A FRAMEWORK FOR DECISION MAKING ON CELLULAR FLOATING CAR DATA TECHNOLOGY DEPLOYMENT

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ABSTRACT

Cellular Floating Car Data (FCD) technology has generated excitements within transportation and telecommunication industries for some time. This is largely due to its lower deployment and maintenance cost, quick implementation time, huge potential as a greener source of traffic data and the fact that it can be deployed and maintained with no disruption to traffic flow. However, limitations of FCD solutions such as the perceived lower data quality and accuracy and safety concerns have prevented wider acceptance. Also, security and privacy issues regarding data handling has proven to be additional challenges. These limitations suggest that FCD despite its many benefits will only provide the most value under specific conditions and in certain situations or locations. In this paper, best use case scenarios for Cellular FCD deployment are suggested to help organizations make an informed decision on whether or not FCD is best placed to deliver its unique requirements.

INTRODUCTION

Traffic detection and monitoring has typically been achieved using information gathered from fixed sensors such as inductive loops buried beneath road surface, installed Automatic Number Plate Recognition (ANPR) system and above ground detectors such as microwave and radar based solutions. To assist in meeting traffic management objectives, traffic data is first collected in real-time from fixed sensor stations and then processed in software with the intention of extracting useful information which can be fed into their decision making process or disseminated to road users. For example, by intelligently comparing similar real time data with historic data using software data analysis or decision support tools, incidents on the road may be accurately detected [1]. Once an incident is detected, a system operator is typically alerted, and confirmation is achieved through the use of CCTV cameras positioned close to the scene of the incident. The fact that this approach requires field installations module which is separate from the software module is a major limitation. This is because installation and maintenance of traffic monitoring systems on the roads can be quite costly. For example, the use of inductive loops, the most common traffic detection device, requires invasive road work during installation. Fig.1and Fig.2 below show the process of cutting and installing induction loops. As can be seen, cutting or maintaining inductive loop will involve some degree of inconvenience to commuters in addition to highlighting some safety concerns.

Fig. 1. Induction loop slot cutting

(Courtesy Missouri DOT Engineering Policy Guide for Sec 902.)

Fig. 2. Induction Loop Installation

(Courtesy Missouri DOT Engineering Policy Guide for Sec 902)

Heavy vehicles such as ploughs and snow-removal vehicles may also frequently damage loops, thereby, necessitating emergency maintenance work to be carried out. Such frequent necessary maintenance works tends to reduce capacity during busy times and this constitutes increased cost. Similarly, other traffic detection technologies based on above ground installations such as infrared or microwave detection systems does require additional infrastructure on which they are to be installed. What this mean is that the same capacity and safety issues pointed out earlier would result during their installation and maintenance. Additionally, data accuracy concerns, especially the average false alarms rate generated by these fixed traffic detection solutions, make them less attractive for some niche applications.

Due to the identified weaknesses of fixed traffic detection solutions, the quests to develop more efficient and accurate methods of collecting traffic data were initiated. Also, current government austerity measures are driving the demand for traffic data collection solutions with quicker implementation turnaround time and lower long term maintenance cost. The reason for this is not farfetched; traffic operating agencies want value for money, and so, solutions that ensures the quickest delivery of anticipated benefits tends to be more attractive to them. One solution that has captured the imagination of several road operating agencies around the world is the Cellular Floating Car Data Collection Technology (FCD). This innovative approach to traffic data collection based on anonymous extraction of location and speed information from mobile probes (mobile phone and/or GPS enabled device) in moving vehicles was well received by the ITS community. The anonymous data generated is then aggregated and enhanced to provide historic and real-time information on journey times and speeds. The advantages of this solution are enormous and include:

- Quick implementation turnaround time
- Lower overall cost of implementation especially for deployment over a wide metro area
- Highly scalable; can easily be re-configured and adjusted to include more roads
- It provides transport planners with a better view of urban traffic behaviour as input into Local Transport Plans
- Far greater coverage of the road network including arterial and collector roadway in addition to major roadways coverage can be cost effectively achieved
- Reduction of construction impact on traffic due to non existing road installations
- It provides a single unified platform for traffic data extraction, processing and traffic information dissemination to road users
- requires very limited infrastructure installation; non on the roads but few at cellular operator's premises

European countries have initially led the research into the potential of FCD solution, resulting in some trial deployments. Results from some of the trials were encouraging and have contributed to improvements in the quality of real-time information services that can now be provided to travelers. In addition to this, other applications such as O-D matrix estimations have been trialed to demonstrate additional values that can be realized from FCD technology. One of such early pilot implementations was announced in 2003 by the province of Noord-Brabant in Netherlands under the 'Better View for Brabant Roads' project [2]. This was implemented by LogicaCMG using mobile phone data obtained from the Dutch Vodafone network. A similar deployment was by the Flanders Government in 2004 which explores the potential opportunities for generating traffic information from mobile phone in moving vehicles [3]. This work was carried out by ITIS holdings, a leading UK traffic information company with data provided by Proximus, the leading Belgian mobile operator. This deployment, which started out as a pilot test, was eventually rolled out on a national scale in 2006. The results from these pilot tests were encouraging and there have been further development of the technology and many more deployments all over the world including in the Middle East, Europe, United States, Canada, Australia and Africa.

