URBAN AND INTER-URBAN PROVISION OF JOURNEY TIMES

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1 INTRODUCTION

This paper will discuss the use of a journey time monitoring system for assessing the performance of strategic traffic routes around the City of Edinburgh. It will also discuss the provision of that information for public dissemination through Variable Message Signs (VMS) and other media and highlight the validation process that must be gone through to ensure confidence in the data being provided. The challenges faced in creating a common link with the Traffic Scotland network for provision of journey time and other traffic information across the urban/inter-urban boundary will also be discussed.

1.1 Background

In 2004 the City of Edinburgh Council (CEC) commissioned a study to investigate how new technology could be introduced as the cornerstone of a new traffic management strategy. This stakeholder led Intelligent Transport System (ITS) Strategy developed into a comprehensive document which matched the operational demands of the city and surrounding region to the functions of a new traffic management system and set out a framework for implementation in a structured, informed and proactive way.

The need for the ITS Strategy was driven by the consideration of the impact that the tram and congestion charging would have on the city. The funding for the implementation of the strategy was to come from the congestion charge scheme with the goal of being in place for the implantation of the tram project. The subsequent rejection by the citizens of Edinburgh of the proposed congestion charging scheme created the need to consider alternative funding. A funding proposal was presented to SESTRAN in late 2005 which outlined the implementation of the technologies highlighted in the ITS strategy. The funding was secured for the financial years 2006/07 and 2007/08 and contracts let for the phased installation of the new traffic management system.

During the preparation of the deployment plan within the ITS strategy a decision was taken to ensure that any ITS equipment purchased for the City conformed to common standards. In the UK the common standards for such equipment are known as Urban Traffic Management and Control (UTMC). These common standards were jointly developed by the Department for Transport, end users and system suppliers to ensure interoperability of equipment and systems.

1.2 UTMC in Edinburgh

The new Urban Traffic Management and Control System for Edinburgh comprised a comprehensive Route Management and Car Parking Guidance System (for off street car parks), providing driver information on available car parking spaces via on-street signs. The core element in collating and controlling the information being supplied to the travelling public, the Common Data Base (CDB), formed the focus of this package. It was recognised that a key requirement of the system was information on road network status, and journey time monitoring was recognised as a key indicator required. An Automatic Number Plate Recognition (ANPR) based system was implemented in 2007/2008 to collate information on journeys into and out of Edinburgh and provide the information to the CDB, shown in Figure 1, allowing the information to be disseminated to the travelling public via website or on to other parties such as Traffic Scotland.

2 URBAN JOURNEY TIME MONITORING SYSTEM

The Journey Time Monitoring System (JTMS) utilises ANPR to monitor the road network and report incidents in close to real-time. When combined with other information sources the UTMC system can be used to undertake more effective management of the network by reacting to traffic problems through centralised traffic signal control and relaying travel information on variable message signs and other media. It also allows Edinburgh to monitor traffic and congestion statistics and any effects upon them of major policy or scheme initiatives.

The JTMS network was designed to cover all strategic roads in to and out of the City. The locations of the ANPR Cameras were constrained by the available infrastructure required to provide a secure location with power and access to communications connections. To reduce costs and avoid a proliferation of new street furniture traffic signal poles at controlled pedestrian crossings or junctions were used to site the majority of the cameras. Sites and camera locations were chosen that constrained the flow of vehicles over a tight path and provide enough vehicle head way to maximise the accuracy of ANPR cameras.

Although such monitoring is a key system role, the focus for road network users is on journey time information. It was decided that two forms of information would be provided:

1) For recurrent or regular congestion – journey time information would be provided
2) For non-recurrent congestion – information about the event, or if possible an indication of delay would be provided

This paper primarily deals with the issue of recurrent congestion and how the JTMS can be used in an automated fashion to provide this information to

the travelling public via the UTMC CDB. It should however also be noted that CEC are also considering how best to provide information regarding non-recurrent congestion to the travelling public with the support of Halcrow.
CEC intend to use the JTMS to act as a trigger to provide information about non-recurrent congestion in the near future.

