A COST EFFECTIVE PUBLIC TRANSPORT MANAGEMENT SYSTEM FOR GO!DURBAN

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ABSTRACT

The eThekwini Transport Authority (ETA) is implementing an Integrated Public Transport Network (Go!Durban) which is essentially a traditional BRT system. Go!Durban requires a Public Transport Management System (PTMS) in order to monitor the performance and compliance of the BRT operator and provide real time information on the BRT system.

In 2014, the ETA advertised a tender for an Advanced PTMS. The lowest tender to specification was priced at around R350 million. This was deemed too expensive, and the tender was not awarded. Subsequent to this, in 2018 the ETA commenced discussions with Netstar, the current eThekwini fleet management contractor, to extend their fleet management system to include compliance monitoring, thus meeting the core functionality of a PTMS.

The Go!Durban team developed a minimum User Requirements Specification (URS), based on the original ETA APTMS specification, which Netstar then used to map their proposal and cost estimate to develop the system. The system is being developed in two phases with a Proof of Concept or Pilot phase, building on their existing system functionality, followed by a Phase 2 to address the gaps in the APTMS minimum URS – essentially functionality that required further development.

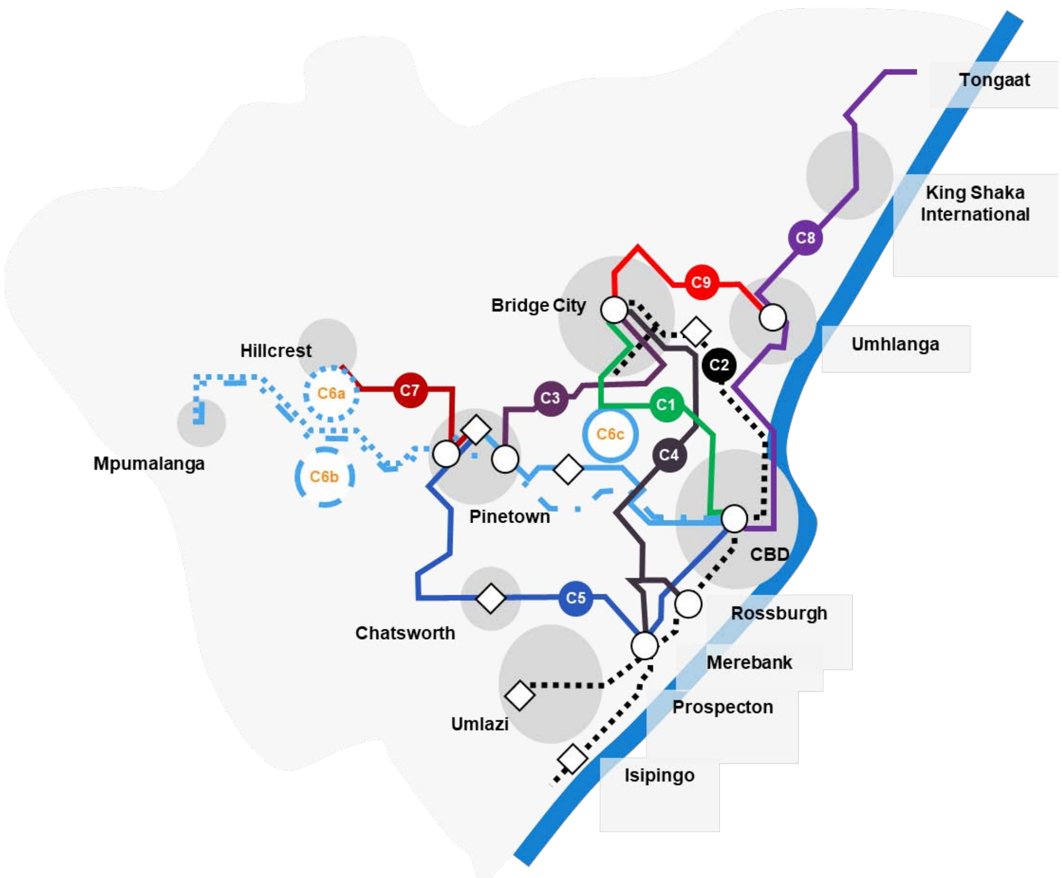
Based on the Netstar fleet management system, the ETA has thus developed a cost-effective PTMS to support the operations of the Go! Durban Integrated Public Transport Network (IPTN). This PTMS Lite system provides the essential functionality of the traditional PTMS at a fraction of the cost. The ETA PTM Lite System is a tool to manage bus movements against a static timetable on the Go!Durban corridors and provide appropriate reporting and bus communication for the Transport Operator.

