WIMAP: Work Zone Interactive Monitoring Application

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ABSTRACT

This paper presents the highlights of Work Zone Interactive Monitoring Application (WIMAP). WIMAP is developed to systematically monitor the impact of long-term freeway work zone activities caused by the I-295 Direct Connection project in New Jersey. A data archive engine in WIMAP can handle not only real-time probe-based speed data from TRANSCOM(1) and TrafficCast but also traffic counts detected by Remote Traffic Microwave Sensor (RTMS) units provided by ASTI(2) and NJDOT. Historical crash and incident records provided by Plan4Safety and NJ OpenReach are also archived in the WIMAP database. In addition, collaborating with local transit agencies, multi-modal travel data is archived by WIMAP to examine the impact of work zone on multi-modal performance.

Through an interactive web-based interface, WIMAP is designed to provide users with instantaneous performance measure reports based on MAP-21, such as Travel Time Index, Buffer Index, Planning Time Index, and percentile Travel Time. With historical events records (e.g., incident, lane closure activity, and roadway maintenance), WIMAP also enables users to investigate the mobility impact of work zones. The prototype WIMAP is deployed for its internal beta test with currently available data sources. Once instrumenting the additional data collection devices to obtain a full set of travel time and counts data for the work zone, WIMAP will be fully functional to support a robust Transportation Management Plan for the I-295 Direct Connection project.

INTRODUCTION

The Moving Ahead for Progress in the 21 Century Act (MAP-21), as the latest transportation fund authorization bill, requires each metropolitan planning organization to establish surface transportation performance targets. The effective date for all measures will be established in spring 2015 (3). Six sets of performance measures was established by MAP-21 such as national highway system (NHS) condition and performance, transit data of good repair, highway safety, transit safety, and congestion mitigation and air quality .

Work zone is a segment of a particular highway with activities of construction, maintenance or utilities work, whose impacts are usually referred to the deviation from the normal performance range of a given transportation network. It is estimated that work zones constitutes 10% of overall congestion, which is equivalent to over $700 million value of fuel loss *(4)*. With an increase presence of work zones, it is vitally important to monitor the work zone impacts, so that a suitable plan may be developed to improve mobility and safety.

NJDOT recently initiated the I-295 Direct Connection Project, a major highway interchange reconfiguration project for I-295/I-76/NJ-42 in Camden County. The project had commenced in March 2013 and it was expected to complete in 2021*(5)*. Four sequential construction stages were assigned to different area of the overall construction zones. In the duration of the project, lane closure (both short-term and long-term) and traffic diversion was necessary and expected. With the anticipation of potential significant impact of the lane closure on the already saturated network, a real-time monitoring system was proposed in order to monitor traffic status, divert traffic flow, and gain readiness for emergency respond.

A web-based performance measure system, namely Work Zone Interactive Monitoring Application (WIMAP), was proposed, which has been developed by Intelligent Transportation System Resources Center (ITSRC) of New Jersey Institute of Technology (NJIT) in research partnership with New Jersey Department of Transportation (NJDOT). Unlike other software developed in previous studies which will be reviewed later in this paper, WIMAP is the first web-based performance monitoring system (WPMS) specialized in work zone monitoring to capture instantaneous mobility measures proposed by MAP-21. It is tailored for NJDOT I-295 Direct Connect Project and expected to be expanded to monitor work zones throughout New Jersey. By collecting, archiving and analyzing the traffic data, the impact of the long-term work zone could be subsequently studied (e.g. recurring & non-recurring congestion, incident impact, and change of traffic pattern).

The remainder of this paper is organized as follows. The next section presents the literature review of available WPMSs and nationwide practices in the United States. Then, the details regarding WIMAP application and its key features will be discussed. Finally, the finding and recommendations will be concluded.

LIETERATURE REVIEW

In this section, relevant research activities are summarized by focusing on state-of-the practice of highway mobility monitoring systems and performance measures applied for work zone projects.

National Practices of Highway Monitoring System

Not only do WPMSs help traffic operators, engineers, and planners to obtain real-time traffic flow information such as current and historical traffic condition, but it also facilitate road users to plan better for their journey (i.e., route choice and departure time); and therefore alleviate the overall congestion and achieve higher network efficiency. Four major WPMSs listed below are reviewed:

- Iteris Performance Measurement System (iPeMS) *(6)*
- Vehicle Probe Project Suite (VPP Suite) *(7)*
- Portland Oregon Regional Transportation Archive Listing (PORTAL) *(8)*
- Performance Monitoring and Measurement System (PMMS). *(9)*

iPeMS *(6)*and its variants are used by different public transportation agencies (e.g. DOTs, Harbor Department, and Regional Transportation Authorities, etc.) for the purposes of traffic operation and transportation planning. It was initially developed by University of California at Berkeley in conjunction with California Department of Transportation, which has been commercialized and tailored to customer's specifications (10) (e.g. availability of data sources and desired performance measure). Caltrans PeMS, a variant of iPeMS, was chosen to review Caltrans PeMS collects data from ITS sensors (e.g. loop detectors, radars, GPS-based probes etc.) as well as existing online databases (e.g. Traffic Accident and Surveillance Analysis System, California Highway Patrol Incident Database, etc.) to display performance measures.

VPP Suite*(7)* , as a tool for congestion monitoring, is currently used by most state transportation agencies which are involved in the I-95 Corridor Coalition. VPP Suite utilizes the vehicle probe data provided by INRIX along with other data sources, such as accidents, volume counts and weather data. The suite allows users to monitoring real-time speed, travel time index (TTI), travel time reliability metrics, queue measurement, and bottlenecks.

PORTAL(8) was developed by Portland State University in conjunction with Oregon DOT. It was designated as the Portland region's official data archiving entity. It gathers speed, volume and occupancy data collected by inductive loop detectors which are part of the Portland region's advanced traffic management system (ATMS). In addition, it contains a comprehensive incident management system and transit data provided by TriMet and METAR weather data from NOAA.

PMMS (9) was developed by the Regional Transportation Commission (RTC) of Southern Nevada's. It supports TMC in monitoring and controlling traffic in the Las Vegas metropolitan area. It allows users to pull real-time and historical freeway performance information. Besides, incident data from Nevada Highway Patrol dispatcher is collected and archived in its database*(11)*. The data sources and their respective performance measures are summarized in Table 1.

Table 1 Summary of Existing WPMS

WPMS	Data Sources	Mobility Performance Measure	MAP-21 Performance Measure	Other Performance Measure
iPeMS (based on Caltrans PeMS)	- Remote Traffic Microwave Sensor (RTMS) - WIM stations - GPS-based probes - Loop detectors - TASAS - CHP - Weather	- Speed - Queue - Delay - Occupancy - VHT - VMT	- Travel time index - Buffer index	- Accident - Lost productivity
VPP Suite	- INRIX data - HPMS(AADT data) (12) - Loop detectors - Radars - Weather - Agencies data	- Speed - 95th percentile speed	- Travel time index - Buffer index - Planning time index	- Throughput Productivity
PORTAL	- In-house incident database - Loop detectors - TriMet vehicle information data(13) - METAR weather data(14)	- 15-min average speed - 5-min delay - 5-min travel time - 95th percentile travel time - Congestion frequency - VHT - VMT	N/A	N/A
PMMS	- RTMS - Loop detector - Bluetooth reader - NHP - CCTV Cameras - Weather	- Daily average peak hours speed - Hourly average speed - Overall freeway average speed congestion	N/A	N/A

Performance Measures

Speed is the intuitive performance measure when it comes to mobility and it is used by multiple WPMSs. Spot speed (i.e., time mean speed) collected by ITS device such as RTMS is an accurate representation of the speed of certain spot. However, spot speed is rarely meaningful in practices, especially when it comes to a long stretch of roadway. In that sense, space mean speed would be suitable for such long segment cases. While space mean speed is the most easily-obtained speed, it often produce a statistical bias particularly when applied to a long stretch of roadway*(15)*. That is, space mean speed may likely suffer from the risk of overly homogenizing the speed. In order to avoid biased estimation as possible as practically allowed, 15^{th} percentile, 85^{th} percentile, and 95^{th} percentile are often used along with space mean speed to preserver the fidelity of the population. PMMS plots the 15^{th} percentile and 85^{th} percentile speeds which are applied to demonstrate the predominant speed range. PORTAL uses 15-min average speed as one of the mobility performance measure to display it in the real-time speed map. VPP Suite provides both mean speed and 95^{th} percentile speed, while Caltrans PeMS only uses mean speed for the time being.

