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Real-time traffic speeds on South African roads: the technology, applications and possibilities

The advent of commercial GPS technology and the inexpensive wireless transfer of bulk data via GPRS, coupled with a large installed base of vehicles tracked for security / recovery purposes, have facilitated anonymous real-time traffic speed monitoring on the country's roads. In this article the underlying technologies are explained and the development of a system which graphically displays average speeds and current journey times is described. Other applications, actual and potential, are also discussed

DEFINITIONS AND ACRONYMS

For definitions of terms, and an explanation of the acronyms associated with the various technologies, please refer to the list at the end of the article.

REAL-TIME TRAFFIC SPEED

The ability to measure / monitor the speed of traffic in real time[1] gives a unique insight into the performance of a road network. This in turn facilitates more effective operation and management of the network, and identification of areas where improvements are required. And, as traffic speed and journey-time are experienced directly by road users, the measurement of these factors provides an objective tool for user-centric performance evaluation of the road network.

GPS-BASED VEHICLE TRACKING

Early vehicle-tracking systems used terrestrial wireless technology, with the position of the tracked vehicle being inferred from triangulation of signals received by antennae installed at known locations. Not only did this require the deployment of dedicated antennae and receivers on a very wide and costly scale, it also only facilitated approximate location of the tracked vehicle.

When non-military devices utilising GPS technology started appearing in the late 1990s, the potential application of this system to vehicle tracking and recovery was obvious. But the problem remained of how to remotely monitor the location of tracked vehicles economically. The digital cellular communication network provided a solution to this problem, with tracking companies initially making use of the short message service (SMS) facility for the exchange of data between tracked vehicles and monitoring centres. The age of 'vehicle telematics' had dawned.

The high cost of SMS messaging necessitated very judicious use of this technology, i.e. the frequency of communications between the tracked units and the monitoring centre had to be carefully managed in order to keep costs down. In effect, the tracked units only reported their position when a specified event (e.g. unauthorised starting of the vehicle, or a message from the monitoring centre) switched the device into reporting mode.

The picture changed with the appearance of GPRS, which facilitated the economical exchange of larger volumes of data between tracking units and the monitoring centre. This allowed for continuous tracking of vehicles, under both normal and 'emergency' conditions (although the reporting frequency is typically higher under emergency conditions).

Tracker adopted the GPS / GPRS technology aggressively, and now has more than 150 000 installed units of this type

throughout South Africa[2]. Tracker also took the decision to adopt a high reporting frequency (typically two minutes under normal conditions) for the GPS-based units. This results in some 15 million reports being received daily from these units by Tracker's monitoring centre.

THE *TRAFFICTRACKER*™ SYSTEM

The enormous volume of data received by the monitoring centre presents a unique opportunity for aggregation and analysis. The *TrafficTracker* system was developed to use the data to generate a graphical display of average traffic speeds on the urban freeways in Gauteng, greater Durban and greater Cape Town, and also on the N3 route between Johannesburg and Durban. In the case of Gauteng, the system also calculates current journey times between major nodes on the network.

Only 'anonymous' data that is relevant to the determination of network speeds is used, i.e. time, location (GIS coordinates), heading and instantaneous unit speed. All personal information and all unique identification relating to the data source are removed before processing. A decision was also taken to eliminate data originating from heavy vehicles, as it was felt that these vehicles would artificially suppress the average network speeds under free-flow or near free-flow conditions.

The first stage of processing involves the association of data points with relevant segments of road. Data is assembled for each segment in five-minute periods. At the end of each period, the average speed for each road segment is determined, using a time-weighted formula. This is done to ensure that the latest speeds are reflected, which is of particular concern in cases where the traffic conditions on a segment are changing rapidly, for example due to the occurrence of an accident.

For convenient graphical representation, average speeds are grouped into one of four categories and colour-coded accordingly. In cases where no average speed is available (due to paucity of data) the relevant segment is not colour-coded.

Figure 1 shows average speeds on freeways in greater Johannesburg as represented by the *TrafficTracker* system at 5:00 pm on Tuesday 12 July 2011.

In addition to average traffic speeds, the system also shows (by means of appropriate icons) the location of known incidents, including roadworks, accidents, stationary vehicles, etc. (Incident information is sourced from TrafficNet's incident database, having been received from road users, emergency services, etc, and verified by TrafficNet.)

The numbers alongside the carriageways in Figure 1 reflect current journey times between major nodes on the network[3]. These journey times are computed by summating travel times for each road segment in the journey, based on the computed average traffic speeds. For comparative purposes, the corresponding 'best' journey times have also been computed, based on the applicable legal speed limit(s).

It could be argued that, from a theoretical viewpoint, the relatively small sample size of around 1,5% (tracked vehicles vs total number of registered vehicles) presents a weakness. In practice, however, roads carrying high volumes of traffic, and zones of congestion (associated with slow-moving traffic) inexorably result in higher tracked-vehicle densities and therefore higher volumes of real-time speed data. The result is that the best data is available for the roads and zones that are of the greatest interest.