In order to drive down operational costs (and therefore subsidies) ITS practitioners have a significant role to play in looking for cost effective solutions. The Netstar system presented here offers significant cost savings for capital and operating budgets. It offers an application centric solution for passenger information and provides all the essential functionality of a traditional APTMS at around a tenth of the cost. This should assist planners in their quest for a more financially sustainable public transport system.

1. INTRODUCTION

The eThekwini Transport Authority is implementing an Integrated Public Transport Network (Go!Durban). Go!Durban is funded by the Public Transport Network Infrastructure & Systems Grant (PTISG). Go!Durban is not only a traditional BRT system but is part of a Vision that has been developed for Go!Durban: ***An Integrated Portfolio of Mobility*** that includes several aspects of mobility as depicted below:

The Go!Durban Network consists of eight road corridors, a rail corridor, bus terminals, stations, bus stops, transfer precincts, depots and a new fleet of vehicles. The various management and ITS required to manage and operate the Go!Durban integrated network are planned to be linked to a Traffic Management Centre via a fibre network.



In 2014, the ETA advertised a tender for an Advanced PTMS. The lowest tender to specification was priced at around R350 million. This was deemed too expensive, and the tender was not awarded.

Subsequent to this, in 2018 the ETA accepted a proposal from Netstar, the current eThekwini fleet management contractor, to extend their fleet management system to include compliance monitoring, thus meeting the core functionality of a PTMS.

This paper presents:

(i) Objective of the PTM Lite System.
(ii) High level methodology adopted to develop a PTM Lite System.
(iii) The functionality of the PTM Lite System.
(iv) Identified gaps and a strategy to deal with the gaps in the functionality.
(v) Performance and lessons learnt.
(vi) A cost comparison of the PTMS Lite versus traditional APTMS.
(vii) A summary of benefits for South African cities.

2. OBJECTIVE OF THE PTM LITE SYSTEM

The ETA PTM Lite System is a tool to manage bus movements against a static timetable on the Go!Durban corridors and provide appropriate reporting and bus communication for the Transport Operator. The current user interface uses a tabular representation of the Block and Run Status's with real time viewing of bus locations using the AVL system.

Passenger Information is limited to data feeds to 3rd parties such as Google Maps and other smart phone applications.

3. METHODOLOGY USED TO DEVELOP A PTM LITE SYSTEM

The Go!Durban team developed a minimum User Requirements Specification, based on the original ETA APTMS specification, which Netstar then used to map their proposal and cost estimate to develop the system. The system is being developed in two phases with a Proof of Concept or Pilot phase, building on Netstar's existing system functionality, followed by a Phase 2 to address the gaps in the APTMS minimum URS – essentially functionality that required further development.

The Pilot phase was implemented and tested on the three People Mover routes using existing timetables as the Go!Durban C3 corridor is not yet operational. Phase 2 will be developed using the Go!Durban C3 corridor.

4. THE FUNCTIONALITY OF THE ETA PTM LITE SYSTEM

A summary of the solution's capability to meet the Go!Durban's minimum APTMS requirements is as follows:

Table 1: Basic Functionality

Function	Commentary on solution
Capture, edit or import of bus schedules	Uses pre-scheduled static timetables in spreadsheet format
Driver voice communications	GSM voice communications via a separate hands-free kit
Driver messaging	Data messaging via driver terminal
Automatic Vehicle Location	GPS only (no dead reckoning)
Compliance monitoring	Specific KPI's defined for checking VOC performance (schedule adherence and Km operated)
Operations and compliance reporting	Specific Reports defined
Data interfaces to other systems	Standard AVL API feeds
Driver login	Bus won't start unless driver logs in

4.1 Solution Overview

The ETA solution overview is presented in Figure 1 below:

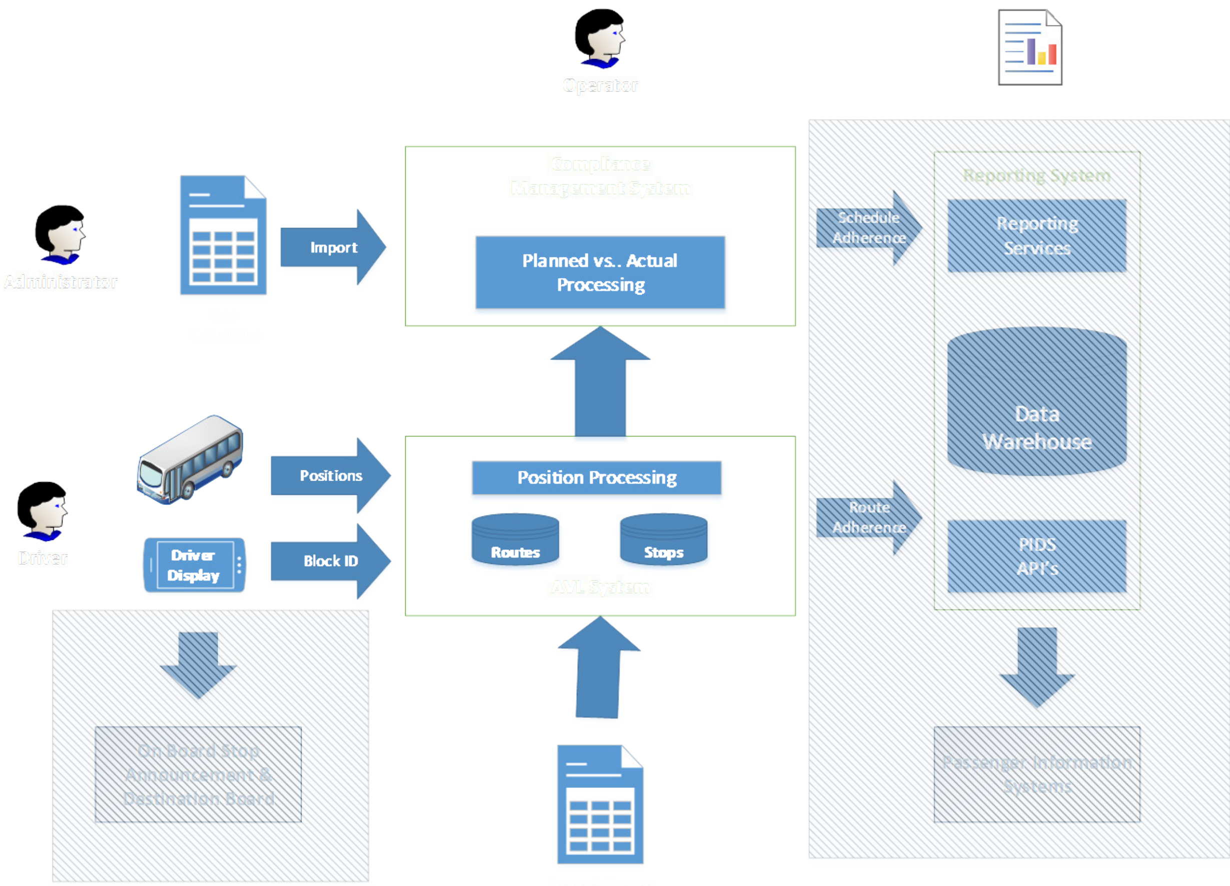


Figure 1: High Level functions currently functional (greyed areas unsupported)

The system comprises AVL and CMS applications running in MS-Azure. User interfaces are web-based. All buses are equipped with Android-based touch-screen terminals and GSM hands-free kits for voice communications.

The Concept of Operation for the system is as follows:

1. The Bus operating schedules are imported into the CMS as Blocks, Routes and associated Trips using CSV files, alternatively edited online on the CMS system.
2. The GIS data associated with the schedules with respect to Depot, sleeping grounds, passenger stop and route corridors are captured directly on the AVL system or imported during setup.
3. The Driver Console is used by the driver to enter Block and Run to link these with bus and driver for monitoring.
4. The driver console will indicate to the driver the schedule details (timetable), however messaging, estimated time of arrivals and navigation is excluded in this phase.
5. The AVL equipment installed in the busses transmit positions on a regular basis; these positions fed into the Vigil Plus AVL and CMS platforms for real time route and stop processing.
6. The processed data on the CMS dashboards provides the operator the current bus status and compliance against the schedule.
7. All operational data is stored so that basic reports can be generated (4 reports containing specific details were defined for the pilot project).

Passenger Information Display Systems are limited to smartphone applications. The system supports a static GTFS feed with proprietary API for real time bus positions from the AVL system. A real time GTFS feed is planned for Phase 2 so that Google Maps can display full transit information.

There is no on-board vehicle integration for Next Stop Announcements and Destination Board integration. Similarly, Station-based Passenger Information Display solutions are excluded.

Strip Maps, Go!Durban route adherence and integrated bus location views are excluded from this phase.

4.2 Component Descriptions

The PTM Lite system comprises of existing Netstar systems that require configuration and extended functionality to meet Go!Durban’s requirements. These components are described in detail below.

4.3 Compliance Management System

The schedules (timetables) imported into the compliance management system provide a baseline for compliance measurement. The system uses a template for manual importing as well as the ability to edit on the system. The basis of the import which includes Block, Runs and Stops as well as pull out times and servicing depots.

The imported schedule provides the baseline against which the system measures the bus’s compliance from a time and sequence adherence perspective. The system includes Go!Durban set tolerance settings against which a bus is considered Early, Late or Did Not Operate (DNO) and supports view filters enabling controllers to identify and manage exceptions. This is particularly useful given there are multiple buses operating concurrently.

The following diagram is a view of the tabular block / route / trip layout that will be imported to provide the schedule compliance baseline.