Travel time is another straightforward mobility performance measure for travelers. More than likely, travelers are assumed making the route decision based on travel time. Average travel time could be somehow misleading in congested network, especially during peak hours of the day. Aiming to promote a performance measure which provides more accurate and practical information, MAP-21 proposes the use of travel time index, buffer index, and planning index to represent the network performance. They are the most effective methods to measure travel time reliability(16). The 95^{th} percentile travel time is applied to measure the delay for a specific roadway during the heaviest traffic days. It is also used as the worst day traveling indicator on particular roadway in a certain month. Buffer time index represents the extra time must be considered to ensure an on-time arrival at traveler's destination. Planning time index is the total time that a traveler should plan to ensure on-time arrival, expressed as a ratio of the planned total travel time and free-flow travel time of particular roadway. Figure 1 is a demonstration of the relationship between planning time Index and buffer time index. It is shown that an increasing number of agencies throughout the country have begun using the travel time reliability indices, such as Federal Highway Administration, Minnesota DOT, and Washington State DOT. A study conducted by MN/DOT indicated that using travel time reliability indices, instead of average travel time, gained operational improvements*(16)*.

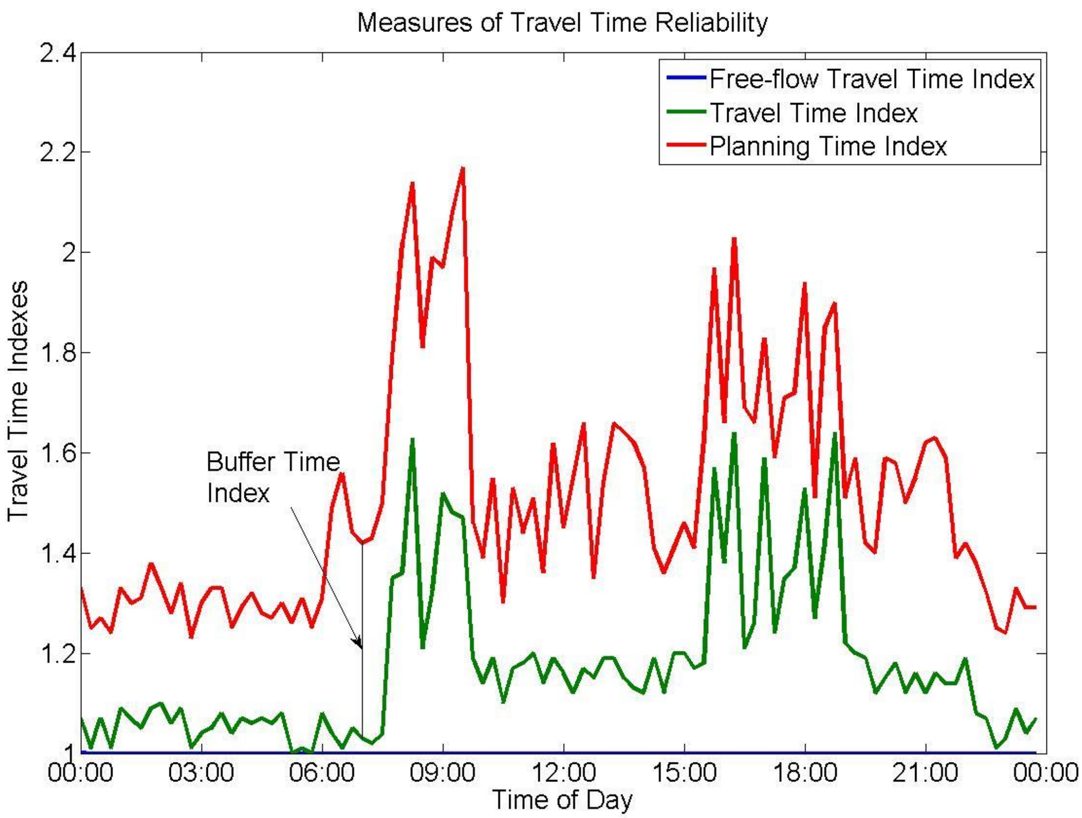


Figure 1 Travel Time Reliability Measures (synthesized data)

Congestion, as opposed to mobility, is also commonly used to measure or quantify the congestion in the network, WPESs use different indicators. Caltrans PeMS provides an algorithm to calculated delay based on user-defined reference speed. It also provides queue measure which is the ratio of VMT and VHT and it can be computed both in single location and over many different links. PMMS used a pre-defined four speed categories to classify congestions. PORTAL uses congestion frequency as an indicator of congestion. Besides traditional measures, the concept of productivity was introduced to the performance measure. However, such social-economics performance measures various among different geographical locations as well as demography.

When it comes to safety performance measure, iPeMS displays real-time accident information on the live traffic map by scraping data from TASAS(17) and CHP database. PMMS obtain incident data from the Traffic Incident Management Coalition, an agreement between the Nevada DOT and Nevada Highway Patrol. PORTAL and VPP suite do not have dedicated module for safety measure.

It is our anticipation that more and more WPMSs will emerge as the desire for real-time traffic monitoring and cost reduction of ITS devices increases. WPMSs will emulate among their peers in providing non-technical-user-friendly interface and enhanced visual presentations. There is, however, none of the available provides a dedicated platform for monitoring long-term work zone area as well as it potential impacts. WIMAP was, subsequently developed to fill such gas and it is expected to exemplify the real-time work zone monitoring practices nationwide.

WIMAP SYSTEM

Overview

WIMAP is a web-based work zone monitoring system dealing with data management and performance evaluation of I-295 work zone in New Jersey. The system architecture of WIMAP is shown in Figure 2. WIMAP has dedicated high-end servers for rapid database managements and the on-line implementation of its applications that will be explained in the next sections. Data from multiple data sources is being collected and transmitted to the databased server housed in NJIT; users are able to access the data by web-based applications on an application server through Internet; the application server retrieves data and performs computation requested by users.

