The Future of Travel Time Data - A Paradigm Shift
A Discussion Paper

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TRB Regional Transportation System Management and Operations Committee
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Task Force on Traveler Information

The Paradigm Shift

In the earlier years of ITS there was a great deal of publicity about market surveys sponsored by ITS America and others that 80% of ITS investment would come from the private sector. In the intervening years, ITS seems to have become more of a public works program where - with a few notable exceptions like OnStar and ATX for cars, Qualcomm for trucks, and the Intelligent Vehicle Initiative - the public sector is expected to fund most of the ITS programs.

The premise of this paper is that within 1 to 3 years real-time, comprehensive travel time and other traffic flow data will be available from the private sector for all major roadways. That data may come from "mining" wireless networks, AVL/probe vehicle technologies, and/or privately owned and maintained sensors.

It is further presumed that the availability of ubiquitous travel time data along with traffic volumes will not only enhance the market for traveler information but will provide public agencies with a powerful new tool to measure system performance, manage traffic, plan for special events and emergencies and plan for future operational and infrastructure enhancements. The private data will not replace all public agency needs, i.e. for control systems like ramp metering on signal systems, but it will permit applications that do not exist today.

The purpose of the paper is to provoke thought and discussion on the implications of this paradigm shift in the source of and availability of ubiquitous travel time data. When such data is available, the private sector will be able to make a fairly straightforward business decision based on a profit motive. The decision making process for public agencies, on the other hand, is not as straight forward and involves many considerations – not the least of which is the culture of "control" of the data – i.e. build, operate, maintain and have complete say over who gets what, when and how. For this reason there is a bias in the paper toward public sector issues.

Another presumption of this paper is that the public sector probably cannot stop the development of private sector traffic flow data but the public sector can certainly affect the rate of expansion and when and where private data becomes available. And one last point - we prefer not to debate whether or when this paradigm shift will occur. For the

purposes of discussion, we ask that you just assume it will and that it will happen very soon.

The Current State of Traffic and Travel Time Data

This section provides a very brief discussion of the current status of traffic and especially travel time data in the U.S.

Today a relatively small percentage of roadways in the U.S. are fully instrumented – traffic flow detection, etc. and many public agencies are struggling to maintain those miles in top working order. The surveillance elements of the existing systems were also generally designed for incident detection, ramp metering and other traffic management and control applications. Most of the traffic flow detection is based on "point" detection technology. More discussion of the limitations of point detection follows in the next section of the paper.

TRANSMIT in the NY/NJ/CT region is a system that uses vehicles equipped with toll tags to serve as probes to measure travel time and report abnormal traffic flow caused by highway incidents. The TRANSMIT data is used primarily for traffic management. The San Francisco area is also now installing a similar system and will use that data for traveler information.

Even optimistic predictions of the ability of public agencies to build and maintain data collection infrastructure on a majority of roadways are not rosy.

In the private sector, Mobility Technologies, nationwide, and Trichord, in the N. Virginia/DC area, are installing their own sensors in public agency owned rights-of-way. The data from those sensors is fused with public agency sensors, video images, and other sources of traffic incidents to produce travel times and other traffic flow measures that are then sold to the media or otherwise delivered to the public.

Telematics – in-vehicle navigation and safety systems – finally seem to be taking hold in the U.S. Vehicles equipped with telematics can communicate their position and other data and presumably can serve as probes in the future. There are a numerous technical, institutional and business issues that will have to be resolved before that can happen but discussions have begun to address those issues. There is also a question of how long it will take for enough vehicles to be equipped before there are enough probes to provide meaningful travel time data.

Two demonstrations of using wireless phones and/or data – the E-Systems/Raytheon CAPITAL operational test on the Washington/Capital Beltway in the mid-1990's and the U.S. Wireless demonstration and evaluation again on the Washington Beltway in 2000 or so - have been completed. Many people think the failure of these two demos means that the technology is not viable. Among the contributors to this paper are most of the people who were involved in these operational tests and evaluation projects to turn wireless

phones/data into travel times. We are convinced it can be done – the only questions left are when, adequacy for which applications, how much it will cost, etc.

Today there are two other companies participating in demonstration and evaluation projects using wireless "probes" AirSage in the Hampton Roads region of Virginia and Cellint in Kansas City. We will know the initial results soon, Air Sage will begin delivering data to VDOT and the University of Virginia (the evaluator) in the spring of this year.