Four compliance reports are currently generated:

a) Compliance per Route.
b) Compliance per Shift.
c) Compliance per Schedule.
d) Did not Operate.

These reports can be exported to Excel and filtered for user defined criteria. The reports are used as a basis for payments to the bus operating company. If any of the information is disputed, each trip is tracked and archived so that the exact route can be examined.

The APTMS outputs from other BRT systems in South Africa (My Citi, Rea Vaya and Areyeng) were reviewed and the output specification for the Netstar PTM Lite System was based on these, so there is some form of consistency within South Africa, although there is not an specific industry standard. The outputs of the system in terms of late departures, kilometres travelled and deviations need to be standardised for the specific type of contract management that Go!Durban has specified which may well differ from other cities in South Africa.

Any AVL tracking system can be used as long as the outputs are consistent for that particular contract monitoring system.

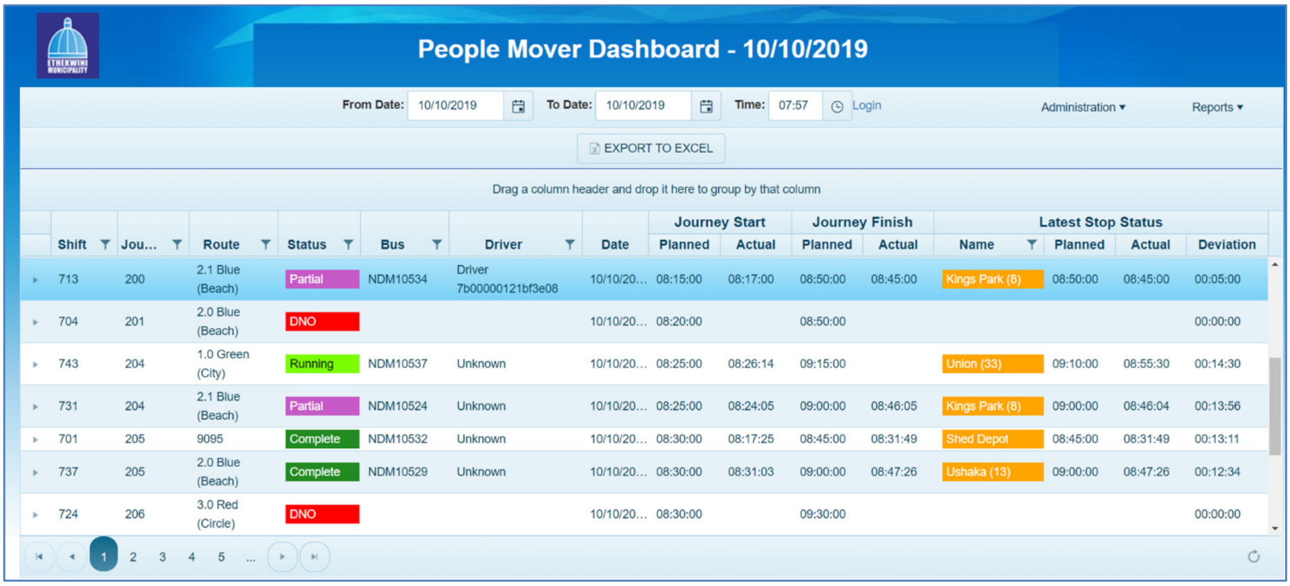


Figure 2: Compliance Monitoring Dashboard

All Blocks with their underlying Trips commence the day in a "pending" status by default and thereafter updated as the Trip progresses.

Filters and Export options allow the controller to view or extract data for all routes for the day based on the column filters i.e. Block #, Run # status, driver, vehicle, event Status.