To ensure that the journey times are reliably and accurately monitored both the cameras and resultant journey time links required validation. In total there are 51 sites and 635 links between these sites. This section will discuss the validation procedure used to check the performance of both the cameras and resultant links to ensure the system could effectively monitor journey times in near to real-time. This process is described in greater detail below.

2.1 System Validation

This Section will discuss the process to validate the performance of both the cameras and links formed by "pairing" of cameras.

Camera Validation

As part of the tendering process each supplier was asked to visit the proposed sites and sign up to Key Performance Indicators (KPI) against which the performance of the cameras would be measured. The KPI's used were:

- Capture rate – the percentage of Vehicle Registration Marks (VRMs) passing through the field of view of the camera that are fully visible and captured by the camera
- Capture Accuracy Rate – The percentage of VRMs captured which are correctly identified

To validate these KPI's it was required to capture video footage for each camera to cross check the number plates recognised by the camera against the vehicles that passed through the site. For each camera 30 minutes of video was recorded, in order to ensure at least 100 VRMs were available to be manually checked against the number plates recorded by the system.

The survey of the cameras was undertaken in November which is challenging due to both increased dirt on number plates and the light contrast problems caused by low direct winter sun. Even with those conditions the validation process showed the great majority of camera's either matched or exceeded the KPI proposed during the tender period. The contractor was required to rectify any cameras which fell short of the targeted level of accuracy.

Link Validation

The JTMS provides updated journey time information on all of the links coded within the system every 5 minutes. For each link it is possible to configure the type of smoothing function or filter used to help reduce the impact of stray journey times out with the general pattern of the reported average for that period. These can occur when buses or delivery vehicles travel through the link very slowly. Therefore it was required to manually process a sample of the raw packet information sent back from the camera through the smoothing function to validate the system performance.

A sample of the packets captured as part of the camera validation process were analysed to validate the calculation of the journey times by the system and to ensure that the encoded smoothing functions were performing correctly.

2.2 UTMC Integration

The JTMS is a powerful monitoring tool that allows assessments to be made on the performance of the network in almost real-time. However in order to look to use the information provided by the JTMS in an optimised manner there was a requirement to integrate it with the UTMC CDB. This allows more proactive control of the traffic network through strategy management and affords the possibility to disseminate the information out to the travelling public.

All of the 635 links configured within the JTMS are contained within the CDB and this information is updated every 5 minutes. However, it isn't feasible to view all of these links on the screen therefore only the main arterial routes are actively displayed with the remainder still available for operator review as and when required. The reduced requirement equated to 108 links being actively monitored. To ensure that meaningful information is displayed for these routes a validation exercise was undertaken to confirm that the configuration of the profile information was relevant to each link in the context it was being viewed.

The provision of information to the travelling public brings with it the continued expectation on the reliability of the information being supplied. The JTMS sends out the calculated journey time on each link within the network every 5 minutes and will smooth where possible the matched journey times to give a reliable average. However given that not all of the network is busy all of the time there are also instances where a journey time provided by the JTMS is for a single vehicle and that vehicle may not have travelled from the start to the end of the link without breaking their journey. This may not give a representative journey time suitable for sharing.

Therefore, before journey times are published from the CDB onto VMS or a website the following checks have been put in place at the link, route and corridor level being:

1. Match check

2. Profile check
3. Corridor check

The match check looks at the number of matches that have been used to calculate the journey time provided by the JTMS and is configurable by time of day.

The profile check looks at how far out of profile the current journey time is and is configurable by time of day.

The corridor check considers two similar routes configured to be in the same corridor and considers the difference in total route journey time.
Should a particular journey time fail any of the checks then the system can be set-up to blank the information. Blanking or removal of the information may occur on the first instance of the failure to meet with one of the above checks or with a configurable grace period in which the last known good journey time is provided until either the grace period ends or the one of the preceding journey times pass the checks. For example should a route be made up of four links and the reported journey time on any individual link fail a check that "time's out" then the information being displayed for the whole route is blanked as there cannot be confidence in the data being provided.

To test how these checks would work in practice a trial was undertaken.

