




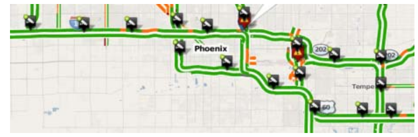

Private Probe Vehicle Data for Real-Time Applications:
FINAL REPORT

UPWP Task Number 600-0170-11
MAG On-Call Contract 435-B, Task Order PL 11-3

Submitted To
Maricopa Association of Governments (MAG)

Submitted By
Texas Transportation Institute (TTI)
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INTRODUCTION

Lee Engineering and the Texas Transportation Institute (TTI) are providing assistance to the Maricopa Association of Governments (MAG) in gathering examples of the real-time applications of private sector traffic data around the country, investigating the data and business models, and summarizing the experience and lessons learned in the procurement, system integration, and data quality.

A 2009 MAG study indicated that the quality of historical private data sources adequately meets the accuracy requirements of the travel demand model calibration process. In recent years, more and more public agencies around the country have begun utilizing private sector traffic data for real-time applications such as traffic/congestion management, traveler information, etc.

The objectives of this study were to:

1. Identify state-of-the-practice and best practices for real-time ITS applications using private probe vehicle data; and,

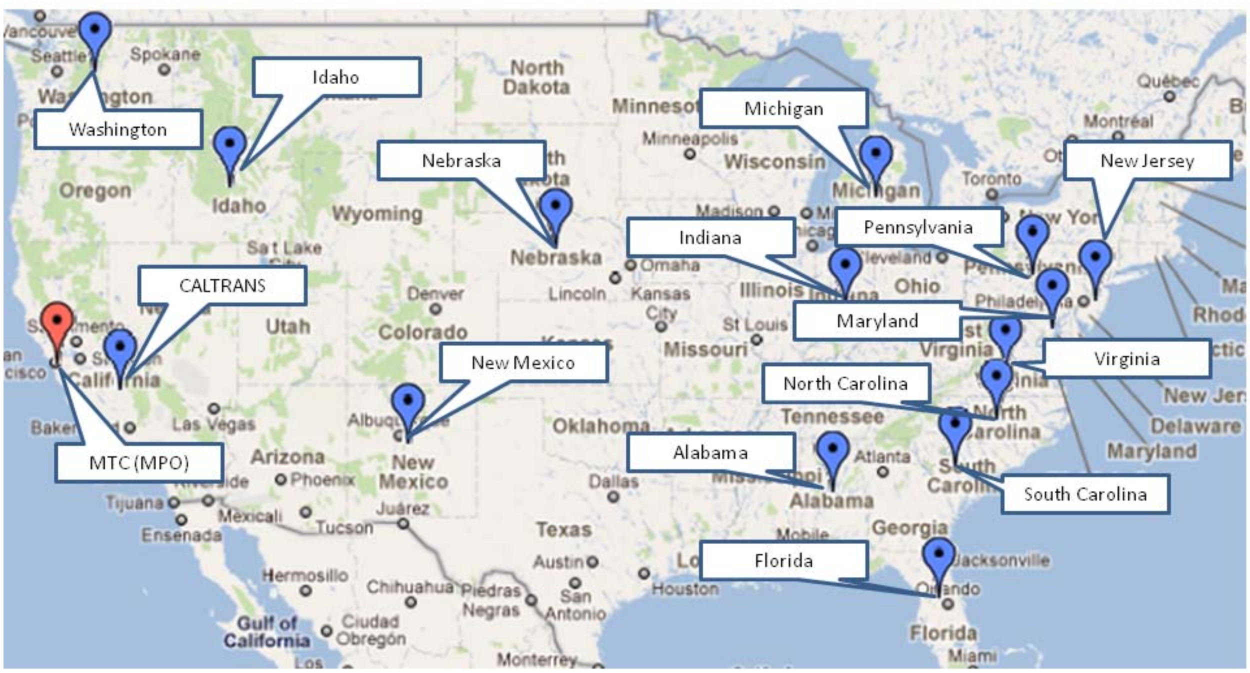
2. Assess the technical feasibility of supporting traveler information and traffic management applications (that are currently supported by one-mile spaced vehicle detectors installed along the freeways) such as segment travel time estimates, color speed map, and ramp metering.

STATE-OF-THE-PRACTICE

The following information on public users and technical issues of real-time private sector data comes from a literature search and a search of the Internet. The Internet search focused on state department of transportation (DOT) and metropolitan planning organization (MPO) websites. Agencies were contacted for more information or clarification, as needed.

The research team identified 15 state DOTs and 1 MPO (Bay Area, CA) either currently using or procuring real-time private data. These agencies are shown in Figure 1. Note only 7 of the 18 I-95 Corridor Coalition DOTs are shown here. These are the members that purchased statewide data under a provision of the Coalition's contract with INRIX. The remaining 11 DOTs (not shown) currently receive private real-time data feeds along the I-95 Corridor. The agencies in Figure 1 are also listed in Table 1. When possible, the different types of real-time applications such as traveler information and traffic management were also identified.

Figure 1. Public Agencies with Existing/Planned Real-Time Private Sector Data



Source of map: Google-Map data @2011 Europa Technologies, Google, INEGI

Table 1. Public Agencies with Existing/Planned Real-Time Private Sector Data

Agency (DOT unless noted)	Data Provider	Traffic Monitoring	Incident Detection/Alerting	Public Travel Info. 511	Travel Time Widget (Phone, Web, Displays)	Corridor Travel Times-signs, web, 511	Work zone Info and Management	Notes
Alabama DOT	**INRIX**	✓				✓		All major roads in Birmingham Area
CALTRANS	**TBD**							In procurement
Idaho Transp. Department	**INRIX**	✓						
Indiana DOT								Planned procurement
Florida DOT	**INRIX**	✓		Development				SunGuide Statewide TMC SW Integration
Maryland SHA	**INRIX**	✓			Development	✓		Statewide through I-95 VPP
Metropolitan Transportation Commission	**SpeedInfo**	✓		✓				San Francisco Bay Area MPO
Michigan DOT	**NAVTEQ**	✓	Development	✓	✓	✓	✓	
Nebraska DOT	**SpeedInfo**	✓		✓				
New Jersey DOT	**INRIX**	✓	✓	✓	✓	✓		Statewide through I-95 VPP
New Mexico DOT	**INRIX**			✓				NM Roads Web Site
North Carolina DOT	**INRIX**		✓	✓	✓			Statewide through I-95 VPP
Pennsylvania DOT	**INRIX**			✓				PA 511 service
South Carolina DOT	**INRIX**	✓				✓		Statewide through I-95 VPP
Virginia DOT	**INRIX**				✓	Development		Statewide through I-95 VPP
Washington State DOT	**TBD**							In procurement

BEST PRACTICES – TECHNICAL ISSUES

Anticipate data integration to accommodate TMC location referencing

Consistent and unambiguous location referencing is critically important when considering traffic data from multiple sources. With private sector location referencing, there is good news and bad news. The good news is that the traveler information industry has largely agreed on a consistent location referencing method called traffic message channel (TMC), which is supported by a consortium of two large mapping companies: NAVTEQ and TeleAtlas (now wholly owned by TomTom). The bad news is that, despite the TMC location references being a *de facto* standard in the commercial traffic information marketplace, they are not widely used or well known by most public sector agencies. Therefore, any efforts to use private sector travel time/speed data on a statewide or nationwide basis **will require the integration of the TMC-referenced road network with the public sector road network**.