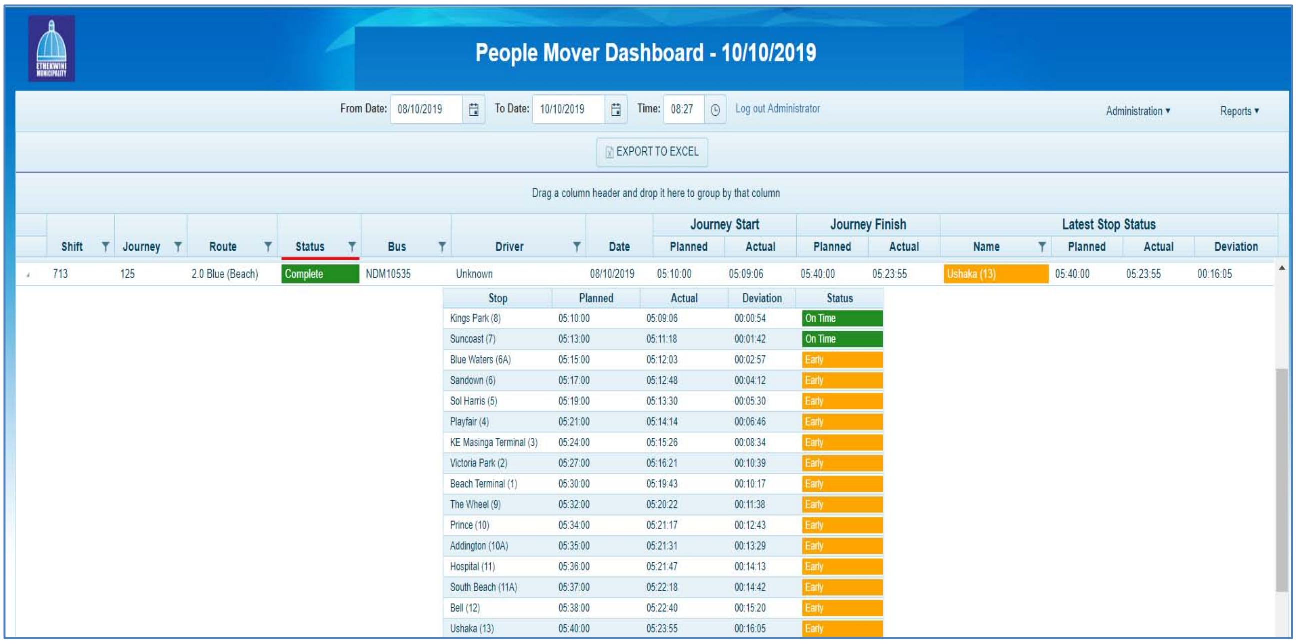


Figure 3: Compliance Monitoring with Individual Trip expanded

Table 2: Trip Status displayed by CMS Dashboard

Block and Run Status - • Signed On / Off – Driver Logged On / Off Driver Console • Pulled Out – Depot departed en-route to departure stop • Running – Departed route starting point (+Hysteresis) • Complete – Located at route end location • DNO – The bus did not operate i.e. reach any stop within a maximum time window threshold. Event Status – • Early – Event prior scheduled time window • Late – Event after scheduled time window • On Time – Event within scheduled time window

4.4 Driver Console

The Android-based Driver Console ensures the driver is recorded by the system and provides him / her with information for timekeeping along the route. It currently does not provide navigation or alternate route assistance.

The following screen shots show the functionality provided:

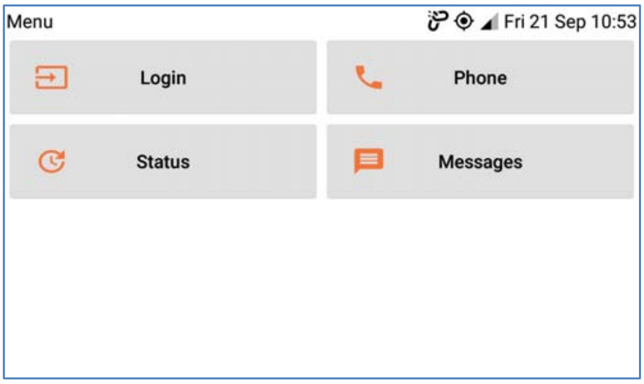


Figure 4: Driver Terminal Home Screen

The driver login screen requires a login before the bus can be started – this ensures that the driver ID is registered on the system. The system was tested, during the POC, with automatic Block allocation, however various issues prompted the decision to disable the vehicle from starting until login is completed on the AVL system.

Once logged in, the driver enters the Block reference which then references the entire schedule of trips for the day commencing with the pull out and ending with the push back locations. The Driver will remain logged in until the ignition is turned off and the unit enters sleep mode.