ITIS Holdings, plc is currently providing real-time travel times in Great Britain using AVL technology and has begun to explore the U.S. market - http://www.itisholdings.com/#

So again to keep the discussion moving, we assume in this paper that privately owned accurate, comprehensive travel time data will be available in no more than 3 years – what are the implications for the state and local DOTs and the rest of the ITS industry?

Using Travel Time-Based Data

Point detection, whether from the widely used inductive loop or more "modern" technology such as video image detection, has provided the following data at a single location (i.e. point) on a facility:

- Vehicle counts (often reported per unit of time – such as vehicles/hour)
- Sensor occupancy (the percentage of time the detector is sensing a vehicle – an indication of traffic density)
- Point speed (either directly measured with a pair of point sensors or derived from a single sensor using an assumed average vehicle length)
- Vehicle classification (typically car, truck, etc)

Based on this data availability, most of the performance measures that have been developed are very much based on count data, given that this is the most reliable from point detection technology. Examples of these measures include:

- AADT
- Volume/capacity ratio
- LOS (based on volume for urban freeways)

A striking aspect of these measures is that they do not directly measure congestion from a motorist's perspective. As a result, very few transportation agencies currently measure congestion in such a way that it can be well understood and compared within a state, or from state-to-state or over time.

Some have argued that using spot speeds and assuming uniform travel conditions between sensors is an adequate approach to extending point sensors to estimate true travel speeds and travel times, especially considering lane-by-lane speeds which cannot

be derived form vehicle probes. However, recent research (Smith, et al, 2003) has indicated that spot speeds can be very risky approach that may produce extremely misleading results in some circumstances. Therefore, there is a significant need within the transportation engineering community to directly measure travel times and travel speeds over linear roadway distance in concert with some point detection. Transportation managers need real-time measures of roadway performance. This is important for day-to-day management, for long-term planning, and for communication with the general public.

Why Travel Time for Performance Measurement?

- Travel time is a "natural" measure of congestion – allowing for the direct measurement and communication of:
    - Spatial extent of congestion (based on end points of measured corridor)
    - Severity of congestion in a form that all people understand (i.e. distance reported as a measure of "time")
- Travel time provides an easy basis for directly measuring delay.
- Travel time allows for reliability/variability measures to be easily computed. While these measures take on a multiple of forms currently, they are related to the standard deviation of travel time.
- Travel time is sensitive to unusual conditions (e.g., incidents, special events) and the effects of mitigation efforts that are often of interest to the public and system operators. This may offer a solution to the development of reliable automated incident detection.
- Travel times are applicable to all modes of transportation (including intermodal transfers) and types of travel (e.g., commute, recreational, freight) allowing realistic comparisons of operating conditions and investment decisions.
- A focus on travel times can facilitate looking at the total trip as opposed to concentrating on individual pieces of the system. This is a principal, and often the primary, concern of the traveler.
- Travel times are only one step removed from a more fundamental measure of transportation performance: how many trips were completed on time? This, in turn, has direct implications for how public transportation agencies and state/local DOTs interact with their customers.

Challenges Associated With Incorporating Travel Time in Performance Measurement

- The transportation engineering community does not have a solid understanding of the "natural" variance of travel time. There have been some papers in this area – but there does not appear to be a consensus at this point. Without an understanding of variance, there is a risk of misleading conclusions in comparing travel time measures. This risk will diminish as data are collected and variance is better understood.
- The community also does not have a solid understanding of the effect of improvements that attempt to change the travel time variation. Incident management programs, traveler information efforts, ramp metering, etc. have

been evaluated in some situations, but more information is needed to understand a broad range of effects on transportation, the economy, quality of life and other factors.

- Different travel time measures are not consistent. Direct travel time measurements (i.e. toll tags, etc) are quite different from derived travel time estimates from point sensors using the extrapolation approach. Both are quite different from continuous measurement of travel time as is possible with probes that sample traffic flow.
- There are no definitive reporting approaches. For example, should times only be reported for peak periods, on a per mile basis, etc? How will the variance be expressed? Of course, in reality, much of this will vary according the demands of individual sets of customers – traffic engineers, transportation planners, daily commuters, supply chain logistics, "Sunday drivers," and so forth.
- The impacts of investment decisions on travel time will need further exploration but the lack of data has been the largest hurdle. Nonmotorized travel, intermodal linkages and connections and the business effects of travel time variation will continue to be areas of weakness.
- The planning processes that drive investment decisions will have to be reoriented to fully consider travel times.
- The operations equipment maintenance processes will have to be reoriented to ensure adequate data quality from public sector devices. Private sector companies that enter the business will thrive or fail based on their data quality and ability to deliver information to customers.
- The next step from reliability measures is the ability to predict travel times. This, in turn, supports two ways that could greatly improve the flow of traffic: 1) provide the traveling public with actionable information that would shift travel times and maybe routes (no mode shifts allowed!) and 2) make performance-based pricing practical. We now use the term HOT lanes for this, but it could be implemented on a larger scale.