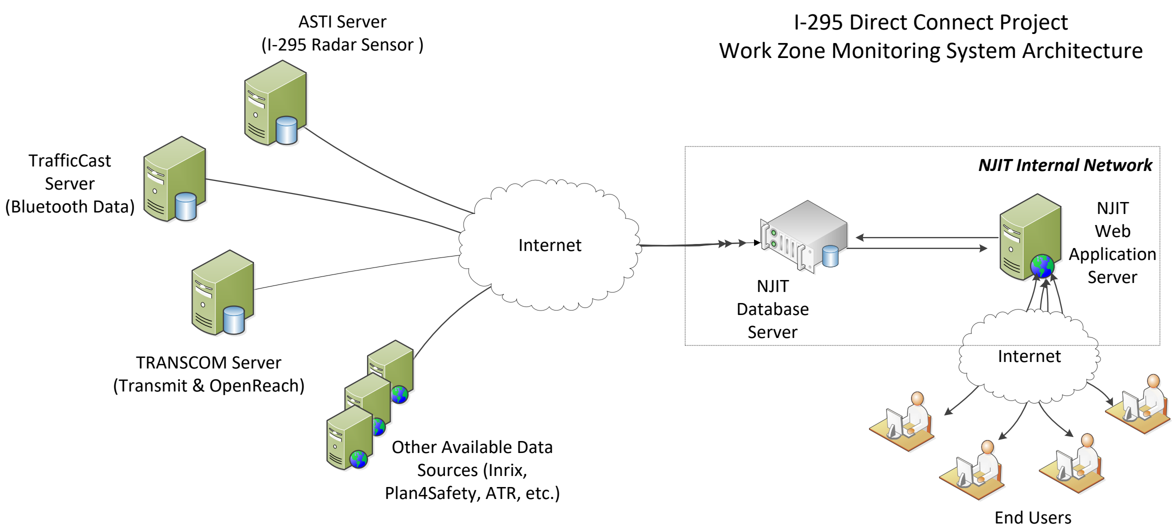


Figure 2 WIMAP System Architecture

Data Sources

One of the key features of WIMAP is the incorporation of multiple data. The real-time and historical traffic flow data are constantly being collected, archived and analyzed in the database server in NJIT. The primary data sources as of July 2014 for WIMAP are listed below

- RTMS data
- Bluetooth data
- Electronic Toll Collection(ETC) Tag data (a.k.a., TRANSMIT)
- Variable message sign (VMS) data

- OpenReach event data
- Plan4Safety (accident) data

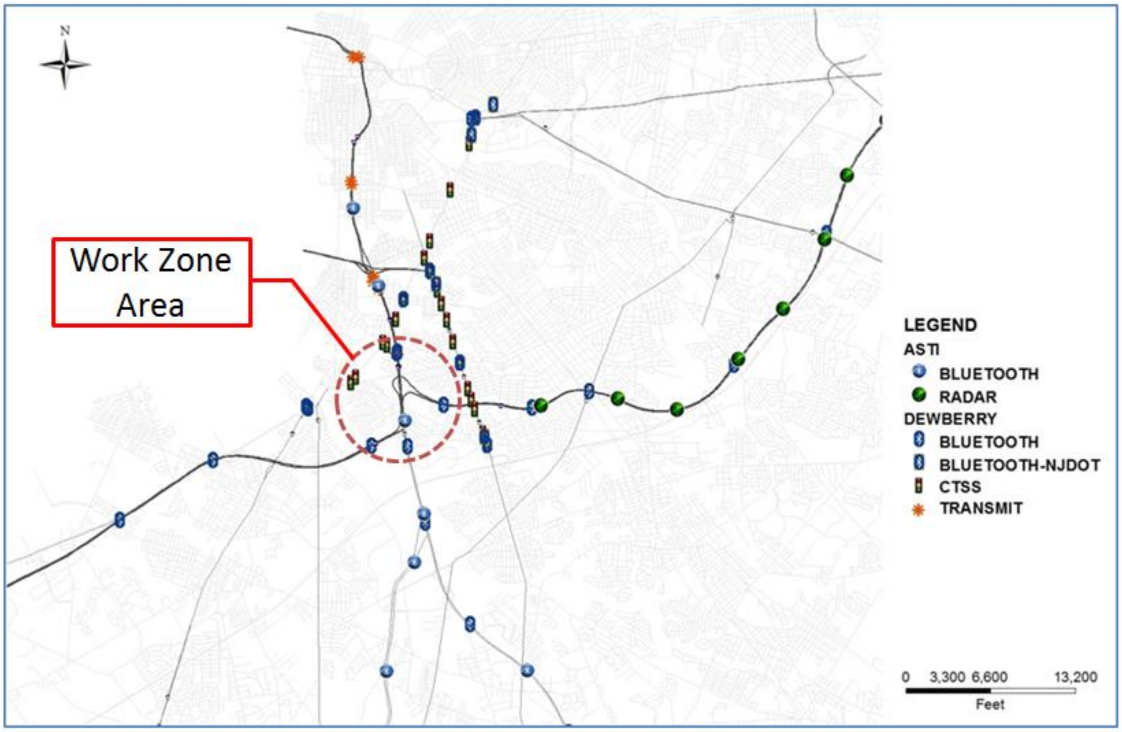
RTMS data provides the spot speed, traffic volume, occupancy for each lane of both directions. RTMS' are among the non-traffic-disruptive traffic flow monitoring technologies. They are typically deployed on the overhead area (light pole etc.) and the microwave is sent out intermittently to capture traffic flow information such as spot speed, lane occupancy, and traffic counts. In current, NJ-DOT deployed 12 RTMS devices to gather traffic counts, spot speed, and occupancy of the westbound of I-295.

Bluetooth has been recognized as a global standard protocol suitable for mid- to short-range wireless communications between two mobile devices (e.g., laptop, smartphone, or tablet PC). One of unique features of Bluetooth is to sense the identification of those devices by capturing their Medium Access Control (MAC) address without data authentication procedure. The travel time can be calculated, once a MAC address is detected by different Bluetooth readers in different locations. In this paper, Bluetooth data provided by a commercial vendor, TrafficCast, are being collected in and around I-295 work zone area. It is reported that the reported MAC address matching rate of is BlueTOAD approximately 4% of the daily traffic stream (18). Currently, a total of 41 Bluetooth readers are installed, or planned to be installed, in and around the construction site of I-295 work zone area to capture route travel times and estimate route diversions by pairing each reader.

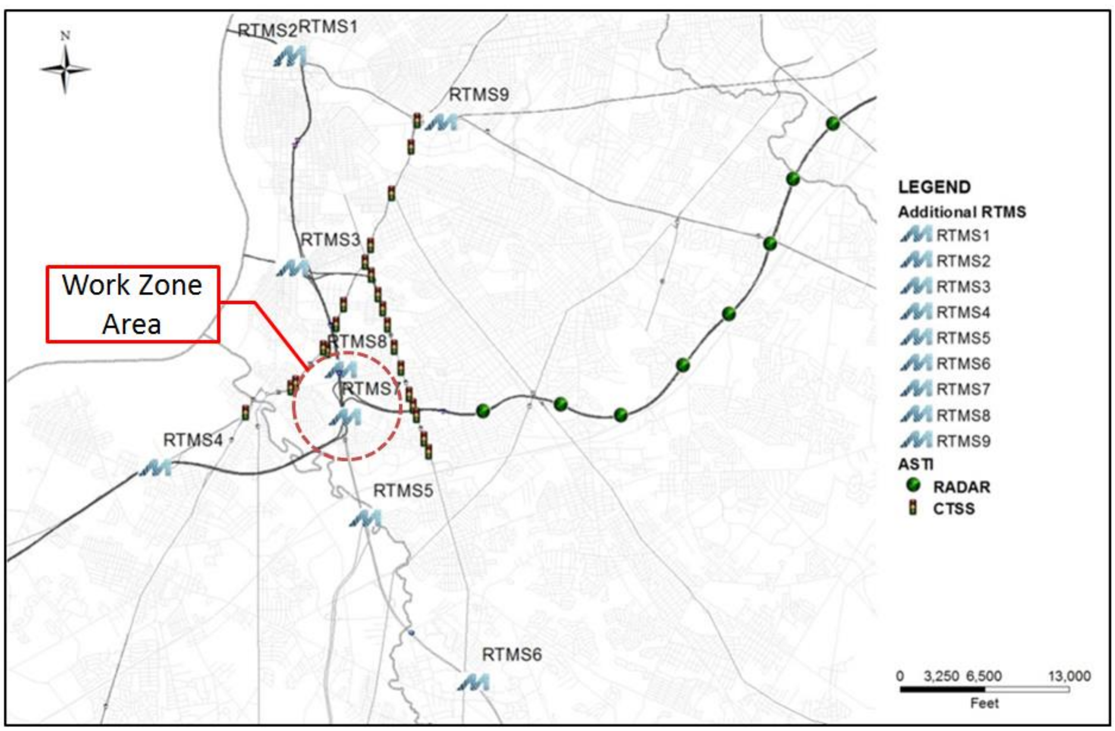
In addition to the Bluetooth readers, 10 Electronic Toll Collection (ETC; a.k.a., TRANSMIT) tag readers are also in operation to provide high-fidelity travel time information for those segments not covered by Bluetooth readers. Centralized Traffic Signal System (CTSS) and Adaptive Signal Control Technology (ASCT) that will be installed on local highways around I-295 (e.g., US130 and NJ168) can be also exploited to collect traffic count data on major alternative arterials. Table 2 summarizes the number of data collection devices currently deployed and Figure 3 demonstrates the locations of such devices in and around the work zone area. It must be noted that as shown in Figure 3(a), the current deployment of RTMS devices are on the east side of I-295 work zone which would be insufficient to fully cover incoming and outgoing traffics for the work zone area. To handle this issue, additional 9 RTMS devices are newly instrumented on major roadway segment as demonstrated in Figure 3(b).