The NAVTEQ and TomTom consortium do maintain and update TMC Location Tables that provide detailed information about the highway network and its segmentation into directional road links (referred to as TMC paths). However, the NAVTEQ/TomTom consortium owns the TMC Location Tables and licenses them (at a negotiated cost) to other private companies and public agencies. Therefore, public agencies that procure private sector traffic data will also need to license the TMC location tables to be able to translate the private sector data to their geographic location referencing system.

Require a confidence interval or quality indicator in real-time data feed

A common practice among private sector traffic data providers is to combine several different data sources and/or data types with proprietary algorithms to produce an estimate of current, up-to-date traffic conditions. This practice is euphemistically called "blending" or "fusion;" each company has their own data blending or data fusion algorithm that produces "the most accurate traveler information in the industry." There are two types of blending commonly used in private sector traffic data:

1. **Time or location blending**: mixes average historical conditions (time blending) or nearby locations (location blending) with stale "real-time" data (e.g., from the past hour).
2. **Source blending**: mixes private sector (typically probe-based) data with public agency (typically fixed-point sensor) data.

Ultimately, the best way to determine and control the effects of data blending is a quality assurance program (see the next section for a discussion of data quality specifications in contract documents) that ensures that the blended real-time estimates do not exceed some specified level of acceptable error. This is the preferred approach, rather than press the private companies to reveal proprietary blending algorithms (which most are unlikely to do).

Another **less-costly method to monitor the effects of blending is to require a confidence interval or quality indicator** in the real-time traffic data feed. For example, the following metadata elements are all data quality indicators and would be useful:

- **Vehicle probe sample size** – The number of vehicle probes that were used in the calculation of a travel time or speed estimate. Typically, sample size is considered to be an indicator of data quality. However, with some probe vehicle types (i.e., vehicles that are not representative of the traffic stream, such as construction vehicles making frequent stops), the sample size may not be the best indicator of data quality.

- **Vehicle probe standard deviation** – The standard deviation among the vehicle probes that were used in the calculation of a travel time or speed estimate. When both the sample size and standard deviation are provided, a standard error and confidence interval can be estimated. This is a surrogate indicator of data quality, because in some situations the standard deviation may be more influenced by the variability of free-flow traffic (in which drivers can select their own speed) than by variability among a limited number of samples.

- **Confidence interval or indicator** – In lieu of providing sample size and standard deviation, the data provider could choose to calculate a statistical confidence interval internally and provide that in record-level metadata. Or, a generalized confidence indicator (say on a scale of 1 to 10) could be used to indicate relative quality levels.

- **Blending indicator or ratio** – A blending indicator is a binary value (YES or NO) that indicates whether a travel time or speed estimate is blended. A blending ratio is a quantitative value (50%) that describes the proportion of historical vs. real-time data in the travel time or speed estimate. Both values could be used to filter out those values that have unacceptable level of blending. For monitoring purposes, the key would be to avoid a blend of data from different years. For real-time reporting, a blend of real-time and historic data may be sufficient, but it is important to know the data source.

Recognize that public sector sensors may still be required for advanced traffic management and control

Private sector companies typically provide link travel times and speeds on freeways and major arterial streets, with the source of this data being GPS-equipped fleet vehicles and other mobile consumer devices. There are a few private companies that deploy fixed-point sensors, but this deployment has been done on a limited basis with regard to roadway coverage. Therefore, in the near term, the private sector likely will not be able to provide traffic flows, lane occupancy, and presence detection data needed for advanced traffic management and control applications.

What this means is that, if public agencies want to perform advanced traffic management and control, the data likely will not come from the private sector. These advanced traffic management and control functions include:

- Traffic-adaptive ramp metering that responds to real-time traffic flows in the vicinity of the ramp entrance.
- Traffic-adaptive signal control systems that provide real-time traffic-responsive traffic signal optimization and platoon progression.
- Managed lanes that are dynamically-priced to provide maximum vehicle throughput.
- Variable speed limits that adjust posted speed limits on a lane-by-lane basis to account for incidents or other traffic flow disturbances.

BEST PRACTICES – CONTRACTING AND LEGAL ISSUES

Include data quality specifications in contract documents and use 3rd party for independent evaluation

In November 2010, the Federal Highway Administration (FHWA) established quality specifications for real-time traveler information via CFR 23 Part 511 (also known as Section 1201 of SAFETEA-LU). This federal law for real-time traveler information takes effect for Interstate highways in November 2014 and for other "State-designated… routes of significance" by November 2016. Therefore, any public agencies that procure real-time private sector data for traveler information should require these same quality specifications of the private companies. The data quality specifications for travel times are as follows:

- Timeliness – Not to exceed 10 minutes.
- Accuracy – Maximum error rate of 15 percent.
- Availability – 90 percent minimum.

The I-95 Corridor Coalition has documented their substantial experience[1] with validating the accuracy of real-time traveler information. Also, in June 2011 TTI released a document entitled "*Guidelines for Evaluating the Accuracy of Travel Time and Speed Data*[2]" that was expressly developed for this purpose (i.e., evaluating the accuracy of private sector data for contract compliance).

Define how the data will be used and by whom (system engineering process)

Several public agencies have commented about the importance of defining uses and users in regards to private sector traffic data. "Defining customer needs and requirements" is a critical first step in the system engineering process, yet it is sometimes still overlooked. Public sector agencies should carefully consider these factors before beginning data procurement:

- **Define applications and requirements**. How will the public agency use the procured data? Which specific applications? For example, will the procured data be used for just for situational awareness? Could the procured data also be used for traveler information, incident detection, traffic control, and/or performance monitoring? Not only will this be important to delineate in the RFP, but it would also help to set appropriate data quality targets for a performance-based contract.

- **Address data integration issues**. How will the procured data be merged and/or blended with other data sources? For example, does the procured data overlap with existing public agency sensor coverage? If there is overlap, will one data source be used as a primary input with the other source providing redundant confirmation of traffic conditions? Or will overlapping data sources be combined, and if so, what relative weights are given to each data source? Which data source(s) will be assumed to be correct if there are significant discrepancies or disagreements?

[1] See the "Highlights" tab at http://www.i95coalition.org/i95/Projects/ProjectDatabase/tabid/120/agentType/View/PropertyID/107/Default.aspx, accessed July 13, 2011.

[2] See http://www.pooledfund.org/documents/TPF-5_200/FINAL-Accuracy-Eval-Guidelines-v1.pdf, accessed July 13, 2011.

- **Address mapping and location referencing issues**. What mapping platform will be used, and how will data with different geospatial references be integrated? Is this scalable to a regional or statewide level? How will map updates from the private sector data provider be handled?

- **Consider funding stability and service continuity**. How stable are the funding sources for future continuity of data feeds? For example, if operating/maintenance budgets are reduced, will this private sector data service be any more susceptible to periodic outages or interruptions?

Negotiate a favorable licensing agreement with data rights based on the use requirements

When referring to the procurement of private sector data for performance monitoring (or other uses), the term "licensing" is more appropriate than "buying" or "purchasing." The terms "buying" or "purchasing" imply that the public agency owns the "purchased" data when, in fact, that is often not the case. With most private sector data providers, the ownership of the traffic data remains with the private company and the public agency is simply given permission to use the traffic data for various applications.