CELLULAR FCD PERFORMANCE

To date, many deployments have been carried out by several companies all claiming to produce data with the best accuracy and quality. However, very few of these can boast of a truly successful independent evaluation of its FCD solution. In the early years, many of the independent evaluation produced poor results, ranging from long delays in detecting incidents to completely failing to detect slowdowns. However, through lessons learned from various pilot projects, it has been possible to enhance the performance and accuracy of FCD systems. For example, recent FCD deployments by Cellint Traffic Solutions in both the US and Europe which were independently assessed by Departments of Transportations (DOT), demonstrated accurate local speed results with only a few minutes delay in detecting slowdown incidents. Specifically, test conducted by Kansas State DOT on Cellint deployed system produced less than 5 mph average local speed error (in all speed bands) and 5.9 minutes average delay in detecting slowdown in comparison to existing road sensors. Now, by analyzing and aggregating raw data consisting of travel time samples within small sections of road, it is possible to generate the following useful information [4]:

- Average speed over short road segments
- Average travel time between junctions
- Incident detection based on the sudden decrease in average speed over specific segments

The ability to generate these information from FCD suggests a significant improvement in the technology since the early trial deployments. Being able to derive the stated outputs from Floating Car Data implies that with some enhancements, it can be a rich source of historic, real-time and predictive traffic information. Also, information derived from FCD can be easily disseminated to road users via a variety of media. These include through websites, RDS radio alerts as well as via Interactive Voice Response (IVR) platforms. The information may also be disseminated as Multimedia Messaging and Short Message Services (SMS) to mobile phones. Furthermore, information derived from FCD may be overlaid on road maps to present a dynamic color coded real time traffic condition of the road network.

CELLULAR FCD LIMITATIONS

Despite the highlighted performance and benefits of FCD over traditional fixed traffic monitoring solutions, there are still some limiting issues. One of the key limiting issues is the perceived low level of data accuracy that is obtainable with FCD solutions. Although most FCD solution vendors argue that data obtained from FCD platform can be independently accurate, carefully combining it with traffic data obtained from other sources such as fixed sensors, ANPR and eye witness reports may result in more accurate information. Another major issue affecting the wide spread use of FCD in some locations is safety concerns regarding the use of mobile phone while driving. Some of the prominent FCD solutions require mobile phone (probes) in vehicles to be in use, thus generating safety concerns that FCD deployments might encourages drivers to use their phones while driving.

Privacy concerns by commuters have been another hindrance to the uptake of FCD. This is based on the premise that collection of location information from mobile devices could lead to infringement of the privacy right of the individuals concerned. Although, FCD solution vendors claims that only anonymous data is used to extract traffic information, some skeptics are still concern about the data handling process before, during and after anonymization. Recent events with regards to loss, theft or misuse of personal information from both public and private records have also made this a serious cause for concern. Yet also, another area of concern that has been identified is the lack of night time traffic detection from FCD. To this concern, FCD vendors have responded that in most cases there are fewer mobile probes available during these periods which make the data generated to be statistically insignificant. As an additional response, vendors have often stated that the demand and value of traffic information is greater during morning and evening peak travel periods and that a good FCD platform would meet this basic requirement.

As a result of these known issues, it is difficult to state expressly that FCD is a superior technology to fixed sensor solutions despite its many obvious benefits. However, FCD becomes the winning choice in certain niche applications where lower installation cost, high reliability and rapid deployment are more important issues than superior accuracy. The next section of this paper identifies in clear terms situations and conditions under which FCD implementation could offer the most benefit to road operating organizations, mobile operators and the general public.

A DECISION FRAMEWORK FOR FCD DEPLOYMENTS

It is important for stakeholders considering the implementation of traffic data collection solution to be well aware of its own context and objectives. Answers to questions such as those set out below could serve as a starting point for informed decision making on traffic data systems deployment:

- What is to be achieved?
- What benefits accrue?
- When does it have to be achieved?
- What budget is available for it?
- What options are there to achieve it?
- What are the longer term and short term implications?

The question on what is to be achieved is often either dictated by a problem or an opportunity that requires attention. This could range from a traffic data collection strategy to help with road management and planning activity to capitalizing on the traffic information market gap by private entities. Answer to the question on when it needs to be accomplished could range from weeks to several years depending on who is trying to answer the question. For example a mobile operator might see opportunity now while an operating agency monitoring traffic trends may predict that a proactive effort might be needed to prevent long term traffic management issues. Therefore, while a traffic management agency is thinking long term in years, the mobile operator might be thinking in weeks.

The relationship between cost or available budget and quality is quite a tricky one. With reference to traffic data collection, having data from a handful of reliable sources and carefully combining these ensure a data quality that surpass that which is obtainable had a single source been considered. A simple way to achieve this is by harnessing the unique advantages of each data source during the merge process. However, setting up multiple sources of traffic data as a way of obtaining superior data quality and accuracy could lead to a spiraling of the cost of delivering the intended solution. With limited budget, a wise move is to consider alternative approaches and the benefit of one solution approach over the other. The key is finding a solution approach which gives the most benefits at the least cost possible or within the remit of available budget.