Table 2 Number of Data Collection Devices

Device Type	Number of Device
Bluetooth	41
RTMS	12
RTMS(Additional)	9
TRANSMIT (Electronic toll tag)	10
CTSS/ASCT	23



(a) Existing Data Collection Device (Bluetooth, RTMS, CTSS, ETC Tag)



(b) Planed RTMS Devices (RTMS 1 through 9)

Figure 3 Locations of Data Collection Device

In addition to data collected by the newly-deployed ITS devices, WIMAP also incorporates OpenReach and Plan4Safety data. OpenReach and Plan4Safety are both related to traffic incidents. The difference is: OpenReach is a real-time basis system which focuses on work zone related information and is updated every 2 minutes; while Plan4Safety is a historical dataset concerning crash records.

Major Modules

Dashboard

The snapshot of WIMAP dashboard is shown in Figure 4. This intuitive web-based interface serves as a portal and allow user to retrieve and display real-time traffic information. Users can select the instrumented roadway segment of interest by clicking and then all the available performance measure is shown. It was developed in Microsoft's Visual Studio 2012 with the incorporation of Microsoft ASP.Net, Google Maps and Google Charts.

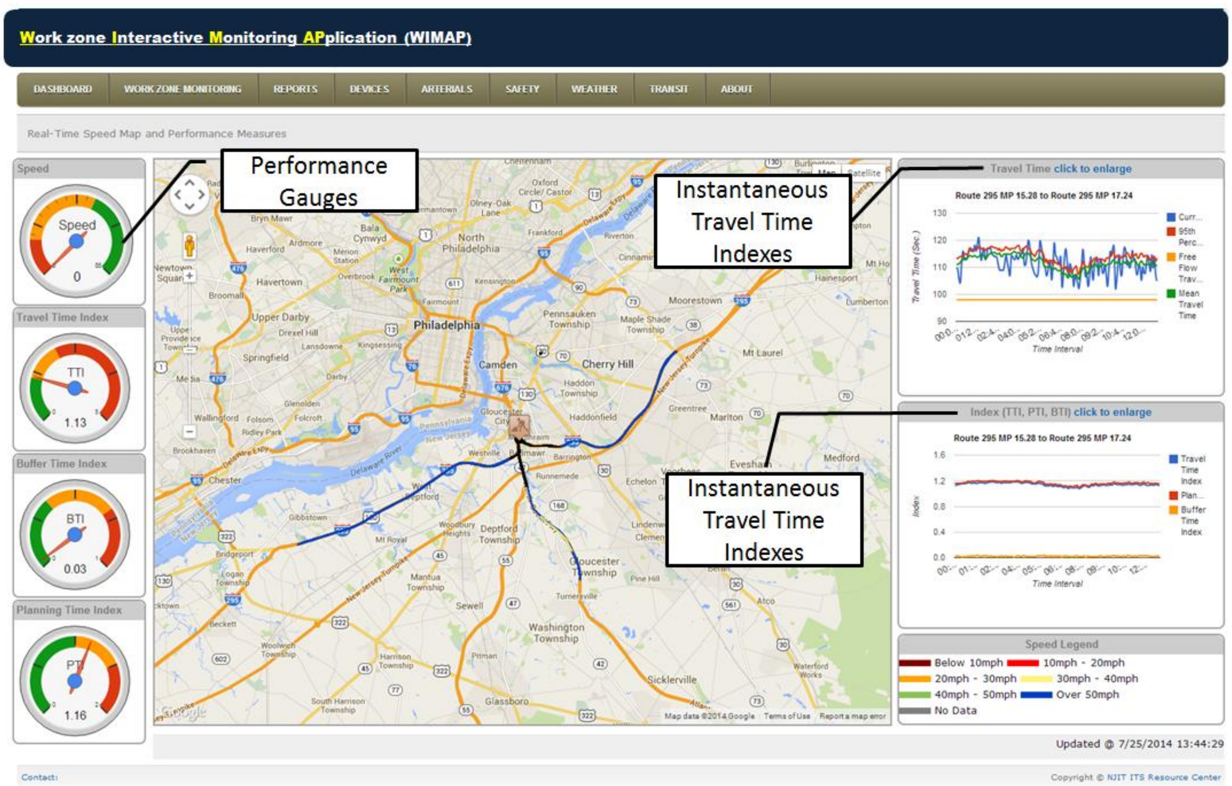
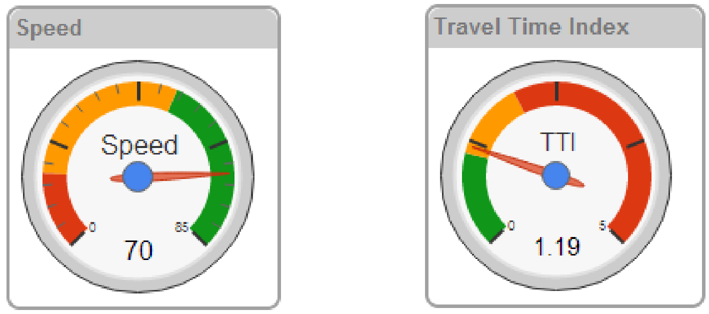


