-trip planning. It allow the user to investigate weather impacts along routes up to 24 hours in the future.

Enhanced Maintenance Decision Support System (EMDSS)

The EMDSS provides road maintenance personnel the capability to obtain road advisories, warnings, and treatment information for road maintenance purposes. The EMDSS display application covers a 72 hour forecast period and is useful for both strategic maintenance planning as well as for tactical decision-making.

Pikalert Data Store

The Pikalert system uses the Linux file system as a data store.

Download Pikalert 5.0 Software

Pikalert 5.0 Software and supporting documentation is available for download at the Open Source Application Development Portal (OSADP)

OSADP: https://www.itsforge.net/

Pikalert 5.0: https://www.itsforge.net/index.php/community/explore-applications#/41/131

U.S. Department of Transportation
Road Weather Management

1200 New Jersey Avenue, E86-205
Washington, DC 20590
Paul Pisano
202-366-1301
E-mail: paul.pisano@dot.gov
http://ops.fhwa.dot.gov/Weather/index.aps

FHWA-JPO-17-513