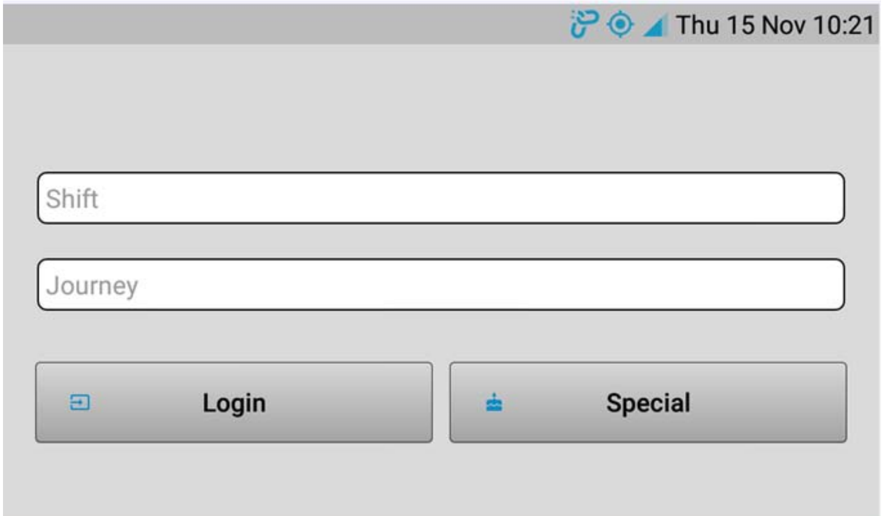


Figure 5: Login to Shift and Journey

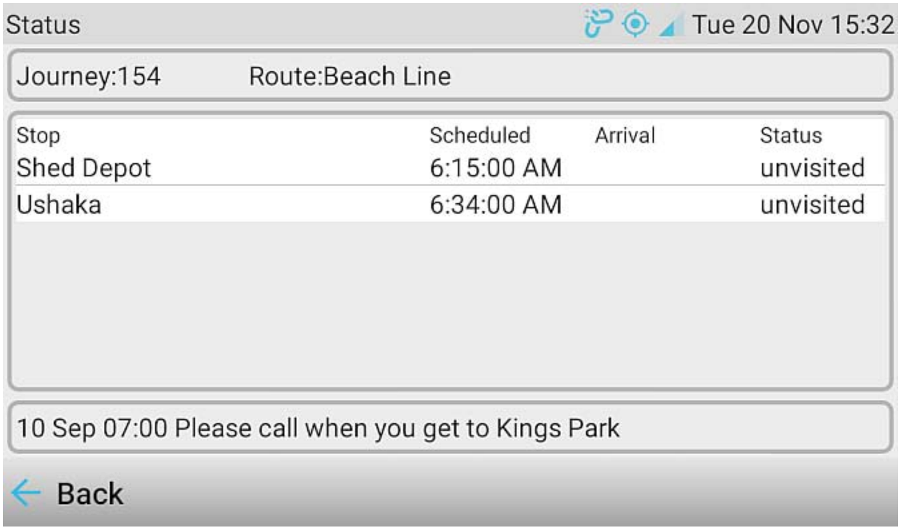
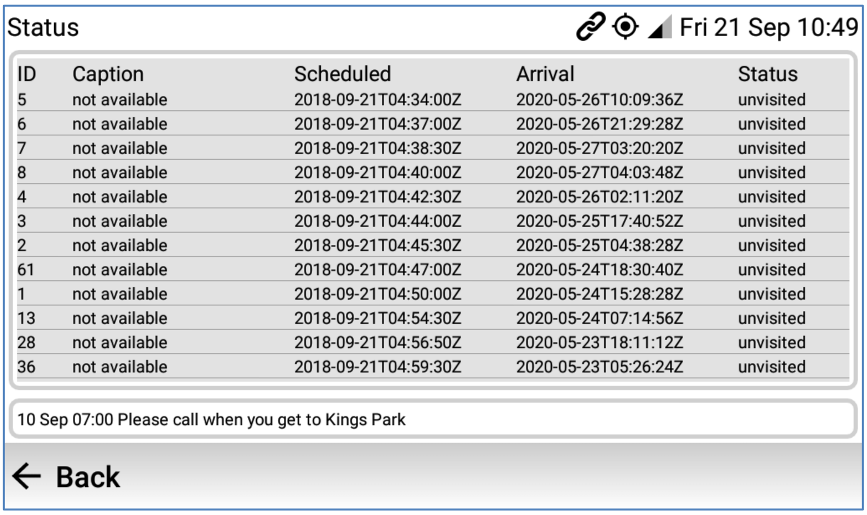


Figure 6: Driver Terminal Status

The home screen displays the current trip with the status for 3 stops (last, current and next), these scroll down automatically as the following stop is departed, with the exception where the last stop is reached when the next trip is automatically loaded (this can be edited if required should this not automatically occur).

There is a daily overview screen available that shows all the trips for the day and the associated status of the completed trips.



Status Fri 21 Sep 10:49

ID	Caption	Scheduled	Arrival	Status
5	not available	2018-09-21T04:34:00Z	2020-05-26T10:09:36Z	unvisited
6	not available	2018-09-21T04:37:00Z	2020-05-26T21:29:28Z	unvisited
7	not available	2018-09-21T04:38:30Z	2020-05-27T03:20:20Z	unvisited
8	not available	2018-09-21T04:40:00Z	2020-05-27T04:03:48Z	unvisited
4	not available	2018-09-21T04:42:30Z	2020-05-26T02:11:20Z	unvisited
3	not available	2018-09-21T04:44:00Z	2020-05-25T17:40:52Z	unvisited
2	not available	2018-09-21T04:45:30Z	2020-05-25T04:38:28Z	unvisited
61	not available	2018-09-21T04:47:00Z	2020-05-24T18:30:40Z	unvisited
1	not available	2018-09-21T04:50:00Z	2020-05-24T15:28:28Z	unvisited
13	not available	2018-09-21T04:54:30Z	2020-05-24T07:14:56Z	unvisited
28	not available	2018-09-21T04:56:50Z	2020-05-23T18:11:12Z	unvisited
36	not available	2018-09-21T04:59:30Z	2020-05-23T05:26:24Z	unvisited