Figure 4 WIMAP Dashboard

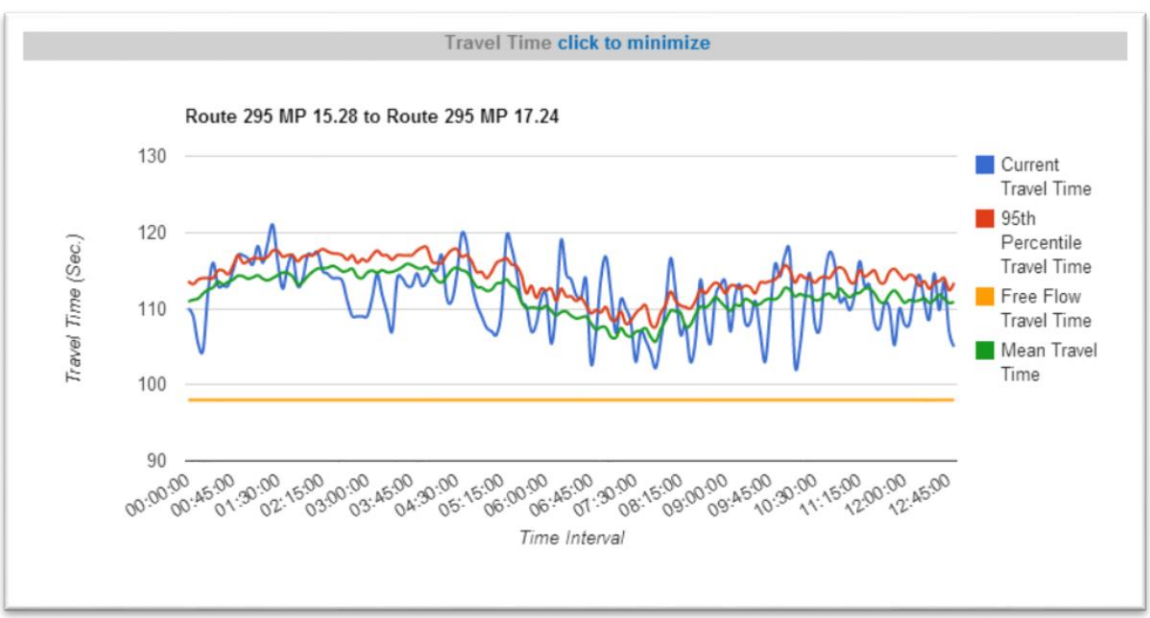
A google map-based real-time traffic map in the proximity of the work zone is shown in the center of the dashboard. The traffic information is updated automatically for every two minutes. Four performance gauges are displayed in the left side of the map, providing real-time speed, travel time index, buffer time index and planning index of selected roadway segment respectively as shown in Figure 5. The right hand side shows the time-series plotting of the performance measures. The upper chart in the column shown in Figure 6(a) displays the current travel time, 95th percentile travel time, free-flow travel time and mean travel time until the current time of the day; while on the lower chart, the index performance measures are shown, including travel time index, planning time index and buffer time index. Users can toggle any of these performance measures as desired for personalized display.



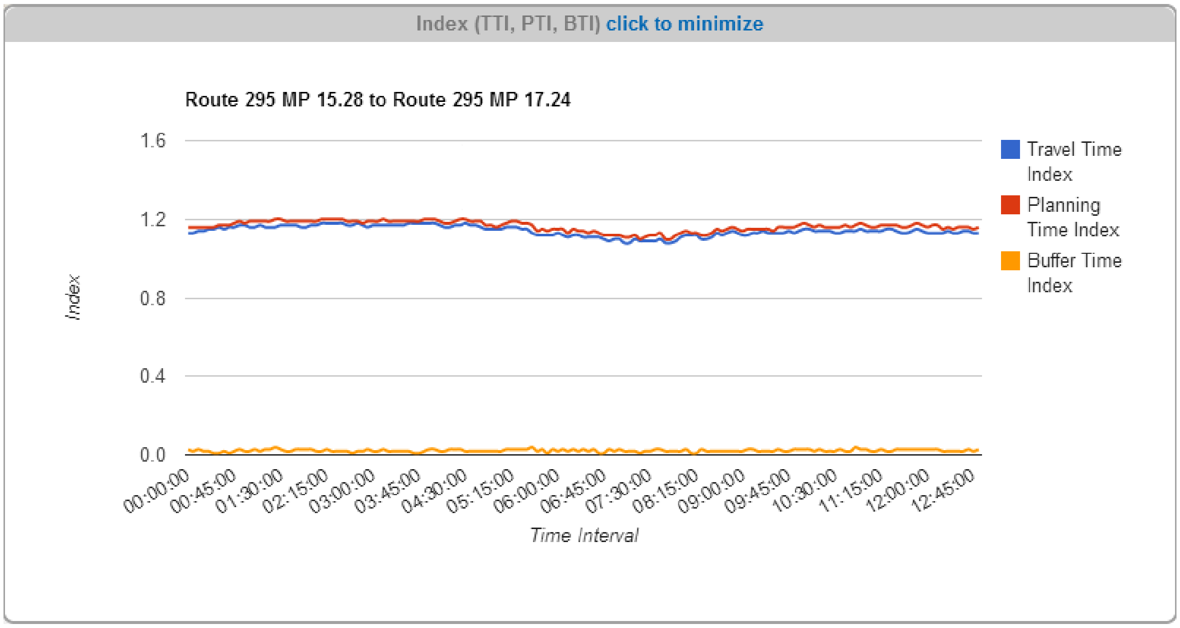
(a) Speed Gauge (b) Travel Time Index Gauge

(c) Buffer Time Index (d) Planning Time Index

Figure 5 WIMAP Performance Measure Gauges



(a) Travel Time Charts (Current, 95%, Free Flow, and Mean Travel Times)



(b) Index Charts (Travel Times, Planning Time, and Buffer Index Times)

Figure 6 Performance Measure Charts

Congestion Comparison Map

With WIMAP, users can interactively examine the current traffic congestion conditions by comparing it with archived historical data. In the map-based comparison module, the users are able to select the range of the historical date, day of the week for comparison in geo-spatial format. An average speed map for the last 5 weeks is generated alongside with the current live-traffic speed map as shown in Figure 7. Users are able to specify the certain data for the day of the week among historical data to tailor intended investigation.

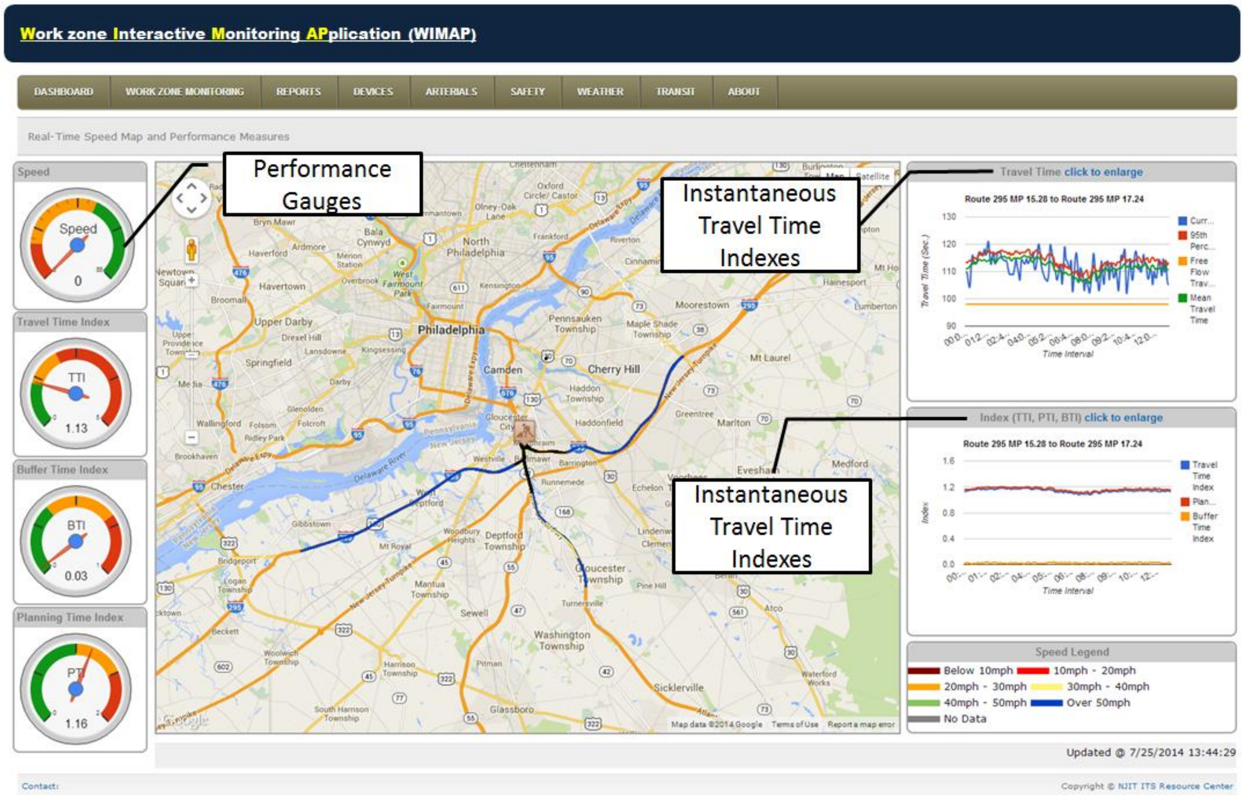


Figure 7 Comparison Map

Report Generator

Besides the real-time information, historical data is vitally important for stakeholder and transportation practitioners. WIMAP is programmed to automatically generate weekly and monthly performance summary at system specify interval. Moreover, in the customized report generator, users can specify the roadway segment of interest and the time period and WIMAP generates the performance chart. It is worth mentioning that WIMAP has incorporated different traffic incident databased. According to the records (location and time of the day information etc.), WIMAP will display such incidents in the performance chart, if data is available. Furthermore, WIMAP allows user to generate customized reported as specified on the webpage. For those who plan to perform more personalized data manipulation, historical data is made available for download to authorized users. Figure 8 demonstrates the snapshot of WIMAP Report Generator.