One can think of private sector data in the same way as a software application—when you "buy" the software, you do not own the software, but you are given permission (the license) to install and/or use the software in a specified way and sometimes on a specified number of computers. The terms of use are typically spelled out in fine print in the attached or enclosed software license.

As a general rule, government agencies obtain "unlimited rights" if the data pertains to an item or process developed exclusively with government funding.[3] "Unlimited rights" means that the government agency may "use, modify, reproduce, perform, display, release or disclose" the data to anyone and for any purpose."[4]

In contrast, a government agency obtains "limited rights" to data (other than software) that embodies trade secrets or are commercial or financial and confidential or privileged, to the extent that such data pertains to items, components or processes developed exclusively with private funding.[5] Such "limited rights" restrict the government agency from disclosing the data outside of the government, except under circumstances disclosed and agreed to between the government and the private sector data provider.[6] Therefore, to the extent public agencies desire to share the data with other agencies and the general public via traveler information, they must expressly set forth in the procurement documents the circumstances and conditions under which the traffic data will be disclosed and used by third parties.[7]

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[3] See 10 U.S.C. § 2320(a)(2)(A); *see also* 48 C.F.R. Subpart 27.404(a).
[4] See 10 U.S.C. § 2320(a)(2)(A).
[5] See 10 U.S.C. § 2320(a)(2)(B); see also FAR 52-227-14.
[6] See 48 C.F.R. Subpart 27.404-2.
[7] See 48 C.F.R. Subpart 27.404-2(c)(1) (listing examples of specific purposes that limited rights data may be used by the federal government).

What this means to public agencies is as follows: Unless a public agency pays for the full cost of data collection, they cannot expect to own or freely redistribute the data. That is, they have limited rights to use the data as specified in the licensing agreement. The data rights terms of private sector data providers vary widely; however, there are two common themes:

1. The licensing costs will increase as the extent of data rights and redistribution increases.
2. Data rights can often be negotiated.

Because of this, public agencies should seek the experience of other agencies who have already procured private section data. These other licensing agreements should give a better idea of what terms are possible at what price.

If in doubt, use a Request for Information (RFI) to gather relevant information from data providers

Several public agencies (e.g., Caltrans, FHWA, etc.) have issued a Request for Information (RFI) prior to issuing a Request for Proposal (RFP), such that they could ensure that the various RFP requirements could be met by more than one private sector data provider. Issuing an RFI not only helps the public agency write a more informed and effective RFP, but it also helps companies that are responding to the RFP.

TECHNICAL FEASIBILITY OF SUPPORTING REAL-TIME ITS APPLICATIONS

The objective of this task was to assess the technical feasibility of supporting real-time ITS applications in the MAG region using private probe vehicle data. Steps within this task included:

1. Identify possible ITS applications (and the supporting data);
2. Assess appropriateness for MAG region; and,
3. Determine needs for implementation in MAG region.

Existing and Planned ITS Applications in the MAG Region

One of the key principles of systems engineering for ITS is to "Start with Your Eye on the Finish Line". [8] What this means is that, when deploying ITS, agencies must begin by focusing on those services, applications, or functions that are to be served by the technology to be deployed. Sometimes, however, agencies become so focused on deploying a specific ITS technology that they don't recognize newer technologies that can more effectively meet those needs of the planned ITS services and applications.

A regional ITS architecture or regional ITS plan is intended to keep agencies focused on those core services and applications, rather than specific technology deployments. Therefore, when considering the use of private probe vehicle data, it is important to revisit the existing and planned ITS applications in the MAG region. The main document used in this regard is MAG's *Regional ITS Architecture* report dated June 2010. The project team also conferred with Arizona DOT staff about near-term ITS plans.

The *MAG Regional ITS Architecture* identifies several ITS user services that are relevant when discussing technologies that gather roadway traffic condition data[9]:

- 1.1 Pre-Trip Travel Information
- 1.2 En-Route Driver Information
- 1.6 Traffic Control
- 1.7 Incident Management
- 7.1 Archived Data

Relevant ITS Market Packages (another way to visualize ITS applications in more detail) in the *MAG Regional ITS Architecture* are[10]:

Traffic Management Service Area

- ATMS01: Network Surveillance
- ATMS02: Traffic Probe Surveillance
- ATMS03: Surface Street Control
- ATMS04: Freeway Control
- ATMS06: Traffic Information Dissemination
- ATMS18: Reversible Lane Management
- ATMS19: Speed Monitoring

[8] See http://ops.fhwa.dot.gov/publications/seitsguide/index.htm, accessed August 18, 2011.
[9] See Table 10 (pages 41-43) in *MAG Regional ITS Architecture*, June 2010.
[10] See Table 13 (pages 56-57) in *MAG Regional ITS Architecture*, June 2010.

Traveler Information Service Area

ATIS01: Broadcast Traveler Information
ATIS02: Interactive Traveler Information
ATIS10: VII Traveler Information

The appendices of the *MAG Regional ITS Architecture* provide substantial detail on the user service and functional requirements for each of these user services and market packages. However, one item that is not addressed (and may not be appropriate for a regional ITS architecture document) is the extent of overlap in the data needs for these user services and market packages. For example, can the traffic data gathered to support Traveler Information services also support the Traffic Management services like Surface Street Control and Freeway Control?

Queries to Arizona DOT operations staff indicated that traveler information remains their primary near-term ITS service objective.[11] Adaptive ramp metering and high-occupancy/toll (HOT) lane management is under study and will likely be implemented in the future.

Current Practices for Meeting Data Needs

One of the common practices within the public sector ITS community in the past 20 or more years has been the deployment of a single traffic data collection system to support multiple real-time ITS services. For example, fixed-point traffic detectors have been deployed on freeways to support: 1) incident detection; 2) traffic control (such as ramp metering and dynamic lane assignment); 3) traveler information (such as color-coded speed maps and travel times on dynamic message signs); and 4) state and federal agency requirements for traffic volume reporting.

This single, multi-purpose traffic detector system installed and operated by public agencies has been appropriate given the absence of other competing alternatives to highway network monitoring. However, developments in the past 5 years have created other alternatives to a single, multi-purpose traffic detector system. For example:

- Widespread mobile phone ownership and traffic management center integration with E911 call centers has reduced the reliance on fixed-point traffic detectors for incident detection.
- Several companies have developed commercially-viable traveler information services that rely more on GPS-equipped probe vehicles than on public agency traffic detectors.
- Public sector funding levels have limited the ability to deploy and maintain fixed-point traffic detectors across the entire regional freeway and major arterial street networks.

Because of these developments, it is appropriate to reassess whether a single traffic detector system is still the best approach to most efficiently and cost-effectively support the desired ITS applications.

[11] Email response from Mr. Reza Karimvand of Arizona DOT, July 8, 2011.

Data Needs Based on Existing and Planned ITS Applications

The previous section identified three overarching ITS service areas that require traffic data:

1. Traveler information
2. Traffic management and control
3. Incident detection and management

The key questions are:

- Given recent developments, can a single, multi-purpose traffic detector system most effectively provide data for all three of these ITS service areas at a relatively low total cost?

Or:

- By requiring a single multi-purpose traffic detector system, is that limiting the immediate region-wide implementation of traveler information (which appears to be the highest priority ITS application) via private probe vehicle data?