Two routes were created in the west of the City; the A8 and the A71. These routes were chosen as they have similar journey times and also form a corridor which allows all of the checks to be tested. Figures 2 and 3 show the journey time that would have been displayed for each route given the configuration of a minimum number of 3 matches for the reported journey time, with a maximum deviation from profile of 200% and a corridor difference check of 10 minutes. One instance of a failed check was allowed before the system stopped reporting the journey time. These figures show each of the rules taking effect at different points in the day. As both routes were linked as part of a corridor they also show how the corridor link works in terms of the time difference between routes, with the peak that occurs at 9 am, and how the link checks cascade over both routes when a failed check on any link times out.

3 INTER-URBAN JOURNEY TIME SHARING

Traffic Scotland (TS) also has a JTMS on the trunk road network to the west of Edinburgh that utilises ANPR technology. This system includes cameras which provide journey times along the M8 to just west of Hermiston Gait roundabout. CEC and TS are working together to develop a process to allow sharing of journey times that will allow dissemination to the public of aggregate journey times from the trunk road network to the city centre and vice versa.

This section will discuss some of the challenges faced to date and the trial currently being undertaken to test the exchange of ANPR information and provide a commentary on the potential benefits of the provision of this information.

3.1 Linking networks

As stated above the TS ANPR network ends just west of Hermiston Gait. The Edinburgh system starts at Gogar and Calder roundabouts for the A8 and A71 respectively. Therefore there is a gap between the two networks, highlighted in Figure 4, which must be addressed before further work can be done.

The following sections will discuss the options that have been considered to facilitate data sharing and what is being implemented as part of the initial trial.

3.2 UTMC Open Protocol

Journey Time Monitoring Systems (JTMS) primarily use proprietary protocols to communicate between ANPR cameras at the roadside and the in-station.

These communication systems have been designed to be as efficient, and therefore cost effective, and secure as possible, using proprietary compression and authentication technology. However, with the advent of more inexpensive forms of communications networks, such as Digital Mesh Radio, as well as the ability to set up Virtual Private Networks (VPN) to ensure security, the potential to use standard protocols with higher bandwidth overheads can now be realised.

Generally the funding constraints and costs for procuring JTMS lead to the implementation occurring in a staged fashion. With a proprietary system of communication the client is likely to be locked into using the same supplier for all stages. Therefore, they are unable to take advantage of any advances by other suppliers, or demonstrate best value procurement by allowing each stage of works to be put to competitive tender.

To help CEC realise best value Halcrow carried out the initial development of a specification for an ANPR Data Object and MIB with information sent over standard transport data protocols. In 2008 Halcrow formed the UTMC ANPR Open Protocol working group by bringing together the key manufacturers of JTMS to define the specification of the new protocol. This working group submitted the final specification to the UTMC Development Group in 2009 and it was subsequently fully adopted at the UTMC conference in December last year.

In this instance for the sharing of data between the CEC and TS systems the in-stations will take the proprietary information and convert it to the open format before transmitting. Although this is not a complete UTMC solution in that the CEC in-station isn't talking directly to the TS camera it would be the simplest to implement rather than forcing any changes to equipment out on

site and is therefore going to be considered for implementation as an interim solution.

3.3 Initial Trial – Closing the Gap

At present both the CEC and TS in-stations require additional development work to implement an open protocol solution that would allow the two JTMS to exchange VRM information with each other. Therefore an interim solution has been put forward by IBI Group on behalf of TS to ensure the trial can progress requiring the temporary installation of CEC cameras at the same location as the TS cameras. i.e. on the M8 west of Hermiston Gate. This will allow the CEC system to create links between the camera's at the TS sites and those at the Maybury and Calder junctions.

Routes can be created from the M8 to the city centre via either the A8 or A71 and the journey times for those routes published incorporating the checking process discussed in Section 2.2 above.

The exchange of the journey times will then be done through DATEX II feeds produced by both the CEC and TS traffic management systems and allowing both systems to add in the external journey times for publication through their own channels.

3.4 Ongoing Data Sharing

It is hoped the initial trial will provide useful information to the travelling public. The long term solution is to incorporate the open protocol rather than installing additional equipment on-site. The use of the open protocol will also create a blue print for allowing TS to integrate with journey time monitoring systems owned by any other local authority with the ability to include the urban end of the journey time.