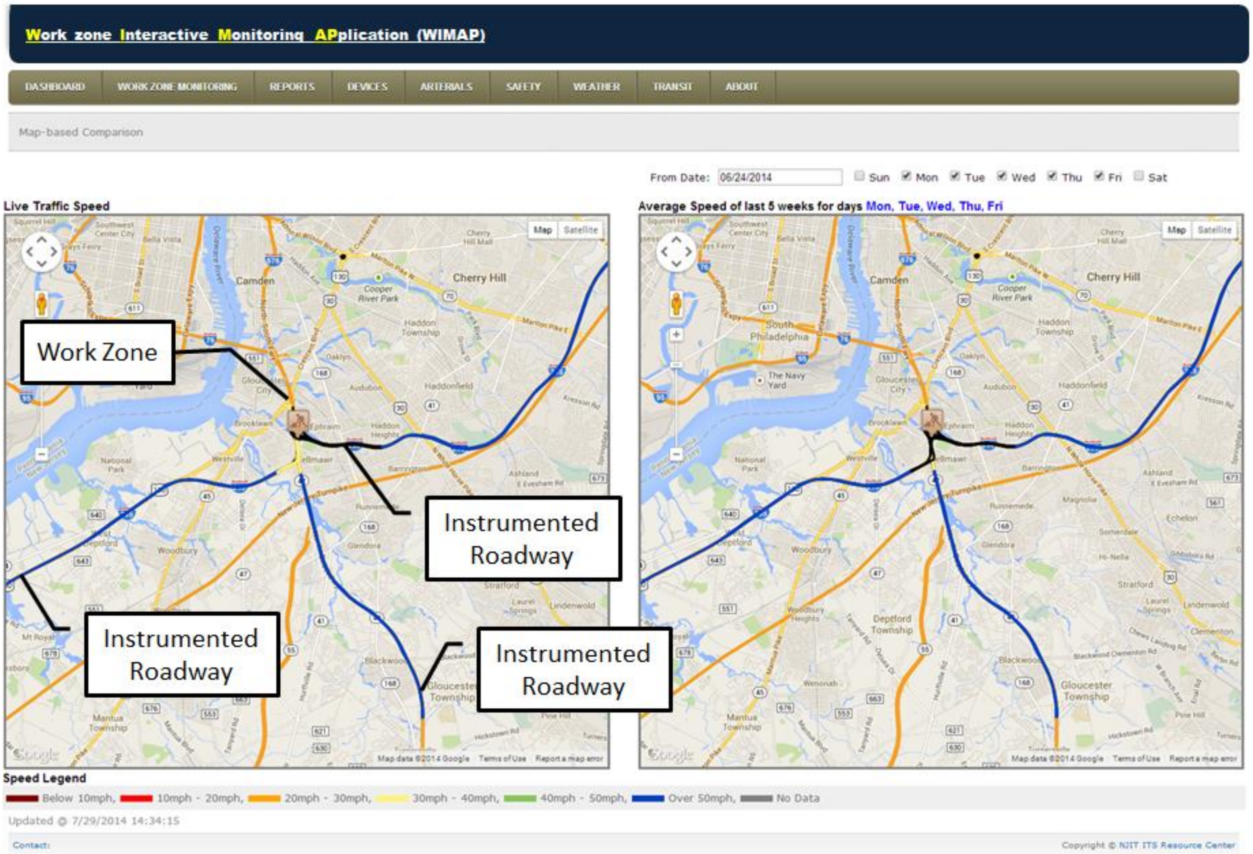


Figure 8 Report Generated by WIMAP

Safety Monitoring

WIMAP is archiving the OpenReach real-time traffic event data from TRANSCOM(19) with 2-minute interval. Besides real-time data, Plan4Safety historical incident data is also collected and stored in the database for display in the performance charts as shown in Figure 8 above. It is envisioned that the real-time incident data will serve as pop-up window (as an indicator to operators) in the TMC monitoring screens and also display in the animation playback of historical data to provide a better understanding on incident impact as well as work zone activities impact.

Device Status

The device status module provides users with information regarding the status of Bluetooth and RTMS device deployed in the proximity of the work zone, including device location, operational status in a user-friendly map-based interface. It provides real-time information regarding the devices for easy maintenance.

Incoming Applications

Dynamic Origin-Destination Flow Estimation

Origin-destination flow is one of the most crucial elements for transportation planning and traffic management. Particularly in traffic monitoring for a long term work zone activity, tracking the mid- and long-term changes of origin-destination flows would be the most suitable indicator for evaluating the effectiveness of work zone congestion mitigation strategies. WIMAP has an application to perform the estimation of a dynamic origin-demand table on a daily basis for the I-295 work zone area by using route selection information collected from the multiple Bluetooth readers and link count data.

In Bluetooth traffic monitoring scheme, one can track the most-travelled path for each O-D pair by anonymously recording the unique MAC address of the mobile device in the network. In Barceló's study(20), a similar approach is adopted to generate a subset of the most likely O-D path flow from Bluetooth readers. To this end, a list of trip samples captured from Bluetooth sensors is generated to produce a route-link index matrix, denoted by A (an example shown in Table 3), by incorporating traffic volume counts from RTMS sensors as demonstrated in vector B. It must be noted that the links in the route-link matrix indicate roadway segments where RTMS devices are deployed unlike the traditional concept of link in graph theory.

Table 3 Example of Route-Link Index Matrix

O	D	Route	Link 1	Link 2	Link 3	Link 4	…
1	1	1	P_{11}	P_{12}	P_{13}	P_{14}	.
	2	2	P_{21}	P_{22}	P_{23}	P_{24}	.
.	1	3	P_{31}	P_{32}	P_{33}	P_{34}	.
	.	.	.	.	.	.	P_{ij}

A route-link index, P_{ij}, for an OD pair, is determined by Equation (1).

$$P_{ij}^{k} = \frac{\rho V_j}{\rho \sum_{j}^{n} V_j} \quad (1)$$

where,

$$\rho = \begin{cases} 0 \text{ if link j is not used by route i during the time period k} \\ 1 \text{ otherwise} \end{cases}$$

i : route number

j : link number and

V : Vehicles captured by Bluetooth readers

Given link counts data from RTMS, denoted by vector **B**, the traffic flow for each OD pair is obtained by solving a constrained linear least-squares problem as shown in Equation (2).

$$\mathbf{A}^k x^k = \mathbf{B}^k \qquad (2)$$

subject to,

$$x > 0 \quad (3)$$

where,

$\boldsymbol{A}^k$: route-link index matrix

$\boldsymbol{B}^k$: link counts vector (=[u_1, u_2, $u_{3,}$, …, u_n])

$\mathbf{x}^k$: OD traffic flow vector

Figure 9 shows a high-level framework for the OD estimation process employed in this application.