Unfortunately, these are complex questions that require numerous analyses, tradeoffs and assumptions. Absent a detailed analysis, perhaps the most instructive approach is to benchmark the prevailing ITS deployment practices in other regions in the US (the topic of Task 1). The common themes of this state-of-the-practice review (with regard to traffic data collection to support ITS services) were:

- Almost one-third of the state DOTs (15 of 50) are pursuing or already use private probe vehicle data for traveler information.

- Of those agencies using private probe vehicle data, there are mixed results in the extent of deployment.
  - Some state DOTs are using private traffic data to fill gaps in their fixed-point detector coverage on selected roadways.
  - Other state DOTs (primarily those in the I-95 Corridor Coalition) are finding it advantageous to contract for the statewide or region-wide provision of private traffic data on all roads, which does create some data overlap on DOT-instrumented roadways.

- Primarily, state DOTs are contracting for private data on corridors that are not currently instrumented with public agency detectors. In their view, the private data allows them to immediately expand their traveler information coverage to all major highways without a costly and time-consuming contracting and equipment installation process. Very few state DOTs are abandoning or decommissioning their already-deployed traffic detectors in favor of private probe vehicle data.

- A few state DOTs and other analysts are thinking that a hybrid data collection system (combining private probe vehicle data and strategically-placed fixed-point traffic detectors) may be necessary to meet multiple operations and planning needs in the near-term.

Cost Considerations

The project team gathered cost information for real-time private sector data and attempted to develop equivalent cost comparisons to Arizona DOT-maintained traffic detectors in the MAG region. The following paragraphs describe these cost considerations for private probe vehicle data.

Most private sector data providers do not quote generalized data licensing costs. The exception is INRIX, which quotes an ongoing licensing cost of $800 per mile per year, with an additional first-year setup cost of $200 per mile per year. Therefore, INRIX pricing amounts to $1,000 per centerline-mile for the first year and $800 per centerline-mile for each year afterward. Numerous state DOTs already have contracted with INRIX to license their data on limited-access highways, and a few of these states are also obtaining INRIX data on their signalized arterial streets (discussed in the next section).

The project team tried to gather comparable cost information for the fixed-point traffic detectors installed and maintained by Arizona DOT.[12] Their current cost accounting system has limitations that will be enhanced in the future with the PECOS system. However, Arizona DOT's estimate of Freeway Management System (FMS) traffic detector maintenance is about $800,000 per year, which includes 360 locations and covers about 145 centerline-miles. This translates to an operations and maintenance cost of about $5,518 per centerline-mile per year. Note that this operations and maintenance cost does not include any of the initial detector installation cost, which has been estimated at about $10,000 per location.

Additional cost information was extracted from Arizona DOT's request for "RTP Funds for the Freeway Management System." This spreadsheet lists FMS detector installations that total 99 centerline-miles of freeway, with a total capital cost of $84.3 million and total operations and maintenance cost of $22.8 million over 20 years, or about $11,553 per centerline-mile per year.

Based on this cost comparison, the annual recurring costs of private probe vehicle data are significantly less than those of fixed-point traffic detectors. If the initial capital costs of traffic detector installation are amortized over the detector life cycle, then the cost for private probe vehicle data is at least an order of magnitude less expensive than fixed-point traffic detectors.

There are several points that must be emphasized:

- This cost comparison assumes that fixed-point traffic detectors are being installed solely for the purposes of traveler information. Fixed-point detectors are also capable of gathering traffic counts and lane occupancy, which could be used in various advanced traffic control strategies as well as planning applications.

- This cost comparison for gathering data to support traveler information only includes two possible technology alternatives: fixed-point traffic detectors and private probe vehicle data. Another technology alternative that is gaining popularity is Bluetooth reidentification. Internal analyses by TTI and the University of Maryland for other projects have indicated that life-cycle costs for Bluetooth reidentification equipment are comparable to licensing costs for private probe vehicle data.

[12] Email response from Mr. Reza Karimvand of Arizona DOT, July 8, 2011; also from Mr. Darrell Bingham of Arizona DOT, July 27, 2011.

There are several considerations when selecting data sources for traveler information, including overall life-cycle cost, local agency capabilities and requirements, and regional integration. The guidance for the selection of a specific technology (i.e., fixed-point sensors vs. Bluetooth vs. private probe vehicle data) was beyond the scope of this project. However, on a separate project, TTI researchers have developed a spreadsheet-based cost estimator (see Appendix A) that gives agencies a better sense of the life-cycle costs for various technologies based on default or localized cost values. These life-cycle costs for various data alternatives would help in making cost-effective decisions about deploying traveler information in the Phoenix region.

Arterial Street Applications

Traveler information for arterial streets is considered the "next frontier" for private probe vehicle data. This private probe vehicle data has been systematically evaluated on high-volume freeways; however, the lower traffic volumes and the interrupted flow due to traffic signals presents a larger challenge for developing accurate traveler information on arterial streets. Several private companies do currently or soon plan to offer real-time traveler information on arterial streets.

As part of the I-95 Corridor Coalition Vehicle Probe Project, INRIX has provided real-time speed data for selected signalized highways that parallel I-95 (i.e., likely diversion routes). The data for these parallel arterial highways were provided to the I-95 Corridor Coalition at no cost; however, the data accuracy requirements of the contract did not apply to the arterial data. This contract clause was a way for the I-95 Corridor Coalition agencies to get free samples of arterial street data with no risk to INRIX for withheld performance payments.

After 2 years of systematically evaluating the I-95 freeway data provided by INRIX, the I-95 Corridor Coalition (and its main contractor, the University of Maryland) has developed a process and begun to review the accuracy of arterial street travel time data.[13] In November 2010, the University of Maryland published a white paper on the validation of arterial street data. Subsequent evaluations in Pennsylvania (November 2010), Virginia (November 2010), and Delaware (December 2010) included arterial streets in the reporting, but not in the determination of contract performance payments.

Long-Term Vitality of Private Sector Traffic Data Market

There is a perception among some public agencies that there is still substantial risk in contracting with private sector data providers (e.g., "they are here today, gone tomorrow"). This perception is based on several failed companies and false starts that occurred 5-10 years ago in the private marketplace for traveler information. However, in 2011, the private marketplace for traveler information has evolved quickly in the past 5-10 years. Certainly, there are still a few "start-up" companies that devote more of their budget to marketing than to technical development. However, there are several major companies that are quickly establishing a worldwide presence in real-time traveler information. Auto manufacturers and navigation/mapping companies are signing multi-year deals with several of these leading private sector data providers.

[13] See http://www.i95coalition.org/i95/Projects/ProjectDatabase/tabid/120/agentType/View/PropertyID/107/Default.aspx, then click on the "Highlights" tab.

Several anecdotes were gathered during the course of this investigation. One of the leading private data providers indicated that their revenue from private sector customers is about 10 times the revenue from public sector customers. This company indicated that their real-time traffic data serves over 18 million private-sector turn-by-turn navigation subscribers worldwide across smart phones, portable navigation devices, (PNDs), and vehicles.

Another leading data provider indicated that their revenue from other private companies is about 75% and growing (with 25% from public agencies). This company also indicated that their business was growing worldwide. This company felt that working with public agencies would continue to be an essential part of their business—that working with road operators helps them ensure that they have the best data and the best quality.

CONCLUSIONS AND RECOMMENDATIONS FOR IMPLEMENTATION

In considering the use of private probe vehicle data, the project team emphasizes the need to have a continued focus on the desired ITS services and functions, rather than being fixed on a traditional ITS technology deployment.

