A Solution for Transportation Pollution Monitoring

Using Intelligent Transportation System Technology to Monitor Transportation Pollution, Collect Accurate, Real-Time Data and Take Action

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Introduction

Highway and road systems have become an integral part of our society. Transportation moves goods and services around the world, allowing businesses to operate efficiently, and provides citizens a way to get from one point to another quickly and safely. This massive transportation system is not without problems and drawbacks. The problems come in the form of crashes resulting in death and injury, traffic delays, system failures (such as a bridge collapse), and the amount of resources required to maintain such a system. The drawbacks may not always be as easy to recognize, but are very much real. One of the biggest drawbacks that continues to gain more and more attention is the air pollution produced by the transportation system and the effects pollution has on the public. Recent research has revealed new insights about how this type of air pollution can harm the body, including taking the lives of infants and altering the lungs of children. All in all, the evidence shows that the risks are greater than we once thought.[1] Transportation researchers are studying ways to lower the output of transportation gases through more efficient vehicles and increasing the efficiency of the transportation system. How will we determine if these efforts are working? The Environmental Protection Agency (EPA) has roughly 5,000 monitoring stations throughout the United States to monitor air quality; however, these monitoring stations are placed in locations away from roadways to make sure their data is representative and not overly impacted by traffic. It is estimated that thirty five million people in the United States live within 100 meters of a major four lane highway.[5] Monitoring the air quality at the specific location where people are most affected is crucial to understanding the problem. With the use of Intelligent Transportation System (ITS) technology we could take the next steps and begin acting on the air quality concerns. By advising and warning the public of areas with high concentrations of air pollution, including offering alternative routes, or adjusting traffic light timing to improve traffic flow, we could make sure our citizens are exposed to as little pollution as possible. This measurement and communication process would be key to creating a true "greener" and healthier transportation system.

Intelligent Transportation

What is an Intelligent Transportation System or ITS? "ITS improves transportation safety and mobility and enhances productivity through the use of advanced information and communications technologies."[2] ITS technologies provide operational benefits to the transportation system by reducing delays, which improves our commerce infrastructure and allows the economy to grow. Roadside ITS

technology can come in a variety of forms, such as solutions from traffic detectors, road weather monitors, and traveler information systems. In the simplest terms, ITS technology collects data from the traffic or the roadway, and reports the information to either the driver or to road decision makers. The benefits from ITS products are more numerous than can be mentioned, but include:

Highway Advisory Radio (HAR)/Traveler Information Stations

- HAR systems create safer traveling environments, while utilizing readily available AM radio frequencies to broadcast messages.
- A simulation study of the system deployed on the John C. Lodge freeway in Detroit, Michigan estimated that HAR and dynamic message signs in combination with ramp metering may reduce vehicle delay by up to 22 percent.[3]
- Traveler Information/Dynamic Message Signs result in a 3 percent decrease in crashes and rank high in keeping mobility of traffic running smoothly.[4]

Road Weather Information Systems (RWIS)

- RWIS is proven to increase safety on roadways, and reduce labor costs and chemical usage.
- Evaluation data shows that anti-icing programs can lower snow and ice control costs by 10 to 50 percent and reduce crash rates by 7 to 83 percent.[3] Winter maintenance personnel from several agencies indicated that use of RWIS decreases salt usage and anti-icing techniques limits damage to roadside vegetation, groundwater, and air quality (in areas where abrasives are applied).[3]
- The RWIS benefit to cost ratio ranges from 2:1 to 10:1 and RWIS ranks high in both safety and mobility impact.[4]

Traffic Monitoring

- The Maryland Coordinated Highways Action Response Team (CHART) program is in the process of expanding to more automated [traffic] surveillance with lane sensors and video cameras. Lane sensors and freeway video cameras in the coverage area supported incident management and contributed to a 5 percent reduction in non-recurrent congestion.[3]

ITS has been developed by a variety of different companies, which means except for a few providers, each company typically has one, maybe two areas of expertise in ITS. This has caused governments to purchase ITS solutions as separate, independent systems. For example, an agency might have a traffic detection system, a road weather system, and a traveler information system (i.e. HAR or Variable Message Sign (VMS)). These systems might be tied together by a traffic operations software, but in the field these individual systems typically have their own mounting equipment, power, and communication. Having separate sensing systems along the roadside is inefficient. Adding an additional sensor to an existing system is cost effective because it reduces redundant costs on installation, communication, hardware, and ongoing maintenance. With data displayed in a single system the relation between the data can be realized. For example, if we began sensing an entirely new transportation parameter such as air quality, integrating it with existing equipment or adding it to new installations of proven technology would greatly increase the return on investment of the entire system.