The ideal traffic data collection system is expected to deliver incident detection services, travel time information, average speed information over road sections, origin destination data as well as junction delays. It should also be possible to deliver volume and lane counting services as well. Therefore, to accomplish these, a series of solutions deployed in tandem is often required as no single solution accurately meets these set of objectives. However, in the face of limited funds and the need to obtain the best return on investment, road management organizations have to decide on the most important services or applications required from traffic data collection solution deployment. This might mean favoring one solution over the other or deploying more than one solution to meet the varied requirements. Fortunately, there are a few FCD solutions that can meet several of these requirements albeit with potentially reduced accuracy. Hence, in order to deploy FCD as an option, operating agencies must have a clear idea of what services or applications align mostly to their objectives. These complexities make deciding on and setting the bar on expected benefits from FCD deployment quite challenging.

CELLULAR FCD BEST USE CASE SCENARIOS

Described below are some ideal case scenarios where the implementation of Cellular Floating Car Data technology is expected to bring about the most benefit in comparison to other competing traffic data collection and information dissemination solutions.

USE CASE 1: LOCATIONS WITH POOR INFRASTRUCTURE BASE

Some locations lack the basic electrification and communications infrastructure base, especially, along or close enough to the road network. This is characteristic of the situation in many developing countries. As a result of this, setting up and maintaining data traffic sources such as loops and other traffic detection system necessitating infrastructure installation close to the road network could be prohibitively expensive. The lack of adequate base infrastructure also prevents the use of electronic driver information signs and enforcement systems such as speed cameras. Such locations however tend to rely mostly on wireless communication systems for most of their communications need. These locations will benefit greatly from the deployment of cellular floating car traffic detection solutions especially from cost and rapid deployment perspectives. This is because the basic infrastructure required for FCD deployment is the cellular communication network and coverage which should most likely be already available. With data from FCD system, operating agencies will have solid evidence for informed decision making with regards to their traffic management and transport planning responsibilities. Advantages will also accrue in the area of information dissemination to drivers as FCD tends to lend itself easily to transmission via multiple delivery channels such as via radio, navigation devices, mobile phones and other web enabled devices. FCD solution vendors would do well to consider exploring the market potential of their product in these locations.

USE CASE 2: AS AN ADDITIONAL SOURCE OF TRAFFIC DATA

In cases where there are existing fixed traffic sensor installations, a need to improve the quality of data available by combining unique characteristics of data from multiple sources may arise. For example superior data may be obtained by combining the unique advantage of continuous data generated from FCD with point detection data from fixed sensor sources. This might be required in order to provide specific service or applications that would otherwise not have been achievable from existing sources. For example a road authority that relies on loop installations spaced 500m apart may decide to improve journey time prediction services to the commuting public by deploying FCD system which can provide high definition traffic information using virtual sensors or probes set at 250m or less apart. Another requirement might be to have a rich source of continuous mass traffic flow data which can be processed to provide a more granular view of the road network's performance.

USE CASE 3: MARKET NEED FOR TRAFFIC INFORMATION OVER A WIDE GEOGRAPHIC AREA

For agencies willing to deploy traffic detection solutions across wide geographical area such as states, regions or countries, Cellular FCD offers the most cost effective way to accomplish this. The alternative of installing road sensors or ANPR cameras every 500m or so, on all roads across the network over an entire region, metropolitan area or country is likely to be prohibitively expensive. In such cases, leveraging on the existing mobile communication infrastructure coverage will ensure that the objective of wide area coverage can be accomplished at a reasonable cost. Many mobile operators across the world have since awakened to the opportunities to provide traffic information as a value added service to their subscribers. Therefore, it is increasingly common to find governments' road agencies forming partnerships with mobile operators to deliver traffic information services to the public. Another model sees mobile operator doing it all by themselves as a unique service to increase their revenue. This has helped mobile operators like Vodafone UK to reduce customer churn and to boost its Average Revenue Per User (ARPU).

CONCLUSION

It is fair to say that FCD is a mature technology irrespective of the few concerns and limitations that are associated with it. As more FCD solutions are deployed all over the world, the vendors have gained more experience and have been able to improve the technology year on year in terms of performance, the quality of generated data and its applications. For organizations looking to deploy FCD solution, care should be taken to ensure that its unique requirement can be met with the technology and that the deployment will fit into the overall organization's strategy. Answers to some of the key questions presented here can be used as a guide by the organization to be well aware of their own context and based on this awareness, a comparison analysis can be embarked on to determine how closely aligned to one or more of the best use case scenarios suggested here is the organization's context. In situations where adequate knowledge about FCD is lacking, it might be wise to employ the services of seasoned independent traffic experts who could help carry out the analysis of the organization's requirements against what FCD or rival technologies can potentially deliver. Either way, organizations wishing to deploy traffic detection and information services whose situations are closely aligned to one or more of the best use case scenarios presented would benefit more from FCD deployment.

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