Significantly, after more than two years of use, it has been found that the system is very reflective of actual conditions (and particularly congested conditions) on the freeways covered, as reported by road users on the affected roads.

CURRENT AND POTENTIAL USES OF REAL-TIME TRAFFIC SPEED INFORMATION

The *TrafficTracker* system, which came into use in late 2008, has been used by TrafficNet, SA's largest independent provider of traffic information and reports to the broadcast industry, to enhance the scope and accuracy of its information, and is also used by a major network operator as a supplementary source of information on the urban freeway network.

TrafficNet has found that eyewitness reports of accidents and incidents on freeways, particularly during busy periods, are rapidly confirmed by a lowering of the average speed on the affected road(s). Conversely, a rapid reduction in average speed is often indicative of the occurrence of an incident, the nature of which is subsequently established through contact with the relevant network operators, traffic authorities or emergency services.

The system also provides an accurate indication of the extent to which an incident is affecting traffic flow, both on roads directly affected by the incident and on other roads (or other carriageways) as a result of 'spectator value'. Similarly, the clearing of incidents and the associated return to 'normal' traffic flow conditions can now be established with a much greater degree of certainty than was previously possible.

1 Average speeds on freeways in greater Johannesburg as represented by the *TrafficTracker* system at 5:00 pm on Tuesday 12 July 2011

For a network operator, the system provides an early warning of abnormal conditions, and facilitates improved response times to incidents, including the location and timing of freeway closures necessitated by the occurrence of major incidents. It also highlights systemic problem areas on the road network.

Real-time traffic information derived from tracked vehicles, together with incident information sourced by TrafficNet, is providing significant input into the live traffic capability that became available on TomTom™ connected[4] PNDs in mid-2010. This is a 'game-changing' application, which gives road users the full benefit of country-wide historic and real-time current traffic data for all classes of road, and computes optimal routes on-the-fly[5].

Navigation incorporating real-time traffic speed information is also becoming available on other platforms, such as smart phones.

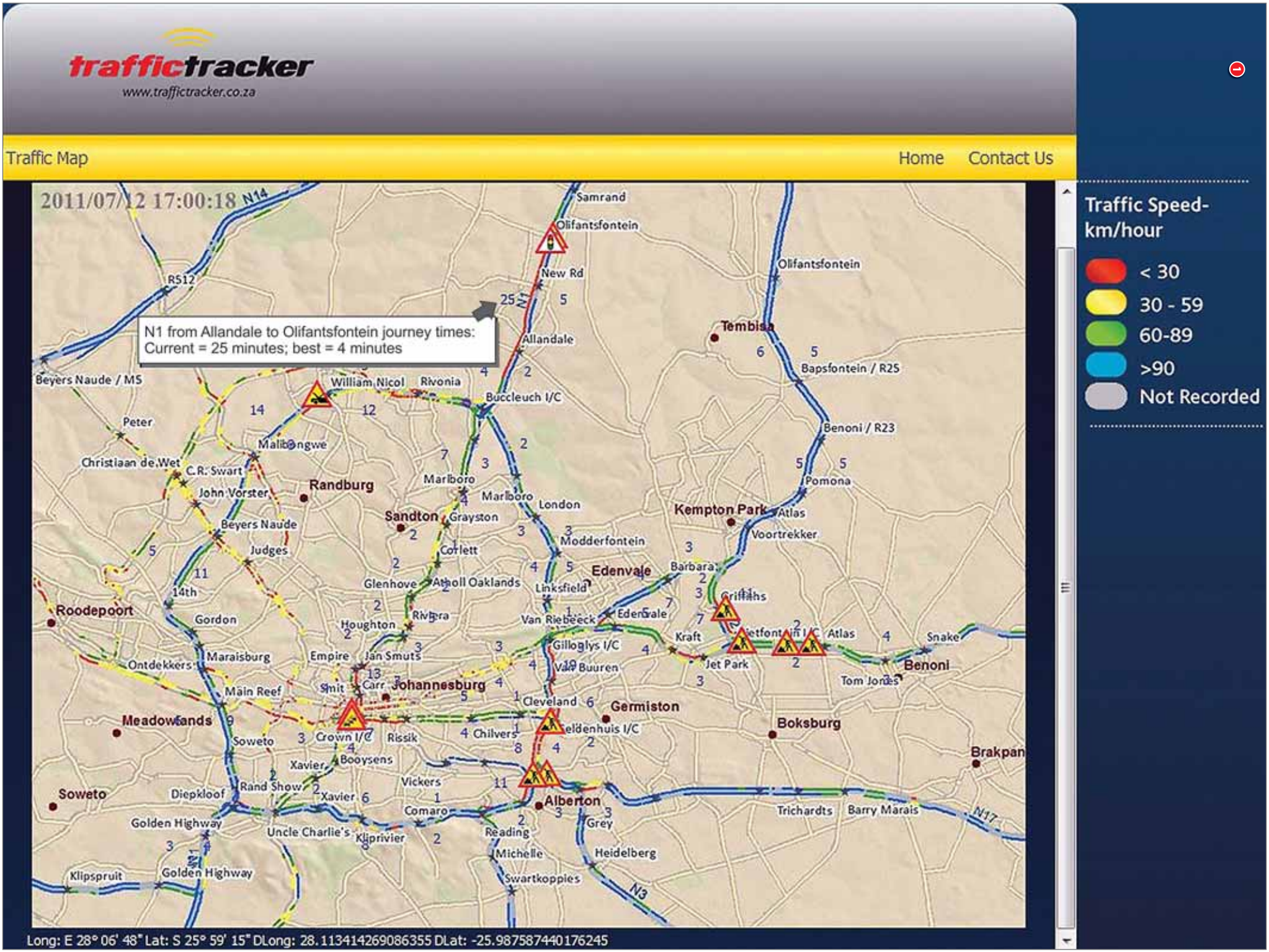
Current journey times on key stretches of the Gauteng freeway network, computed in the manner described above, will soon be made available to road users by means of electronic advertising billboards located at or near the freeways or on-ramps.