The Side Effect of Transportation

Air pollutants from Interstate 10 in Santa Monica extend as far as 2,500 meters — more than 1.5 miles — downwind, based on recent measurements from a research team headed by Dr. Arthur Winer, a professor of environmental health sciences at the UCLA School of Public Health. This distance is 10 times greater than previously measured daytime pollutant impacts from roadways, and has significant exposure implications, since most people are in their homes during the hours before sunrise and outdoor pollutants penetrate into indoor environments.[6] We must also remember that even if we do not live next to a major roadway, if we drive on it we are still exposed to the air pollution. Although the average Los Angeles driver spends about six percent (1.5 hours) of his or her day on the road, that period of time accounts for 33 to 45 percent of total exposure to diesel and ultrafine particles (UFP).[7] The adverse health effects caused by transportation produced gases cause a serious health risk to our population and include:

> Air pollution from heavy highway traffic contributes to higher risks for heart attack, allergies, premature births and the death of infants around the time they are born.[1]
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> The annual death toll from particle pollution may be even greater than previously understood. The California Air Resources Board recently tripled the estimate of premature deaths in California from particle pollution to 18,000 annually.[1]
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> Two major analyses recently concluded that air pollution is especially harmful to children. They found that air pollution is so dangerous the exposure to pollution can even threaten children's lives:[1]
>
> - short-term and long-term decreased lung function rates and lower lung function levels, critical measures of how well the child will breathe throughout his or her life (due primarily to exposure to particle pollution and traffic-related pollution);
> - worsening of asthma (from exposure to particle as well as ozone pollution);
> - increased prevalence and incidence of cough and bronchitis (primarily from particle pollution); and
> - increased risk of upper and lower respiratory infections

The research on the effects of transportation pollution goes on and on, and is especially troubling when looking at the impact it has on children up to the age of 18.

It is All about Location

The EPA air quality monitoring stations are placed across the United States to monitor the overall air quality of an entire region. In fact, air quality stations are specifically placed away from high traffic roadways, so the monitoring units are not influenced by the local source of pollution. The U.S. Department of Transportation's Congestion Mitigation and Air Quality Improvement Program funds are restricted to projects that reduce pollution. It enables local areas to experiment with non-traditional strategies for improving air quality and reducing congestion that receive little funding from other sources. How do you know congestion and air pollution mitigation strategies are working if you don't measure before/after project implementation and determine where the problem is occurring? Many

solutions to solve air pollution use a computer that factors all known conditions and creates a projection of what the air quality will be. Wouldn't it be better to get actual measurements from the exact location being affected by air pollution? For example, an article written in the April issue of the ITE Journal[8] called "Reducing Carbon Emissions and Congestion by Coordinating Traffic Signals" highlights the City of Portland, Oregon, which has adjusted signal light timing to save fifty metric tons of Carbon Dioxide (CO_2) per year, per signal. The study results are based on computer projections not actual measurements. Computer programs known as "models" are a good, inexpensive way to make projections, but they are subject to a wide margin of error due to assumptions used, or the quality of the modeling program itself.

The Solution is Clear

The EPA network of monitors is effective for large scale pollution detection; however it is unable to solve our transportation problem because monitoring sites are not located near roadways as described above, and the sites are cost prohibitive to deploy. Vaisala, Inc. is a global leader in weather technologies, providing some of the highest quality ITS solutions, including Highway Advisory Radios, Road Weather Information Systems, traffic analyzers, and customer designed ITS solutions. Vaisala has partnered with Aeroqual Limited, an Auckland, New Zealand, company whose exclusive business is designing highly technical gas sensors and systems within a low manufacturing cost environmental. The integration of Vaisala products and air quality monitoring allows Vaisala the ability to provide multiple sensor technologies in a single ITS monitoring and reporting system. When connected to one of Vaisala's existing products, new solutions for monitoring and acting on transportation pollution can be realized such as:

Condition Alerting - Vaisala can detect hazardous levels of Ozone, Particulate Matter (PM), or Nitrogen Dioxide (NO_2) and notify the public through HAR, Variable Message Signs or local media. Alerts could be automated or manually controlled. When high levels are detected citizens that are sensitive or at risk, could avoid exposure to those specific locations during those periods, or take alternate routes as communicated by a transportation agency.

Traffic Signal Timing - If gas monitoring sensors were placed along the route, a series of traffic signals could be adjusted when levels of pollution become dangerous due to heavy traffic. Improved signal light timing could reduce harmful emissions (Carbon Monoxide, Nitrogen Oxides and Volatile Organic Compounds) up to 22 percent.[9]

Tunnels – Vaisala's solution for air quality monitoring could be joined with tunnel ventilation systems to adjust operation during non-peak needs, reducing the amount of energy required to operate the tunnel.

Sensitive Areas - In communities or environmental areas where roadways pass nearby, data could be collected for future design changes.

The clear solution is for government to begin addressing the problem of transportation pollution by monitoring gas levels where they are being created, and using ITS as a way to inform and manage the problem. State, city and county agencies can protect their communities by implementing a solution that is low cost and accurate. By using existing ITS products and equipment infrastructure, then adding pollution monitoring, transportation agencies greatly increase the return on investment of the entire system. For example, by incorporating air pollution monitoring agencies that could not justify a road

weather station due to limited amounts of winter weather now have an added year-round benefit of the product. Agencies that might not use their HAR often enough to warrant upgrading, now are broadcasting air quality information daily in the summer. Lastly, agencies that use their traffic sensors to only monitor traffic flow, now could be providing real-time warnings when traffic volume and air quality conditions indicate a hazard. The transportation system will only continue to grow, and our transportation infrastructure needs to be smarter and more environmentally friendly to ensure it continues to provide us the benefits we have become so dependent upon.

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