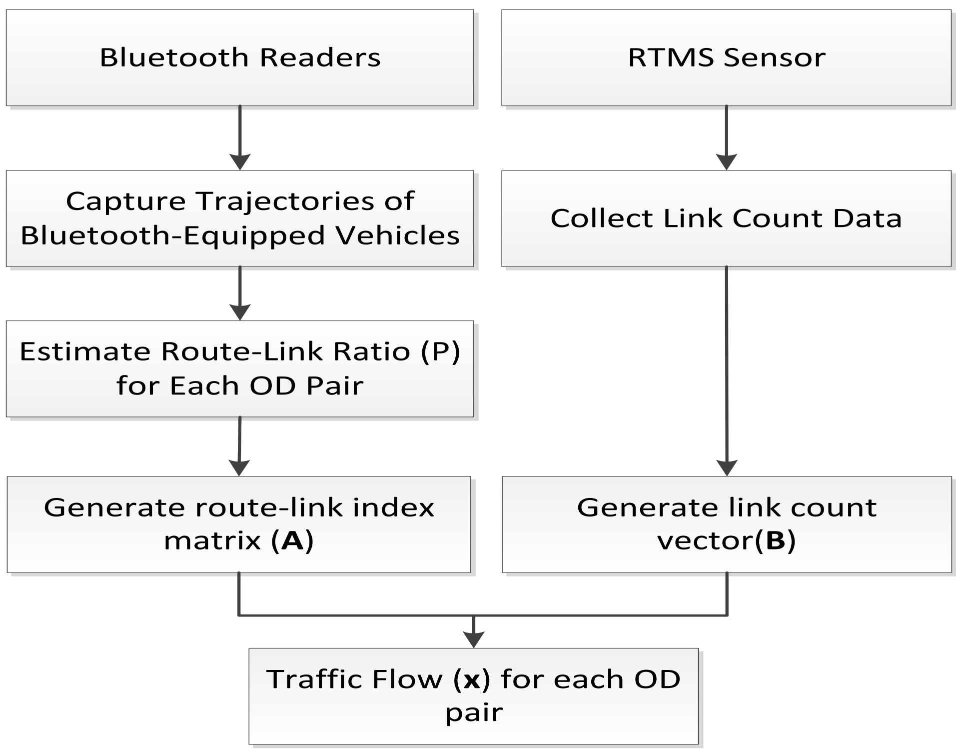
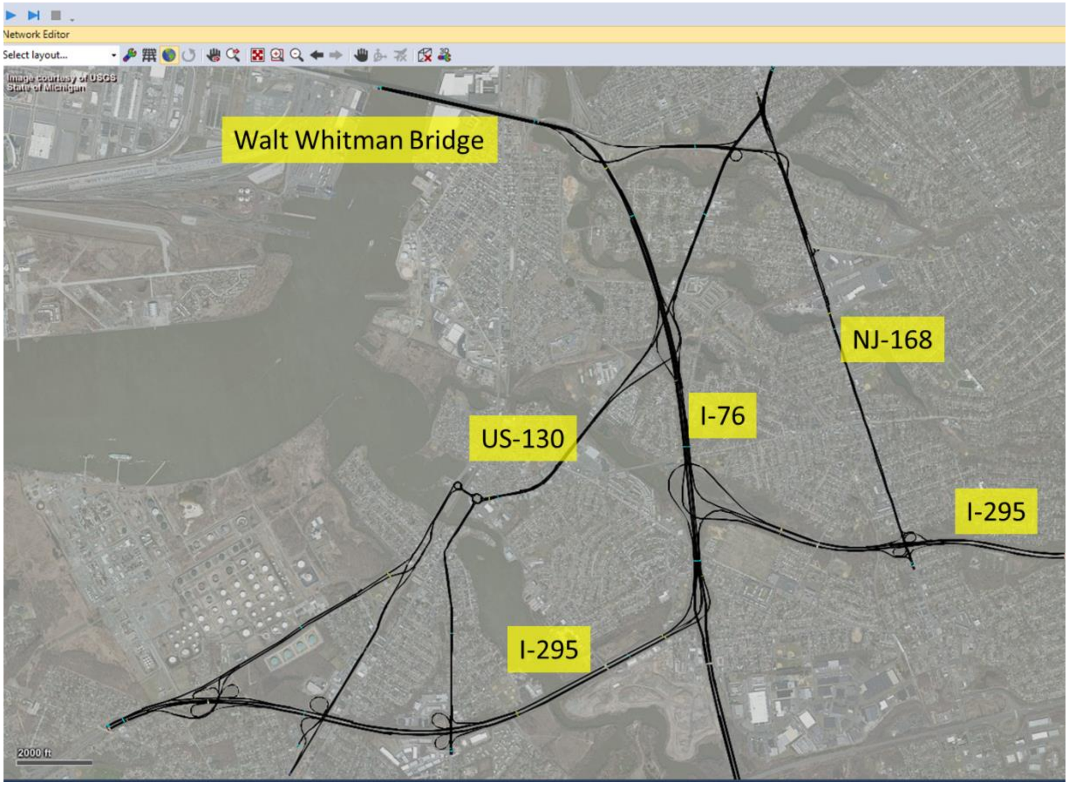
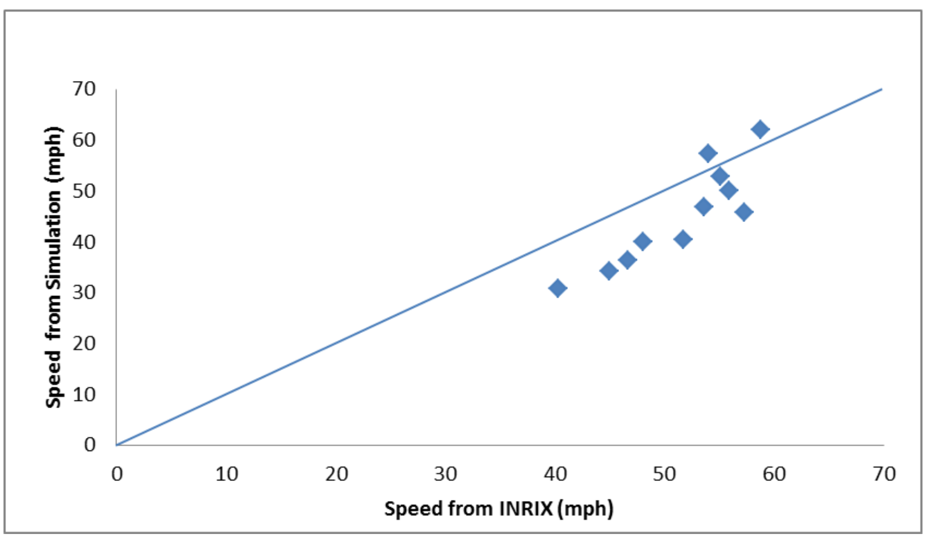


Figure 9 OD Estimation Framework in WIMAP

Since instrumenting a full set of RTMS devices for link counts data collection is still in progress, the performance of the OD estimation application was examined by using a simulation-based approach. A VISSIM-based simulation test-bed dealing with the I-295 work zone area was created by using multiple data sources including NJ CMS and INRIX travel speed data. It is noted that an initial OD demand table was created by using a transportation planning program and a GIS tool. The network has been calibrated by adjusting driver behavior model parameters based on an empirical approach. Figure 10(a) demonstrate a snapshot of the VISSIM-based virtual test-bed for I-295 work zone area in `and speeds from INRIX and Figure 10(b) shows the simulation model for several selected roadway segments as a calibration result.