Applications currently under investigation include the adaptive control of large signalised intersections on the basis of real-time vehicle monitoring, and the use of historical traffic speed information as a benchmark to facilitate performance assessments associated with physical improvements to the road network.

DEFINITIONS AND EXPLANATION OF ACRONYMS APPEARING IN THIS ARTICLE

GIS: Geographical / Geospatial Information System.

GPS: Global Positioning System. Space-based global navigation satellite system that provides location and time information anywhere on or near the earth, where there is an unobstructed line of sight to


traffictracker
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2011/07/12 17:00:18
N1 from Allandale to Olifantsfontein journey times:
Current = 25 minutes; best = 4 minutes
Traffic Speed-km/hour
< 30
30 - 59
60-89
>90
Not Recorded
Samrand
Olifantsfontein
New Rd
Allandale
Tembisa
Bapsfontein / R25
Benoni / R23
Pomona
Kempton Park
Atlas
Voortrekker
Modderfontein
London
Marlboro
Grayston
Sandton
Randburg
Beyers Naude / M5
Peter
Christiaan de Wet
C.R. Swart
John Vorster
Beyers Naude
Judges
14th
Roodepoort
Gordon
Maraisburg
Ontdekkers
Main Reef
Meadowlands
Soweto
Diepkloof
Golden Highway
Klipspruit
Uncle Charlie's
Klipriver
Xavier
Booysens
Rand Show
Vickers
Comaro
Reading
Michelle
Swartkoppies
Heidelberg
Alberton
Grey
Trichardts
Barry Marais
N17
N3
Brakpan
Boksburg
Germiston
Cleveland
Johannesburg
Crown I/C
Rissik
Chilvers
Houghton
Empire
Jan Smuts
Van Buuren
Gilloglys I/C
Edenvale
Linksfield
Van Riebeeck
Kraft
Jet Park
Benoni
Tom Jones
Snake
Griffiths
Barbara
Glenhove
Atholl Oaklands
Corlett
Malibongwe
William Nicol
Rivonia
Buccleuch I/C
R512
Long: E 28° 06' 48" Lat: S 25° 59' 15" DLong: 28.113414269086355 DLat: -25.987587440176245

four or more GPS satellites. It was initially developed by the United States for military purposes, and civilian use was somewhat restricted until May 2000, when users were permitted to receive non-degraded signals, facilitating accurate location.

GPRS: Global Packet Radio Service. A mobile data service utilising grouped blocks of data or 'packets'.

SMS: Short Message Service. The text communication service component of phone, web or mobile communication systems, using protocols that allow the exchange of short text messages between fixed line or mobile phone devices.

PND: Personal Navigation Device. Often referred to colloquially as a 'GPS' or 'satnav'.

Tracking unit: Electronic device installed in a vehicle that allows for the location of the vehicle to be monitored remotely.

Monitoring centre: Facility operated by a vehicle tracking company, where the location of tracked vehicles is monitored.

Heading: Direction of travel, measured in degrees clockwise from map north.

Mapset: A set of GIS data that is used for display and analysis of geographic features. Due to the constant change in the road network, mapsets have to be updated regularly.

Segment (road): A section of road between intersections or other points (for example freeway off-ramps).

Vehicle telematics: The integrated use of telecommunications and information technology for application in road vehicles and for control of vehicles on the move.

NOTES

[1] More precisely, 'near' real-time, as there is inevitably a delay between measuring and reporting data; in the case of the *TrafficTracker* system the delay is between three and five minutes.

[2] Tracker still supports a very large base of legacy units based on terrestrial wireless technology.

[3] Journey times are rounded up to the nearest minute.

[4] These devices both receive and transmit data via the cellular network, and are themselves anonymous sources of traffic data.

[5] The devices receive updated traffic information every two minutes. □

Source:
http://www.saice.org.za/downloads/monthly_publications/2011/2011-Civil-Engineering-september/#/0