10 Sep 07:00 Please call when you get to Kings Park

Back

Figure 7: Driver Terminal History Performance

The Driver Terminal also provides text communication with the TMC using a set of pre-defined messages:

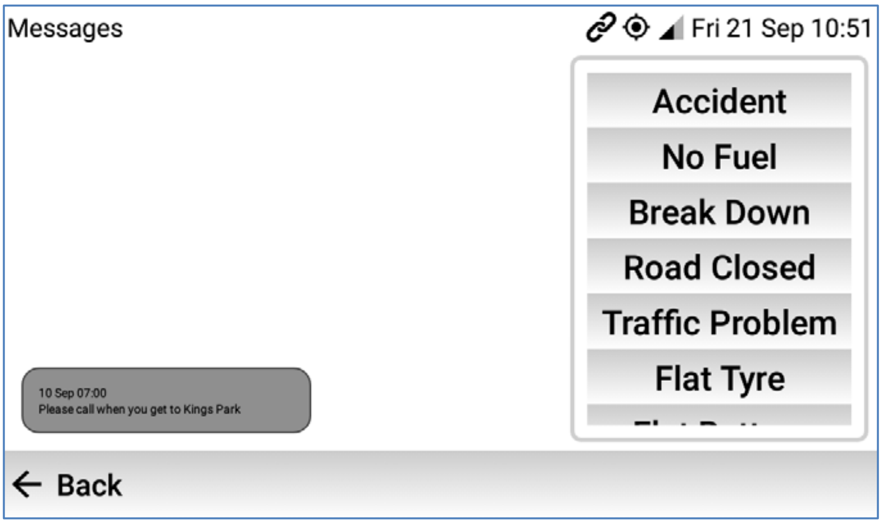


Figure 8: Driver Terminal Messaging

4.5 AVL System

The AVL system installed on the eThekwini fleet manages the spatial display and processing requirements for the system comprising two areas as follows;

- **Location stop processing**
  Stops and Depots are either imported or defined on the AVL system and comprise Polygons or simple Points of Interests (POI) that utilise a location and radius. Each location name is in accordance to a convention used in the schedules such that the compliance system can reference as a bus has entered or left a location on the schedule. The definition and establishment of these areas and locations formed part of the initial set up of the system and were updated as new routes and stops are added during the Proof of Concept.

- **Route deviation processing**
  Bus routes are defined in the AVL system and either drawn by hand on the GIS mapping, derived from trip history or imported from external GIS files. Each route comprises a specified road network with a deviation tolerance whereby an alarm is raised should the bus operate outside of the route. The route includes POI's and other specified areas required such as refuelling and maintenance areas. Each Route is named in accordance to the same convention used in the schedules. This enables the information received from the driver display unit to allocate the bus onto the specified route for adherence monitoring.

  During the Pilot Phase, the buses will be linked to all 3 routes concurrently (Approved Routes) and report route deviations locally on the AVL system UI.

- **Bus location and route display**
  The AVL system supports Client and Web user interfaces that provide controllers visibility of the bus, route and stop locations. Each controller workstation area has two screens as a minimum, one screen dedicated to the AVL with the other to the compliance management system. The AVL screen provides real time bus position and status information including alarms and alerts. Where required the controller can replay the bus trip on the AVL map to inspect the trip history whereby every position and event is displayed.

  The AVL system supports control rooms utilising multiple screens to make up a "video wall" with each screen dedicated to display predefined vehicles.

- **Voice and messaging communications**
  The vehicle equipment deployed for the AVL system supports hands free voice kits for the driver, comprising a call controller unit, microphone and speaker. The basic kit allows voice calls to the bus driver or from the bus driver to a dedicated pre-programmed number. Call control (answer, dial and volume) is via simple voice control unit mounted on the dashboard. All voice communication is by GSM and uses the SIM card on the AVL tracking unit, and for the Pilot Phase will not be integrated with the equipment included with the bus (microphone and speaker).

- **Text Communications**
  Text communications is supported on the driver console and includes free text and pre-configured messages. All messages are sent using the data channel on the driver console unit integrated to the CMS. The voice solution is free standing and not integrated into the CMS solution.

5. GAPS AND A STRATEGY TO DEAL WITH GAPS IN TERMS OF FUNCTIONALITY

The system, in its current form, is missing 2 key components provided by legacy or traditional APTMS. These are a Scheduler and Passenger Information Displays

5.1 Scheduling

The PTM Lite System has no functionality for scheduling. However, it is able to capture, edit and or import route and timetable information, and uses this information as the basis for its monitoring of operations.