Therefore, the project team reviewed the long-range ITS plan for the Phoenix region, which includes numerous ITS services such as advanced traffic management and control, as well as different types of traveler information. However, Arizona DOT operations staff indicated a primary short-term focus on only traveler information. Private probe vehicle data can be used to support various types of traveler information; however, private probe vehicle data may not be useful to support other advanced forms of traffic management and control, such as ramp metering, managed lanes, etc.

A cost comparison indicated that private probe vehicle data is significantly less expensive than installing and maintaining fixed-point traffic detectors. However, this comparison assumes that the only application is traveler information, and ignores the traffic count and lane occupancy data provided by fixed-point traffic detectors that could be used for traffic management and control functions.

If the near-term goal is the provision of region-wide traveler information, then private probe vehicle data has several advantages over traditional fixed-point traffic detectors. The main advantages include full and immediate coverage of the region's major highways (including major arterial streets) at a cost significantly lower than fixed-point detectors. Bluetooth technology offers a cost advantage over fixed-point detectors, but still requires time to deploy equipment as well as maintenance resources.

Based on these findings and conclusions, the project team offers the following recommendations:

- MAG member agencies need to reach consensus on this policy decision: whether to immediately pursue region-wide traveler information using alternative technologies (like private data or Bluetooth reidentification) versus a longer-term all-in-one traffic detector system that serves multiple purposes (traffic management and control, as well as traveler information) but is much more costly to install and maintain.

- Conduct a more detailed cost analysis for specific corridors for these three traveler information alternatives: traditional fixed-point detectors, private probe vehicle data, and Bluetooth reidentification.

- Consider a pilot application of real-time traveler information application using private probe vehicle data or Bluetooth reidentification. This pilot application could include a side-by-side evaluation of real-time data accuracy for the three possible traveler information alternatives: fixed-point detectors vs. private probe vs. Bluetooth.

APPENDIX A: LIFE CYCLE COSTS FOR REAL-TIME TRAVELER INFORMATION TECHNOLOGIES

On a separate research project, TTI researchers developed a spreadsheet-based cost estimator that gives agencies a better sense of the life-cycle costs for various technologies based on default or localized cost values. These life-cycle costs for various data alternatives would help in making cost-effective decisions about deploying traveler information in the Phoenix region.

Detector Life-Cycle Costs and Considerations
Mobility Measurement in Urban Transportation Pooled Fund Study
Tool Available at: http://mobility.tamu.edu/resources (under "Data Collection and Management")
May 2011
Texas Transportation Institute

Researchers developed the corresponding spreadsheet tool of typical data collection devices along with estimated life-cycle costs. The objectives of the cost-estimating detector tool are:

1. Provide an overview of the key issues and cost elements one needs to consider for a given detector technology/method, and
2. Provide a range of costs for each detector cost element, as well as overall costs (including Year 1, 5-year life-cycle cost, 10-year life-cycle cost) per mile and for a given segment length.

Development of such a tool includes a number of assumptions, clarifications, and user-inputs. These are highlighted throughout the spreadsheet, and each worksheet of the spreadsheet corresponds to a detector technology/method. The following detector technologies/methods are included in the spreadsheet:

1. Bluetooth® probes
2. Private-sector probe data
3. Toll tags
4. Radar
5. Dual Loops
6. Magnetometers
7. Video

Using user-entered "low" and "high" estimates of each cost element within a detector technology, the spreadsheet estimates a "low" and "high" estimate of the Year 1 costs, 5-year life-cycle cost, and 10-year life-cycle cost. Costs are shown in table and graphic form in the "Summary" tab of the spreadsheet as "per mile" and "for a given segment length." Costs were developed considering a freeway environment.

Researchers built the initial version of the spreadsheet with the vision/intent of the practitioner who ultimately desires a real-time data feed for traveler information. While costs for the actual data integration by a system integrator are not currently included, there is a place for them to be added. This application provided a good starting point for developing the spreadsheet and considering the necessary cost items. The tool can be used for other applications by editing the available inputs.

For any application, users should first consider system design and what they want to ultimately do with the data. This will assist in determining what data are needed and subsequently where/how the data are collected. The system design will also determine ultimate installation and/or licensing costs if provided through a vendor. The detector technologies included in the spreadsheet provide a range of data elements (and a range in quantity of data). For example, dual loops, magnetometers, video and radar provide lane-by-lane data that is vital for operations (e.g., active traffic management, ramp metering), while technologies like Bluetooth®, private-sector data, and toll tags are not disaggregated by lane.

The results of the tool are best used to identify the relative cost of the technologies to one another, given the user-inputs. As an example, users can input different roadway lengths and detector spacing to identify the impact on the estimated costs. In some cases, there is a rather large difference between the final "low" and "high" cost estimates due to the number of assumptions that go into the calculations.

APPENDIX B: SCREEN CAPTURES OF REAL-TIME TRAFFIC INFORMATION IN THE PHOENIX REGION

This appendix presents screen captures from several different traffic information providers within the Phoenix region. This is not a comprehensive survey of all private traffic data providers, but rather a representative sample. The screen captures were made on Tuesday morning, September 20, between 7:35 and 7:47 am Phoenix local time. All screen captures were made from free, publicly-available websites.

Readers should note that all screen captures are at similar zoom ranges to enable visual comparison of real-time traffic conditions, and the maps have been centered on downtown Phoenix. Different traffic information sources provide different extents of coverage outside the downtown Phoenix area, and the websites are visible in the screen captures for further exploration and comparison by the reader.

Figure B-1. Google Traffic Map (captured 9/20/2011 7:35 am Phoenix local time)