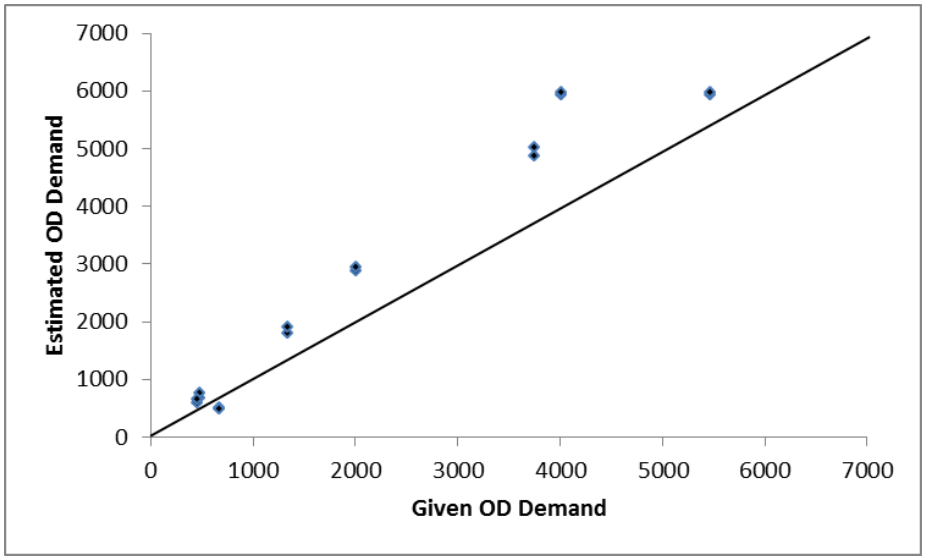
(a) VISSIM-based I-295 Simulation Network



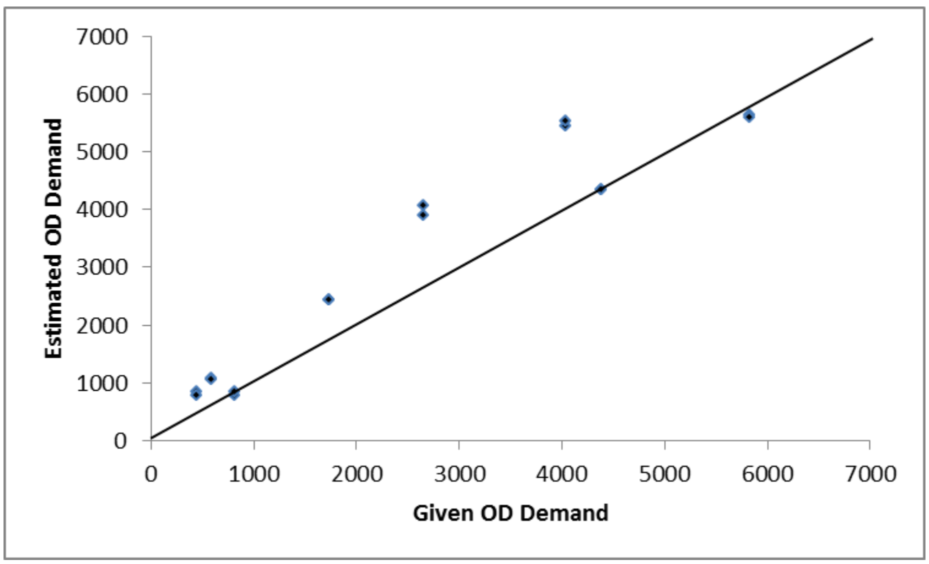
(b) Comparison of Speed from Simulation and INRIX

Figure 10 Simulation Model Network and Calibration Result

Assuming 5% Bluetooth detection pairing, the OD estimation process has been implemented by estimating the route-link index matrix and link count vectors obtained from the simulation test-bed. Figure 11 and 12 show x-y plots for OD demands estimated for 3:00 to 4:00 PM and 4:00 to 5:00 PM.



(a) OD Flow (3:00-4:00pm)



(b) OD Flow (4:00-5:00pm)

Figure 11 OD Flow Comparison

Arterials Monitoring

Compared to other WPMS', arterial performance measure is limited due to real-time data availability and limited coverage for detection. NJIT is planning to incorporate real-time performance measure in the near future by instrumenting Bluetooth readers. At this stage, the research team is still in progress of archiving the signal timing plan data for future use.

Transit Ridership Monitoring

Considering the duration of the I-295 Direct Connect project, it is expected that some travelers may switch their commute mode to transit, given the presence of transit options (bus, light rail and ride sharing). With the transit ridership data provided by NJ Transit and Cross County Connection Transportation Management Association (CCCTMA), WIMAP could provide useful information regarding impact of a long-term work zone on multi-modal performance measures.

CONCLUDING REMARKS

In respond to ever-increase traffic congestion caused by work zone activities, WIMAP is developed to collect, store, and analyze traffic data to support real-time work zone management. WIMAP is a web-based application primarily focusing on long-term work zone monitoring for the I-295 Direct Connection Project. By adopting performance measures recommended by MAP-21, WIMAP produces real-time mobility measures in and around I-295 work zone area in various formats such as Travel Time Index, Buffer Index, Planning Index, and Percentile Speed and Travel Time.

WIMAP incorporates multiple data sources to precisely capture prevailing traffic conditions in real-time. The primary mobility data sources include 1) probe-based travel speed obtained from INRIX, TRANSCOM, and TrafficCast and traffic counts collected by RTMS through ASTI and NJDOT. In addition to the mobility data, WIMAP also archives on-line roadway event data from OpenReach and off-line crash records from Plan4Safety.

While instrumenting the additional data collection devices to obtain a full set of travel time and counts data for the work zone are is still in progress, the prototype of WIMAP has been deployed for a web service and is being beta-tested by the research team. The test results show that the real-time mobility performance reports produced by WIMAP enable users to rapidly and precisely capture prevailing mobility conditions of work zone area through MAP-21-based performance measures. The map-based congestion comparison module also appeared informative for users to figure out how the current traffic condition is distinctive from historical congestion profile. A module producing user-customizable reports appeared one of highlighted features of WIMAP. By allowing an interactive customization through the web-based interface of WIMAP, users are able to generate various types of performance reports incorporating not only MAP-21 measures but also any historical events and activities causing the congestions of work zone.

It is worth emphasizing the additional data collection devices are being installed in and around the I-295 work zone area to fill out the gaps uncovered by existing data collection equipment. Once completed the device instrumentation, WIMAP is expected to be the first on-line tool dedicated for a long-term work zone monitoring to support transportation management plans for a long-term large-scale work zone project.

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APPENDIX

List of Acronyms

Acronyms	Name
ASTI	ASTI Transportation
CATT LAB	the Center for Advanced Transportation Technology Laboratory
CCTV	closed-circuit television
CHP	California Highway Patrol
CTSS	Columbus Traffic Signal System
ETC	electronic toll collection
HPMS	Highway Performance Monitoring System
MAC	Medium Access Control
ASTI	ASTI Transportation
MAP-21	Moving Ahead for Progress in the 21st Century
METAR	Meteorological Aerodrome Report (data format)
NHP	Nevada Highway Patrol
NHS	national highway system
NJDOT	New Jersey Department of Transportation
NJIT	New Jersey Institute of Technology
PeMS	Performance Measurement System
PMMS	Performance Monitoring and Measurement System
PORTAL	Portland Oregon Regional Transportation Archive Listing
RTC	Regional Transportation Commission
RTMS	remote traffic microwave sensor
TRANSCOM	TRANSCOM Company
TASAS	Accident Surveillance and Analysis System
TriMet	Tri-County Metropolitan Transportation District of Oregon
VHT	vehicle hours traveled
VMS	variable message sign
VMT	vehicle miles traveled
VPP Suite	Vehicle Probing Project Suite
WIM	weight in motion station
WIMAP	Work Zone Interactive Monitoring Application
WPMS	web-based performance measurement system