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Begin the Discussion

Will public agencies buy privately owned and maintained data? How can travel time data to be incorporated into traffic management systems? What new traffic management opportunities will arise from the availability of ubiquitous traffic data and specifically travel time data? What about quality control? How will the accuracy and adequacy of private sector data be determined? Is the market place enough to determine whether or not data quality matches need or will some folks call for federal standards? Even with good travel time, what additional data may be needed by the public sector and for what types of functions and systems?

Many questions, few answers today. But if we don't prepare for this new reality it may not become reality, or as a minimum the availability of valuable travel time data from the private sector may be delayed.

To start the discussion we pose a number of questions that follow. These are not all inclusive but a starting place. There are an infinite number of issues and questions that could be addressed so we would like to focus on only two. They are:

- Assume that privately owned, accurate, comprehensive travel time data will be available in no more than 3 years and probably less.

- Assume the availability of ubiquitous travel time data along with traffic volumes (i.e. some point detection) will not only enhance the market for traveler information but will provide public agencies with a powerful new tool to measure system performance, manage traffic, plan for special events and emergencies and plan for future operational and infrastructure enhancements.

The questions:

Assuming privately developed and owned travel time data is a good thing, how do public agencies and the traveler information private providers speed up this development? How can they be ready to take advantage of this new world when it happens?

Without a definable and ready market, will the private sector invest the resources necessary to develop this new tool – travel time data?

How can/should public agencies try to influence this new industry and its products?

Who is the customer – private travel information providers or public agencies or both?

If public agencies buy the travel time data and give it away thru 511 and other media, is there still a private sector market?

In addition, if the public sector is precluded from giving it away, and the private sector begins offering 511-like services, in competition with 511, will 511 disappear?

Should public agencies only provide "exception" information – incidents, work zones, special events – and leave travel times exclusively to the private sector?

Or, is the private sector a customer for the "exception" data (perhaps with a price), but then integrates the data into private sector traffic information to provide an even higher quality product. This might involve travel time predictions or other measures of reliability.

Besides real-time travel time information, what other applications can this data be used for, i.e. performance measures, operational analysis, traffic management (including the ability to "tune" control strategies such as signals, ramp meters, VMS, and info about alternate routes), roadwork activity, regular reporting to government and the public?

How can this data be incorporated into real-time traffic management systems? What type of new algorithms will have to be developed? Who should do that? Are there new types of analysis tools that will be needed; models that use travel times; analyses of capacity improvements based on travel times?

What kind of economic analysis does a public agency use to determine if buying the privately owned data is a cost effective solution?

- What costs do they compare against?
- How many years into the future does the analysis include?
- Is there a public sector alternative?
- Should they factor the risk that the private sector operation dramatically raises its rates once the public sector allows their data collection effort to end?

If a public agency wants to buy the data, what procurement method is appropriate, i.e. competitive bid, sole source? Do the DOTs have a choice? In the near term, there may be only one provider of these new data.

Does the new data allow DOTs to stop deploying more traditional sensors, thus saving capital and operating funds?

How does the buyer – public or private – assure the data are accurate and adequate?

- What are acceptable levels of accuracy and adequacy?
- When do we need standards and when can we rely on market forces? In reality, the quality of probe data will improve over time, just as all other sources of data have. There is a risk that a standard may become a ceiling.

Even if region/network wide travel time and speed data are available, what additional detection is needed for what applications? For example, traffic counts. Some basic and advanced traffic management functions (ramp metering) and advanced travel time prediction requires network flows, as does sound performance monitoring and many basic planning applications. Where does this come from? The cost saving from private sector travel time/speed collection, in this case, should include expenses for the public

sector to maintain a count program. Or, do we still need this data? Historically, we've collected this data because it was easiest and we've developed analysis tools to use the data.

If we have travel time data – or other data from this approach – are there other analysis tools that will give us what we need without count data?

- What about trip generation tools?
- If we had historical travel time data, will we be able to better understand the impact on reliability of various types of development patterns?

The use of travel time data would give us the capability to analyze transportation improvement projects based BOTH on expected volume increases and reliability impacts.

and finally,

What if public sector inertia retards the development of travel time data available from the private sector for another 5 years or more?