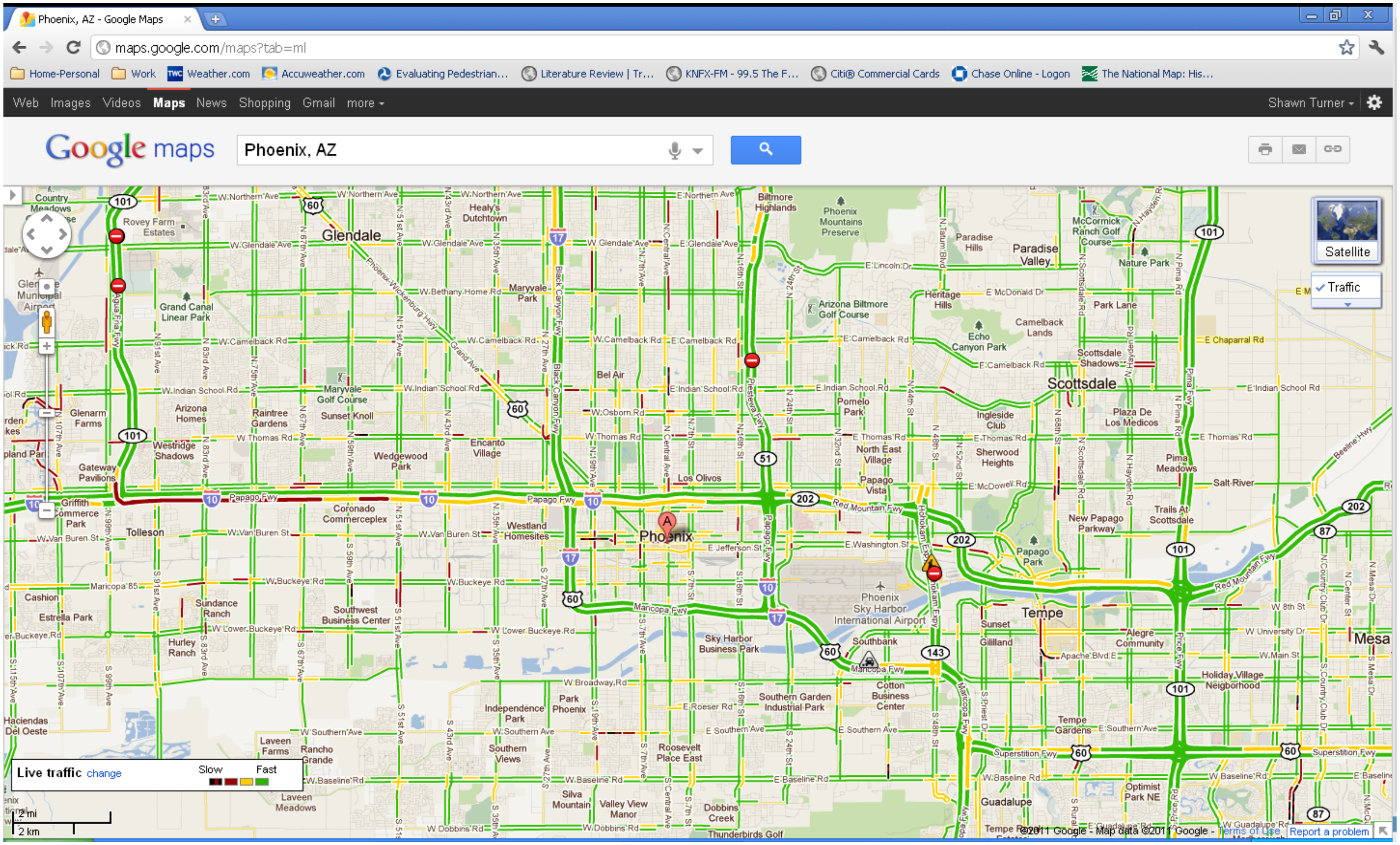

Figure B-2. Mapquest Map showing INRIX Traffic Data (captured 9/20/2011 7:36 am Phoenix local time)

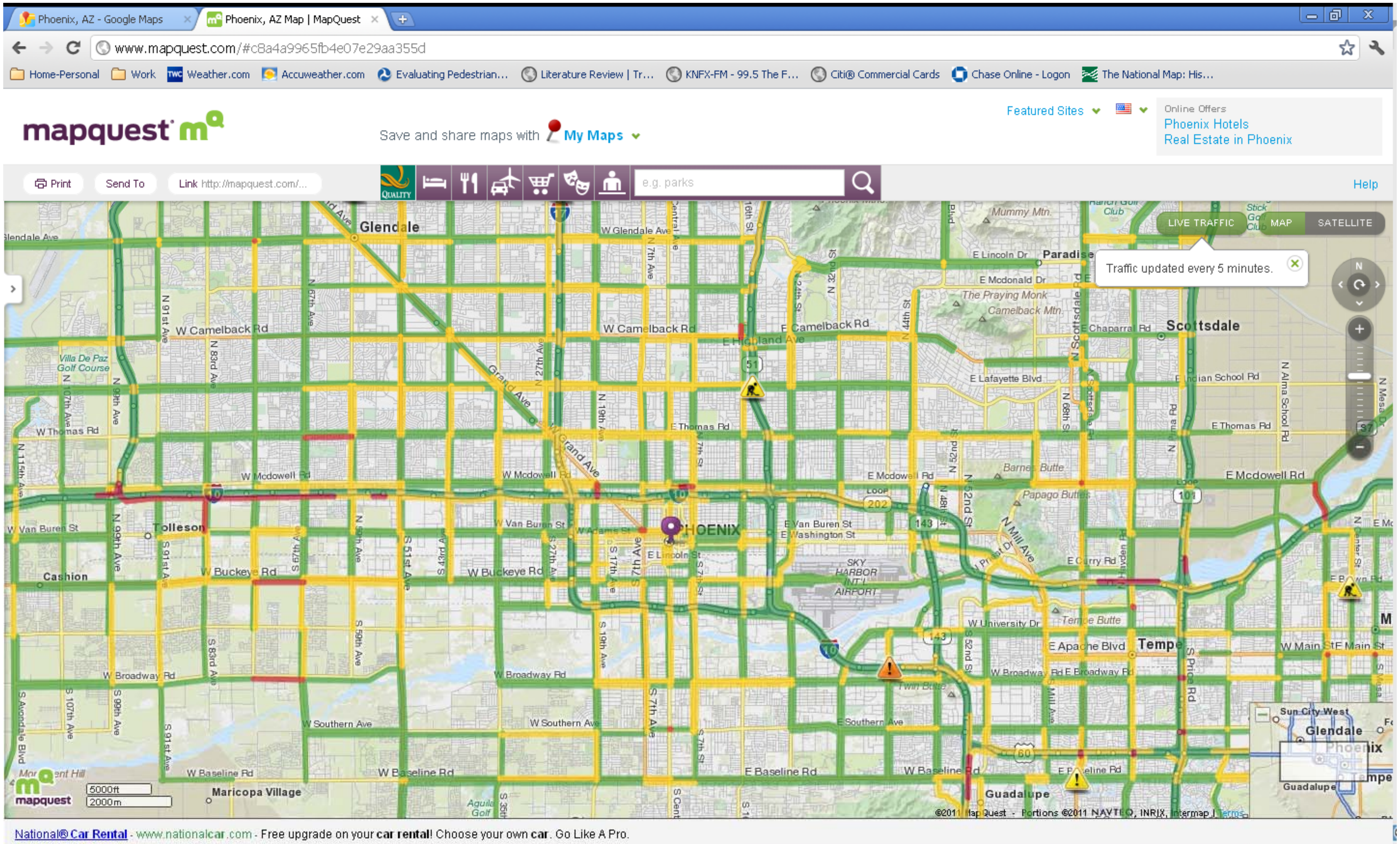

Figure B-3. Yahoo Map showing TrafficCast Traffic Data (captured 9/20/2011 7:39 am Phoenix local time)