The DATEX II feeds being produced by the CEC traffic management system also incorporates the car park information for all of the park and ride site around Edinburgh and it is hoped that this information can also be supplied on trunk road variable message signs and potential to be used to trigger automatic changes to VMS legends on the trunk road.

4 FUTURE DEVELOPMENTS

Considerable work and investment has gone into the development of traffic management systems for Edinburgh since 2006. The system is now at the stage where the vast majority of the on-street equipment is in place.

This paper has considered the work being undertaken as part of the provision of journey time information. The feeds for the car park and variable message legend information are live and it is planned to have accurate local roadwork information being published by the end of the year.

Future stages for the development of the JTMS system and the provision of information to the travelling public within Edinburgh will relate to maximising active management of the road network and dissemination of useful travel information. This will include customisable content which will allow users to choose to receive only information relevant to their journey. For instance a bus passenger travelling into the City from Fife is unlikely to want to receive traffic information relating to the A701.

The creation of the DATEX II feeds from the traffic system is a major step in the provision of such information to other interested parties. Feeds have been created to allow for the provision of near real-time information on journey times, car park availability including park and rides site, variable message legends and traffic events which can be used by third parties.

In terms of using the new systems to more actively manage the network there are future aspirations for the use of traffic models, known as decision support systems, to aid in the prediction of traffic behaviour during incidents and to feed that back into traffic management plans. This is being considered in both offline and online modes. In the offline mode the traffic model would be used to look at historic incidents and take in the historic data stored by the system and look to create plans that could be put in place for an occurrence. In the online mode the traffic model would be used to monitor existing equipment to look for key triggers and then run simulations to determine the best way to resolve or mitigate the problems occurring on the network.

5 CONCLUSIONS

Work began on the installation of a new traffic management system for CEC in 2006. The main installation phases were completed during 2008. Work since then has been focused on validating and developing their operation prior to providing their output to the end users. This paper has highlighted the importance of ensuring any information to be provided to the travelling public is thoroughly validated, and has described the validation processes used by CEC.

The trial currently being progressed by CEC and TS to share journey time information across the urban/inter-urban boundary is part of this ongoing work to provide the travelling public with useful and timely information.

Further work on the UTMC systems will look at how dynamic traffic models can be used to help analyse historic network traffic situations offline and to act pro-actively in offering solutions on-line as they occur.

