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Towards a Better Urban Mobility

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Abstract: A real-time road traffic monitoring system based on mobile telephone network usage and cell switching for easy mobility is presented here. Existing road traffic management system demands installation of sensors, which are expensive, many roads in developing countries are not equipped with such sensors. The present paper explores the possibilities of using cell-switching data from cellular networks to monitor real time traffic management and in turn, help in better urban mobility. As every road user on a car is also a sure user of cellular network, one can use network usage and cell-switching information to monitor the traffic conditions. Mapping road networks to this information help us to optimize urban dynamics. This service if implemented can save lot of money on urban infrastructures.

Keywords: *Vehicles traffic, Transport management, Cell-Tower, Roads.*

Introduction:

Haphazard growth of cities is a matter of great concern in developing countries. Due to the exponential growth in inhabitants and vehicles traffic congestion is enormous. Hence it is the need of the hour to upgrade Transport management systems to cope with increasing mobility demands of persons and goods. Maximizing the utility of moving people and goods while minimizing the cost. Traffic congestions also cause air pollution and greenhouse gas emissions. Economic losses due to road congestion is considerable in developing countries. Optimal use of the road can save individual's time and money can also provide sustainable mobility. Existing traffic management system makes use of sensors and other sources of traffic information for monitoring current traffic conditions. As these sensors are expensive, it can only be installed on selected locations in selected cities. This is not viable for smaller cities and towns. Added to that traffic tracking outside the cities in the large span of areas need to be covered. A high density of sensors on these roads can only be achieved with high costs. Inside cities the road density is very high and there are lot of traffic signals that interrupt a free flow. Webster, (1958), the fact that traffic density will continue to grow and calls for efficient traffic guidance policy and systems to perform real-time load balancing that should result in an optimization of the overall traffic flow through the available road infrastructure Disange, (2000). A study of the dynamics of the citizens' daily mobility patterns is needed for the planning and management of urban infrastructures. Real time analytical techniques for spatio-temporal data of daily travel patterns inhabitant in urban areas help us to arrive at better urban mobility. Also compatibility with the existing traffic management infrastructure also has to be kept in mind. The present paper tries to quantify, visualize and examine urban mobility patterns spatially and temporally using cellular network signaling to provide real time decision support for the city. We know that each road user on a car is also a potential user of a cellular network, obviously one can consider mobile service provider as an alternative source of road traffic information. The use of cellular networks for estimating patterns of human mobility is largely unexplored. Within a mobile phone network, a data generated is record every time a phone hands over from one cell tower to a connecting cell tower. Further, as cell towers are fixed in their location, it is possible to accurately determine the intersection areas of the cell tower coverage on a map. By combining the handover event and cell tower intersection areas, it is possible to determine possible paths of a phone through a mobile phone network. Overlaying this information with a navigation quality digital roadmap, an analytical engine can determine the potential paths of vehicles through the road network. When this data is generated for many potential paths, patterns of road traffic information can be created. This information is then augmented with GPS probe vehicle data to assist in calibrating the setup.

Survey of Existing Traffic Management System:

Currently, data collection is done by road operators by using road sensors, cctvs, and emergency calls from road users as shown in figure 1. The measured data are sent to a control unit which also has access to road infrastructure data and can map measured values to road segments. The subsequent processing produces a picture of the current traffic conditions. It is then forwarded to third party entities for the final dissemination to the road users through traffic police communication means. This approach presents a cost hurdle: a complete coverage of the road network would not be possible without the deployment of new infrastructure Gonzalez, et al. (2008). In addition, Traffic management system must also suggest alternative routes to avoid congestions or by temporal speed limits to optimize traffic throughput. Because alternative routes are not mandatory for travelers, commuters and drivers, traffic flows can only be influenced within certain limits Herman, (1992).

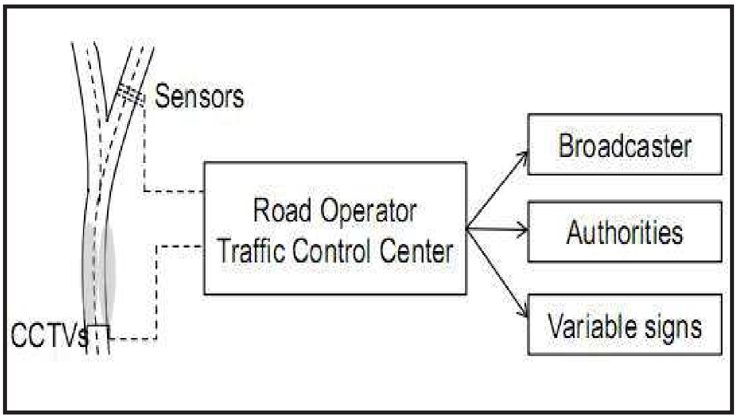

***Figure 1:** Conventional System for Road Traffic Data Collection*

A Framework for Better Traffic Management:

A cellular network is a radio network distributed over land areas called cells, each served by at least one fixed-location transceiver known as a base station. Large geographic areas are split into smaller cells to avoid line-of-sight signal loss and to support a large number of active phones in that area. When joined together these cells provide radio coverage over a wide geographic area. This enables a large number of portable transceivers (e.g., mobile phone, smart phones, etc.,) to communicate with each other and with fixed transceivers and telephones anywhere in the network, via base stations, even if some of the transceivers are moving through more than one cell during transmission. Providing services when the subscriber is in move through different cell towers is called cell switching. As each road user on a car is also a potential user of a cellular network, it is natural to consider mobile operators also as road traffic information service provider. Better cellular technologies like 3G with features like GPS and mobile GIS led to the idea of using mobile networks to monitor the road traffic. Overlaying Traffic management infrastructure on top of the cellular network consists of several steps. Location and mobility data needs to be collected first. The collected information is then sent to a processing unit. This along with the help of geographical maps, signal strength maps, and other data/information available to the cellular operator, filters out data related to non-road users. Finally users of different roads are differentiated and the road traffic condition inferred out of the collected data and then distributed to the system users. These steps are depicted in figure 2.

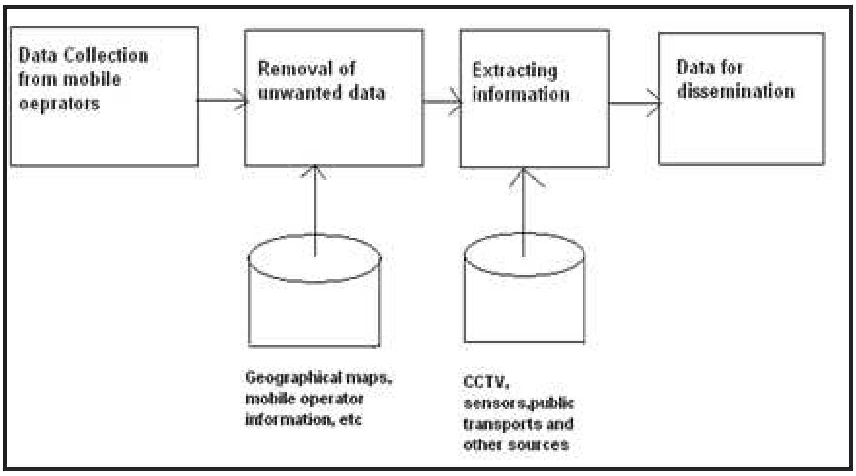

Figure 2: *Overlaid Traffic Management System above Cellular*

(A) Distinguishing Static users:

Static cellular users (neither commuters nor travelers) present specific characteristics as they confined into a single Cell for considerably longer periods in comparison to dynamic users. Hence, active users can be identified easily by cell update rate Puntumapon and Pattara-atikom (2008).

(B) Road Condition Estimation:

The road estimation module performs the mapping of the signaling information to the road conditions and rises warnings in case of relevant deviations for the anomalies (unexpected changes). The knowledge deduced from these abrupt changes is that, it may be a signal of road anomaly (accident). For instance a drop in the handover rate or a drop in the specific cell updates.

(C) Mapping Events on the Road to the Events on the Cellular Network:

The purpose of the setup is to map events on the cellular network to events on the road network. In order to achieve this, two software modules run in sequence on the processing unit. The first module takes input network events like mobility and activity patterns of users and selects data concerning road users on the road of interest. The output of first module is then processed by the second module in order to infer the road traffic condition. Finally empirical studies must be made with GPS probed vehicles for mapping on weekend days as substantial differences are evident on these days and in turn calibrate the setup.

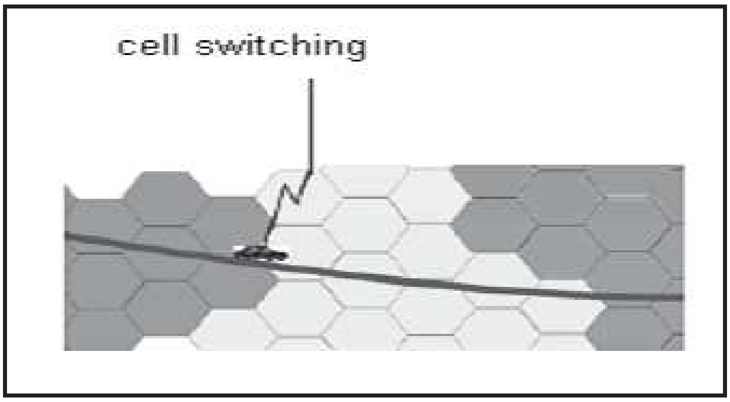

Figure 3: *A mobile User on Car*

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