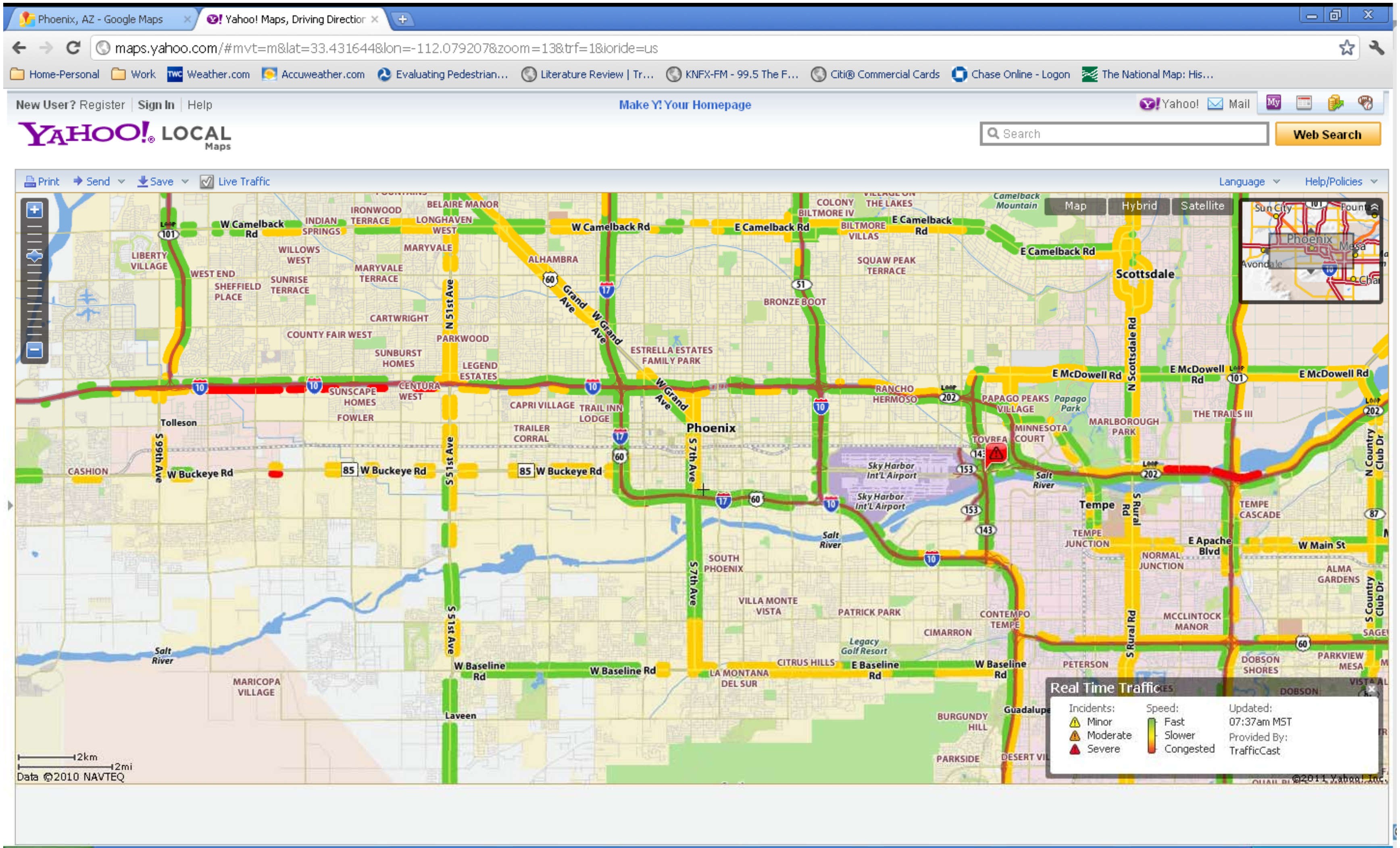

Figure B-4. NAVTEQ Map showing NAVTEQ Traffic Data (captured 9/20/2011 7:40 am Phoenix local time)

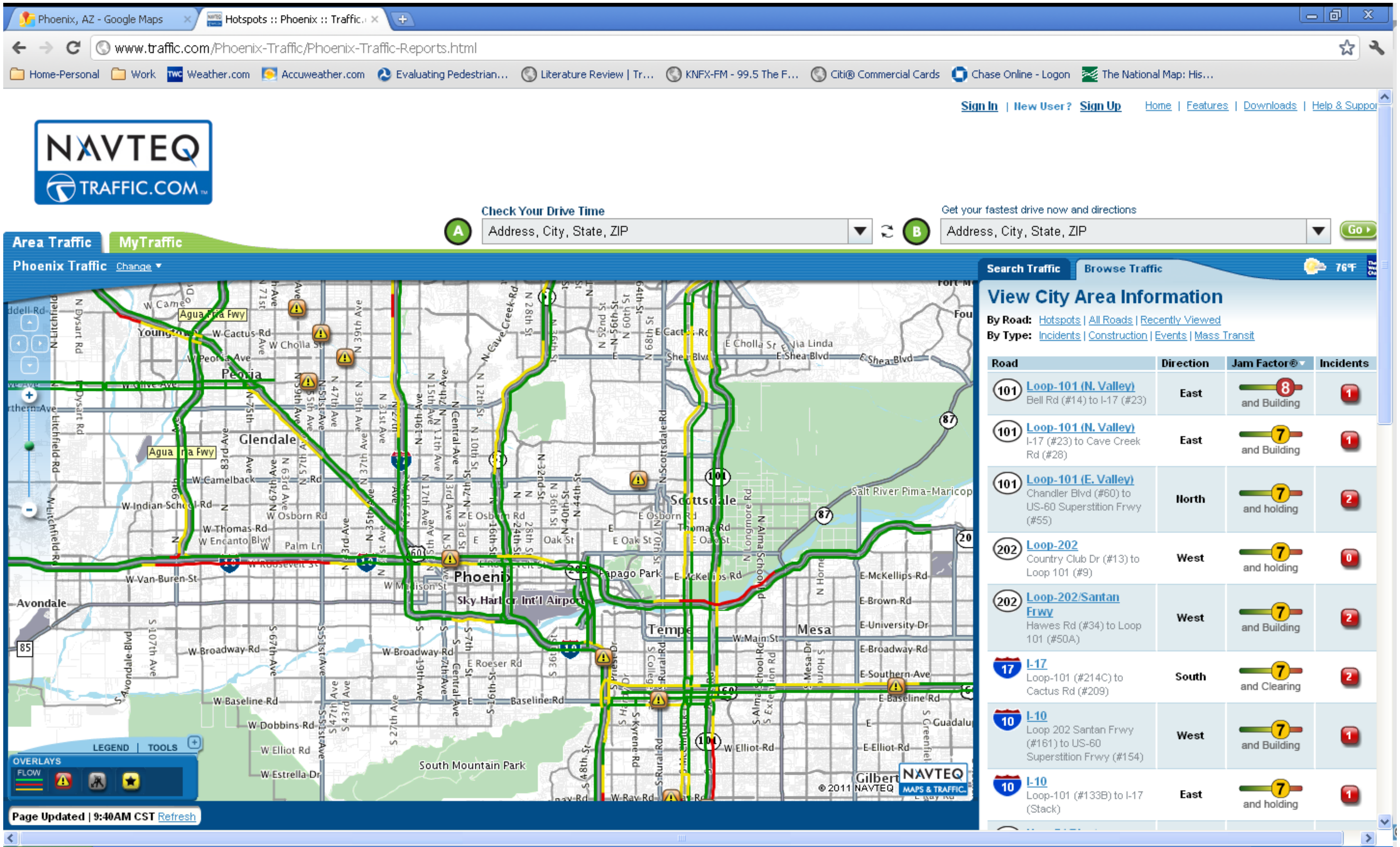

Figure B-5. SigAlert Map showing Arizona DOT Traffic Data (captured 9/20/2011 7:44 am Phoenix local time)