3rd party scheduling software can therefore be procured as an independent module and the outputs from the scheduling software can be customised to the format for input to the Compliance Monitoring System. This functionality is therefore not deemed to be a significant gap that needs action.

5.2 Passenger Information

No passenger information is available from the system.

Go!Durban are planning to procure an application centric product, including a smartphone app, that can receive the static data (timetables and routes) and live AVL feeds from the PTM Lite System and supply the following functionality:

- Route planning.
- Static routes and timetables.
- Real time information on the status of buses.

The application centric product will be connected, via an interface, to the Passenger Information Displays on the station platforms to give real-time information on bus departures. The status of the bus will be determined using current delays experienced on route rather than complex algorithms that predict arrival times.

On-board information will be provided by a stand-alone system procured in the fleet tender. This simple system utilises pre-recorded messages (voice and visual) that are triggered using the bus GPS and geo-fences.

The system currently supports a GTFS output of the static information (route, stations and timetable) which is then available on Google Maps. In addition, real-time data is available for third party applications free of charge in a proprietary, and possibly GTFS, format. This provides the opportunity for further passenger information systems to be developed at no cost to the ETA.

5.3 Other Gaps

The ability to manage deviations in real-time and integrate the deviations into the passenger information and compliance reporting was also identified as a gap, however, was deemed to be a 'nice to have'. The system does allow for notes to be made against trips, where authorised deviations can be recorded for the purpose of compliance monitoring. This functionality will therefore not be developed for Go!Durban.

The Netstar PTM Lite System may not be suitable when other corridors (C1 and C9) and other services (rail and feeders) are introduced to the integrated network especially if there are going to be different operators and different services share the same infrastructure (stations and terminals). This will have to be evaluated in the future. It is possible that when more corridors and services are introduced to the network, a more traditional APTMS may need to be procured.

6. PERFORMANCE AND LESSONS LEARNT

The pilot project on the ETK People mover buses highlighted some issues with the system and IT environment.

The system initially recorded arrival times at stations and derived the departure time as a fixed period after this, however it was found that this was not accurate enough, due to varying conditions at stops, and the departure time was subsequently recorded.
It was found that, due to the CMS sharing bandwidth with the AVL system which is monitoring a large number of vehicles (2000+), network loading became an issue. This was overcome by firstly logically separating the PT vehicles from the general fleet, so their positional data could be prioritised, and secondly transferring the PT database onto a cloud.

One of the requirements was to be able to provide transit information on Google maps. This requires the provision of GTFS encoded data. This was done, however the process from initial data submission to Google acceptance and map display proved lengthy (>12 months).

7. EQUIVALENT COST COMPARISON OF THE PTMS LITE SOLUTION

The table below outlines costs for the PTM Lite System as well as legacy APTMS and also presents some costs for some other independent modules.

As can be seen the Hybrid solution will result in significant capital and operating expense savings on just one ITS component of the Go! Durban BRT system.

Table 3: Cost Summary (based on a fleet of 200 buses, 30 stations over 36 months)

Type of System	Description	Cost
Go!Durban APTMS Tender 2014	Full APTMS – Capex	R155 Million
	Full APTMS - Maintenance	R55 Million
PTMS Lite		
ETA PTMS basic component	AVL & compliance monitoring	R 6.5 Million
PID at stations	2 screens driven by simple software	R 4 Million
PID on buses	Next stop announcement and display	R 5 Million
Maintenance	3 years for all equipment & software	R 3.5 Million

8. CONCLUSION – THE BENEFIT FOR SOUTH AFRICAN CITIES

Concerns have been expressed about the operational costs of the various IPTN systems being rolled out in major cities of South Africa. ITS interventions have the reputation of being relatively expensive, with high maintenance requirements and costs. In order to drive down operational costs (and therefore subsidies) ITS practitioners have a significant role to play in looking for cost effective solutions.

The system presented here offers significant cost savings for capital and operating budgets. It offers an application centric solution for passenger information and provides all the essential functionality of a traditional APTMS at around a tenth of the cost. This should assist planners in their quest for a more financially sustainable public transport system.

It must be emphasised that Go! Durban has not developed a totally new and unique software solution that cannot be replicated elsewhere. An existing tracking company with standard tracking equipment and software are used as the basic system. Software customisation is then used to develop the relevant outputs for specific contract management and information systems. This has turned out to be very cost effective use of grant funding as has been demonstrated. Other cities may have different output requirements depending on their operating contract and how it is monitored and managed and therefore the CMS can easily be adapted to the output requirements for any contract management system using a standard tracking device and software.

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