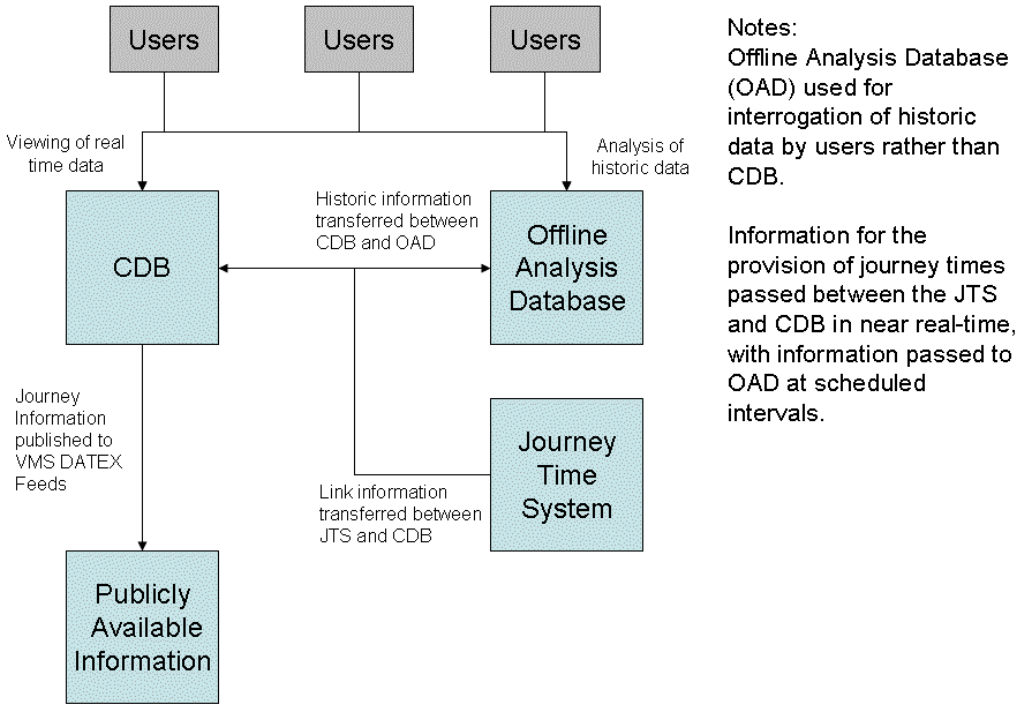

Figure 1 – Diagram of connectivity between JTS and CDB

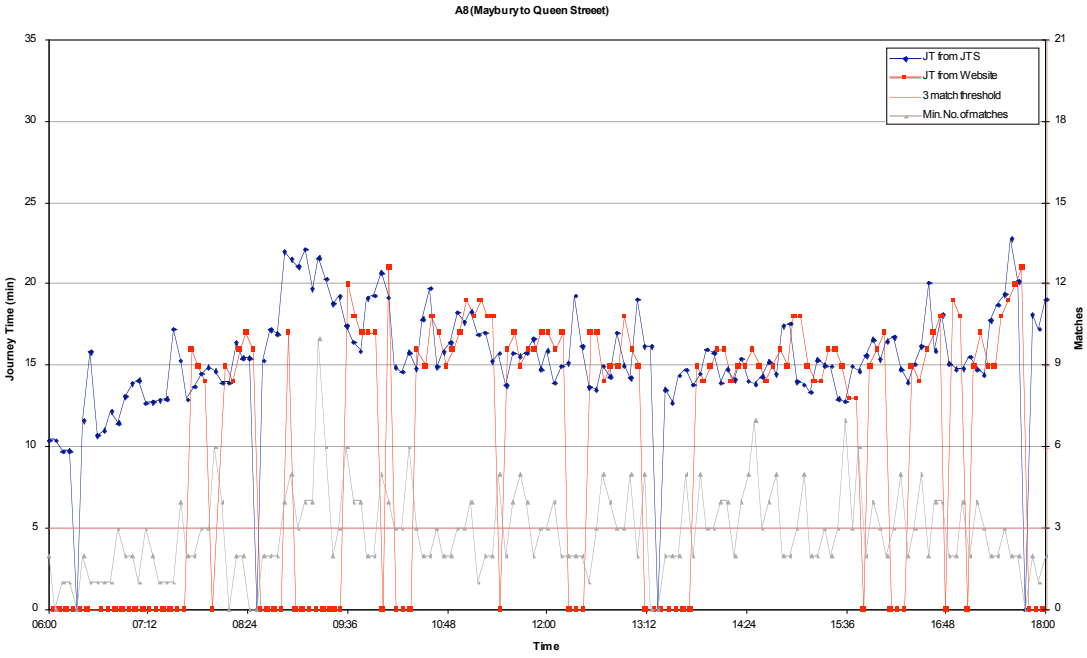

Figure 2 – Graph of journey times from A8 trial