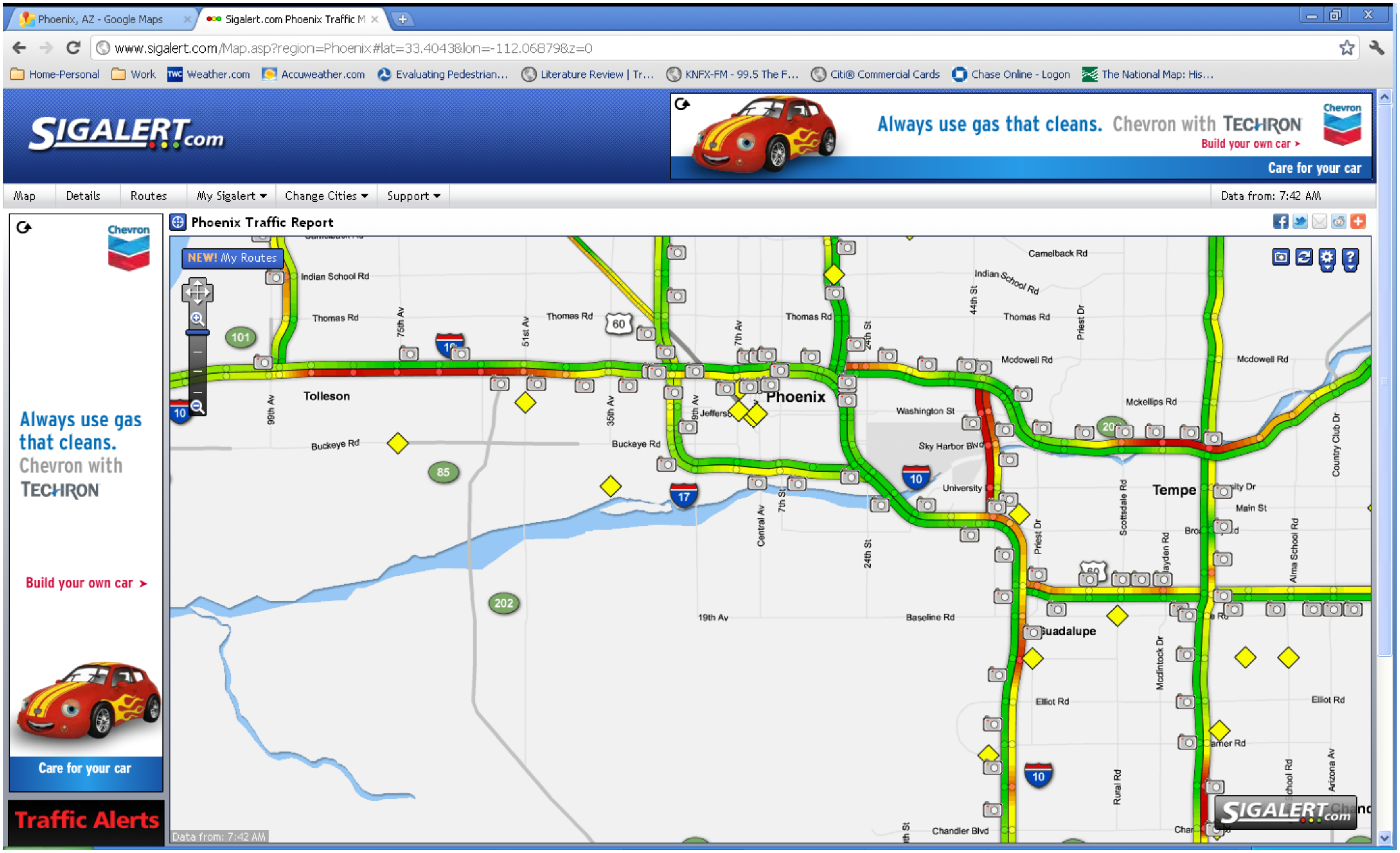

Figure B-6. AZ 511 Map showing Arizona DOT Traffic Data (captured 9/20/2011 7:45 am Phoenix local time)

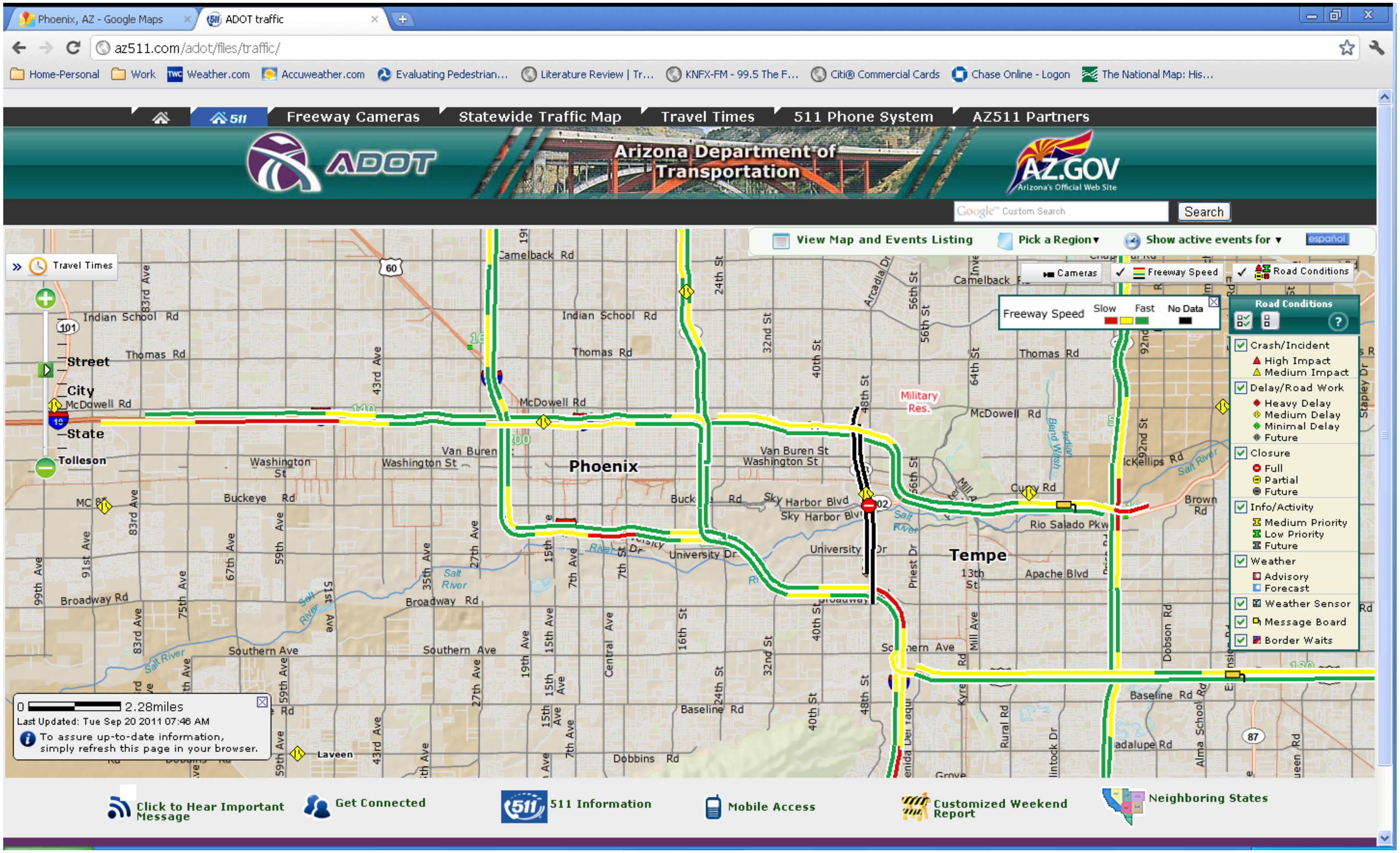

Figure B-7. BeatTheTraffic Map showing BeatTheTraffic Data (captured 9/20/2011 7:47 am Phoenix local time)