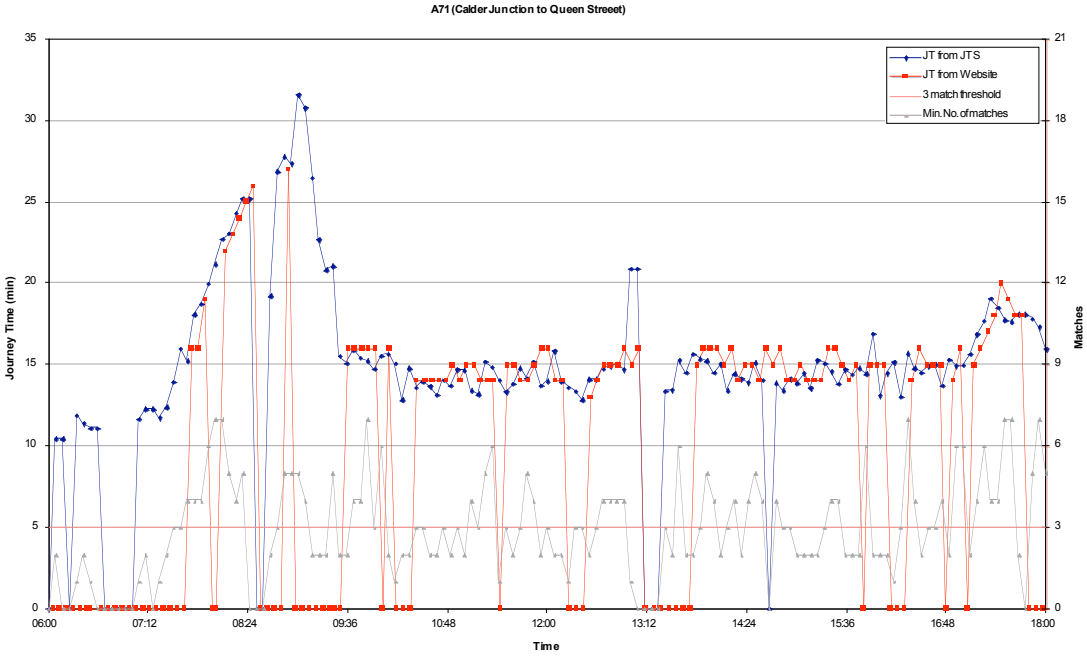

Figure 3 – Graph of journey times from A71 trial

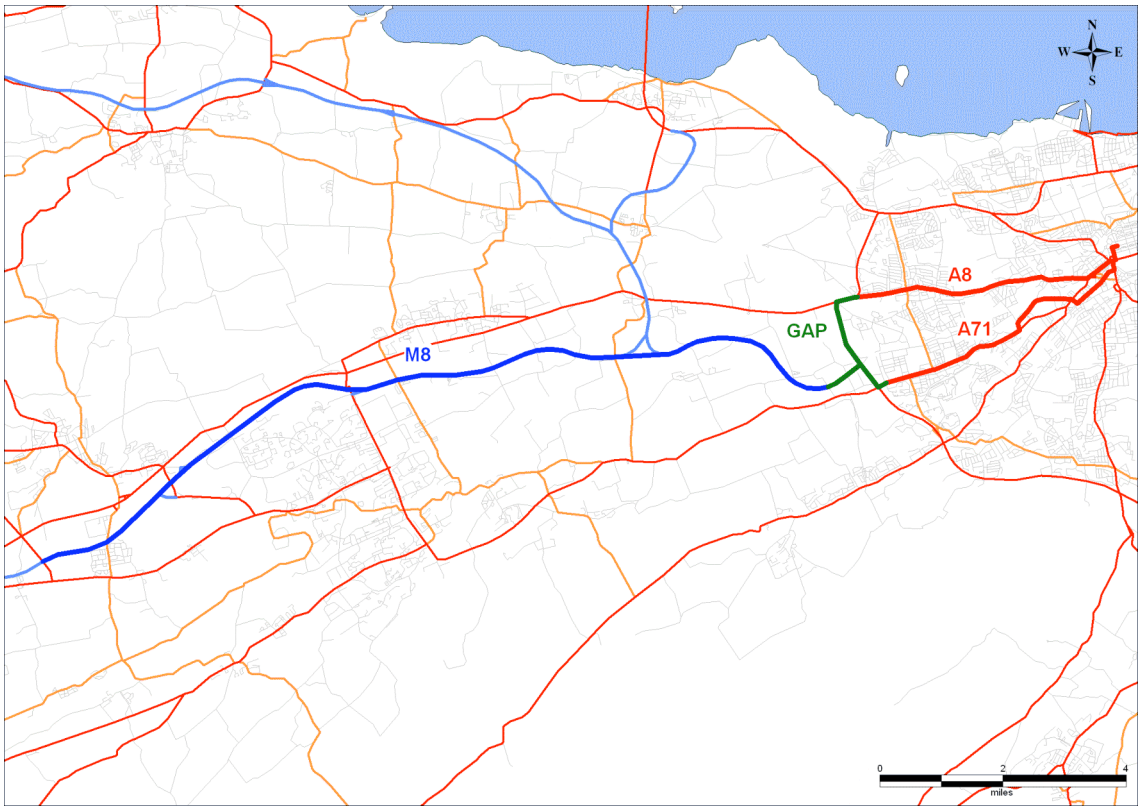

Figure 4 – Map showing gap between CEC and TS networks